Work Zone Safety and Mobility Manual

MDOT Michigan Department of Transportation

www.michigan.gov/mdotworkzones

Updated 12/3/2020

Work Zone Safety and Mobility Manual Content Managed by Work Zone Management Unit in Construction Field Services.

MICHIGAN DEPARTMENT OF TRANSPORTATION

WORK ZONE SAFETY AND MOBILITY MANUAL

Engineering Manual Preamble

This manual provides guidance to administrative, engineering, and technical staff. Engineering practice requires that professionals use a combination of technical skills and judgment in decision making. Engineering judgment is necessary to allow decisions to account for unique site-specific conditions and considerations to provide high quality products, within budget, and to protect the public health, safety, and welfare.

This manual provides the general operational guidelines; however, it is understood that adaptation, adjustments, and deviations are sometimes necessary. Innovation is a key foundational element to advance the state of engineering practice and develop more effective and efficient engineering solutions and materials. As such, it is essential that our engineering manuals provide a vehicle to promote, pilot, or implement technologies or practices that provide efficiencies and quality products, while maintaining the safety, health, and welfare of the public. It is expected when making significant or impactful deviations from the technical information from these guidance materials, that reasonable consultations with experts, technical committees, and/or policy setting bodies occur prior to actions within the timeframes allowed. It is also expected that these consultations will eliminate any potential conflicts of interest, perceived or otherwise. MDOT Leadership is committed to a culture of innovation to optimize engineering solutions.

The National Society of Professional Engineers Code of Ethics for Engineering is founded on six fundamental canons. Engineers, in the fulfillment of their professional duties, shall:

1. Hold paramount the safety, health, and welfare of the public.

2. Perform Services only in areas of their competence.

3. Issue public statement only in an objective and truthful manner.

4. Act for each employer or client as faithful agents or trustees.

5. Avoid deceptive acts.

6. Conduct themselves honorably, reasonably, ethically and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

WORK ZONE SAFETY MANUAL

CHAPTER 1

INDEX

INTRODUCTION

1.01 PURPOSE

1.02 PROCESS

1.02.01 Scoping Transportation Management Plan (TMP)

1.02.02 Development Transportation Management Plan (TMP)

A. Agency Coordination

1.02.03 Peer Review Team (PRT)

1.02.04 Peer Review Team (PRT) Submittal Process

1.02.05 Construction Transportation Management Plan (TMP)

A. Transportation Management Plan (TMP) Implementation
B. Work Zone Construction Peer Review (WZCPR)

1.02.06 Design Build Transportation Management Plan (TMP) Reviews

1.02.07 ATC Transportation Management Plan (TMP) Reviews

1.03 OPERATIONS AND MAINTENANCE

1.03.01 Restricted Routes

1.03.02 Non-Restricted Routes

1.03.03 Emergency Maintenance

1.04 UTILITIES AND PERMITS

1.04.01 Restricted Routes

1.04.02 Non-Restricted Routes

1.04.03 Emergency Operations

1.05 TRAINING

1.05.01 Annual Work Zone Training

1.05.02 TMP Training

1.05.03 Traffic Regulator Training

WORK ZONE SAFETY MANUAL

CHAPTER 2

INDEX

TRANSPORTATION MANAGEMENT PLAN (TMP)

2.01 PROJECT SIGNIFICANCE

2.01.01 Design Build Project Significance

2.01.02 ATC Project Significance

2.01.03 Local Agency Project Significance

2.02 TEMPORARY TRAFFIC CONTROL PLAN (TTCP)

2.02.01 Maintaining Traffic Typicals

2.02.02 Detour Routes

2.02.03 Multi-Modal Considerations

2.02.04 Special Provision for Maintaining Traffic

A. Boilerplate Document

2.02.05 Preliminary MOT Cost Estimate

2.02.06 Internal Traffic Control Plan (ITCP)

A. Review
B. Construction

2.02.07 Incentives / Disincentives (I/D)

2.02.08 Temporary Traffic Control Plan Strategies (TTCP)

2.02.09 Alternatives Analysis

2.03 TRAFFIC OPERATIONS PLAN (TOP)

2.03.01 Work Zone Mobility Analysis

A. Traffic Information
B. Travel Time Analysis

C. Queue Lengths Analysis
D. Operational Factors
E. User Delay Costs

2.04 WORK ZONE CRASH ANALYSIS

2.05 DESIGN CRASH ANALYSIS

2.05.01 Agency Coordination

2.06 TRAFFIC OPERATIONS PLAN STRATEGIES

2.07 PUBLIC INFORMATION PLAN (PIP)

2.07.01 Communication Plan

A Public/Stakeholder Information

2.07.02 Communication Methods & Strategies

2.08 PERFORMANCE ASSESSMENT PLAN (PAP)

2.09 FHWA FINAL RULE

2.10 WORK ZONE MONITORING

2.10.01 Work Zone Field Reviews

2.10.02 Work Zone Delay

A. Travel Time Delay

2.10.03 Work Zone Crashes

2.10.04 Work Zone Crashes during Construction

2.10.05 Program Performance Measures

2.10.06 Process Review

2.10.07 Statewide Project Review

2.10.08 Travel Time Delay

2.10.09 Work Zone Compliance

2.10.10 Statewide Work Zone Crash Evaluation

2.10.11 Customer Feedback and Perception

2.10.12 Project Review

WORK ZONE SAFETY MANUAL

CHAPTER 3

INDEX

MOBILITY ANALYSIS

3.01 Travel Time

3.01.01 Uninterrupted Flow Facilities

- **A.** Capacity Determination – Freeway
- **B.** Traffic Demand Determination
- **C.** Speed Delay
- **D.** Queue Delay

3.01.02 Traffic Regulator Operation

3.01.03 Temporary Traffic Signals

3.01.04 Interrupted Flow Facilities

- **A.** Control Delay Signalized Intersections
- **B.** Travel Time Determination

3.01.05 Detour Routes

3.02 OTHER MEASURES OF EFFECTIVENESS

3.03 MOBILITY ANALYSIS TOOLS

3.03.01 Construction, Congestion, Cost (CO3)

- **A.** Important Notes Regarding CO3 Inputs

3.03.02 Synchro and SIM Traffic

3.03.03 Synchro

- A. Important Notes when using Synchro for Signalized Work Zones

3.03.04 SIMTraffic

- A. Important Notes when using SIMTraffic for Signalized Work Zones

3.03.05 Highway Capacity Manual (HCM) and Highway Capacity Software (HCS)

3.03.06 PTV-VISSIM (Planung Transport Verkehr)
Vissim (Verkehr In Städten – SIMulationsmodell)

3.03.07 Travel Demand Models and Tools

A. TransCAD
B. DynaSmart-P
C. Regional Integrated Transportation Information Systems (RITIS)

WORK ZONE SAFETY MANUAL

CHAPTER 4

INDEX

WORK ZONE SAFETY

4.01 GENERAL

4.02 CONSTRUCTION AND CONTRACT METHODS

4.03 WORK ZONE CONSIDERATIONS

4.03.01 Work Zone Hazards

4.03.02 Workers

A. Traffic Regulators and Spotters

4.03.03 Road Users

A. Drivers
B. Non-Motorized Users
C. Oversized Vehicles

4.03.04 Work Zone Crash Reduction Strategies and Mitigations

4.04 WORK ZONE TRAFFIC INCIDENT MANAGEMENT (TIM) CONCEPTS

4.04.01 Assess Existing Processes and Procedures

4.04.02 Planning and Design

A. Identify Stakeholders
B. Establish Response Objectives and Procedure Guidelines
C. Determine Appropriate Levels of Response
D. Identifying and Evaluating Detection, Response, and Clearance Strategies
E. Develop and Distribute Response/Action Plan
F. TIM Training

4.05 WORK ZONE LAW ENFORCEMENT

4.05.01 Agreements, Documentation, & Strategies

WORK ZONE SAFETY MANUAL

CHAPTER 5

INDEX

NON-MOTORIZED WORK ZONE SAFETY AND MOBILITY

5.01 DEFINITIONS

5.01.01 Pedestrian Facilities

5.01.02 Bicycle Facilities

5.01.03 Recreational Facilities (Future)

5.02 DESIGN CONSIDERATIONS

A. Site Review
B. Data Collection
C. Feasibility Analysis
D. Non-motorized Design Guidance

5.03 DETOURS

5.03.01 Pedestrian

5.03.02 Bicycle (Future)

5.03.03 Recreational (Future)

5.04 Signing

5.04.01 Pedestrian

5.04.02 Bicycle (Future)

5.04.03 Recreational Vehicle (Future)

5.04.04 Channelizing Devices

5.04.05 Pedestrian Barriers

5.05 PATHWAYS, CROSSWALKS AND RAMPS

5.06 TRAFFIC SIGNALS

5.07 TRANSIT STOPS

5.08 GRADE SEPARATED CROSSINGS

5.09 NON-TRADITIONAL FEATURES

5.10 LIGHTING

WORK ZONE SAFETY MANUAL

CHAPTER 6

INDEX

TRAFFIC CONTROL DEVICES AND IMPLEMENTATION

6.01 TEMPORARY TRAFFIC CONTROL

6.01.01 Cones

6.01.02 Plastic Drums

6.01.03 42 Inch Channelizing Devices

6.01.04 Tubular Markers

6.01.05 Delineators

6.01.06 Barricades

6.01.07 Temporary Barriers

A. Movable Barriers
B. Mobile Barrier Walls
C. Water Filled Barrier
D. Barrier Endings (attenuation)
E. Mobile Attenuators

6.01.08 Temporary Signs

A. Ground-Driven Temporary Signing
B. Portable Temporary Signing
C. Portable Temporary Signing – Roll-up
D. Innovative Temporary Signing

6.01.09 Sign Covers

A. Directional Guide Signs
B. Overhead Signs
C. Regulatory Signs

6.01.10 Signing Coordination

6.01.11 Project Specific Signing

6.01.12 Temporary Pavement Markings

A. Pavement Marking Removal
B. Shift Markings
C. Temporary Raised Pavement Markers (TRPM), Type 3
D. Pavement Marking Cover
E. Curing Compound Removal
F. Edge Line Markings
G. Capital Preventive Maintenance (CPM) Projects

6.01.13 Lighting

6.01.14 Arrow Boards

6.01.15 Portable Changeable Message Sign (PCMS)

6.01.16 Temporary Traffic Signals

A. Temporary Mounted Signal System
B. Temporary Portable Signal System

6.01.17 Automated Flagger Assistance Device (AFAD)

6.01.18 Glare Screening

6.01.19 Transverse Temporary Rumble Strips

A. Fixed Temporary Transverse Rumble Strips – Freeway
B. Fixed Temporary Transverse Rumble Strips - Non- Freeway
C. Portable Temporary Transverse Rumble Strips - Non- Freeway

6.01.20 Existing Longitudinal Rumble Strips

6.01.21 Pilot Vehicles

6.01.22 Innovative Traffic Control Devices

6.01.23 Rolling Roadblocks

A. Work Activities
B. Construction
C. Operations Plan

6.02 SPEED LIMITS IN WORK ZONES

6.03 QUALITY GUIDELINES

6.03.01 Channelizing Device Quality Process

A. Process

6.04 DETOURS & ALTERNATE ROUTES

6.04.01 Full Road Closures

6.04.02 Directional Detours

6.04.03 Ramp Closures

6.04.04 Detour Signing

A. Sign Color and Sizes
B. End Detour
C. Portable Changeable Message Signs (PCMS)

6.05 GEOMETRIC DESIGN & SAFETY

6.05.01 Lane Transitions and Widths

6.05.02 Shy Distance and Buffer Zones

6.05.03 Work Zone Clear Zone

6.05.04 Vertical Under Clearance

6.05.05 Lane Edges

6.05.06 Freeway Ramps

6.05.07 Relocating Traffic

A. Road Way
B. Vertical and Horizontal Clearance
C. Objects within the clear zone
D. Shoulder Conditions

6.05.08 Value Engineering Change Proposals (VECP)

6.05.09 Transport Permits for Oversize (Weight, Width, Height, & Length) Vehicles

6.05.10 Temporary Median Crossovers

6.05.11 Traffic Control - Setup, Removal, and Stage Changes

A. Traffic Switch
B. Advance Warning of Traffic Switch Operations
C. Law Enforcement During Traffic Switch Operations

6.05.12 Nighttime Traffic Switches

A. Nighttime Lighting for Traffic Switch Operations
B. Lane Rental or Liquated Damage Assessments during Traffic Switch Operations

6.06 WORK ZONES, INTELLIGENT TRANSPORTATION SYSTEMS (ITS) AND TECHNOLOGY

6.06.01 Permanent Systems (cameras, detectors, signs)

6.06.02 Temporary Portable Cameras

6.06.03 Variable Speed Limits

6.06.04 Stopped Traffic Advisory System

6.06.05 Dynamic Lane Merge Systems (Early/Late Merge)

6.06.06 Highway Advisory Radio (HAR)

6.06.07 Portable Traffic Detectors/Sensors

6.06.08 Ramp Metering

6.06.09 Information Response Systems

A. Trucks Entering, Crossing, and Exiting
B. Temporary Speed Radar Trailers
C. Work Space Intrusion
D. Oversize Vehicle

6.06.10 Additional ITS Resources

WORK ZONE SAFETY MANUAL

CHAPTER 7

INDEX

WORK ZONE SAFETY AND MOBILITY ON FEDERALLY FUNDED LOCAL AGENCY PROJECTS

7.01 INTRODUCTION AND PURPOSE

7.02 LOCAL AGENCY POLICY BACKGROUND INFORMATION

7.03 IMPLEMENTING THE LOCAL AGENCY WZS&M POLICY

7.04 RECORDS RETENTION

WORK ZONE SAFETY MANUAL

CHAPTER 8

INDEX

MAINTENANCE AND SURVEYING OPERATIONS

8.01 INTRODUCTION

8.02 TYPICAL TRAFFIC CONTROL PLANS

8.03 WORK ZONE DEFINITION

8.04 WORK ZONE DURATIONS

8.04.01 Long-Term Stationary Work

8.04.02 Intermediary-Term Stationary Work

8.04.03 Short-Term Stationary Work

8.04.04 Short Duration Work

8.04.05 Mobile Work

8.05 MOBILITY AND SAFETY

8.06 GENERAL TRAFFIC CONTROL GUIDELINES

8.06.01 Regular Work Zone Inspections

8.06.02 Partial Lane Closures

8.06.03 Temporary Signs

A. Portable Signs

8.06.04 Existing Permanent Signs

8.06.05 Channelizing Devices

8.06.06 Traffic Regulators

8.06.07 Arrow Boards

8.07 MOBILE OPERATIONS

8.07.01 Adequate Sight Distance

8.07.02 Shadow Vehicles

8.07.03 Mobile Attenuators

8.07.04 Examples of Truck Mounted Attenuator Applications

8.07.05 Equipment Requirements for Truck Mounted Attenuator

8.08 SURVEY OPERATIONS

8.08.01 Working without TTCD

8.08.02 Setting up Traffic Control

8.08.03 Temporary Traffic Control Considerations

8.08.04 Surveying Operations, Locations, and Durations

8.08.05 Equipment Requirements for Truck Mounted Attenuator

WORK ZONE SAFETY MANUAL

CHAPTER 9

INDEX

APPENDICES

Appendix A
Project Development Process

Appendix B
Mobility Analysis Tool

Appendix C
TMP Examples and Best Practices

Appendix D
Travel Time Delay Sheet

Appendix E
2006 Guidelines to Establish Speed Limits in Work Zone

Appendix F
Portable Changeable Message Sign Guidelines

Appendix G
Resource Links

Appendix H
Traffic Regulator Zones

Appendix I
LCCA Maintenance of Traffic Flow Charts

Appendix J
MDOT Work Zone Forms

Appendix K
Temporary Sign Design Guidelines

Appendix L
Sample of Design Build TMP

Appendix M:
Sign Face Types – A, B, and C

ACRONYMS
(Updated 12/3/2020)

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
ADT	Average Daily Traffic
ANSI	American National Standards Institute
ATC	Alternative Technical Concept
ATSSA	American Traffic Safety Services Association
BTP	Bureau of Transportation Planning
BWBTOC	Blue Water Bridge Transportation Operations Center
CAADT	Commercial Annual Average Daily Traffic
CCS	Continuous Count Station
CIA	Construction Influence Area
CPM	Capital Preventive Maintenance
CPS	Construction Permit System
CO3	Construction, Congestion, Cost Software
CS	Control Section
DB	Design Build
DHV	Design Hour Volume
DUI	Driving Under the Influence
FHWA	Federal Highway Administration
FUSP	Frequently Used Special Provisions
GVMC	Grand Valley Metropolitan Council
HAR	Highway Advisory Radio
HCM	Highway Capacity Manual
HOV	High Occupancy Vehicle
I / D	Incentive / Disincentive
IC	Innovative Contracting
IDR	Inspector's Daily Report
ITS	Intelligent Transportation System
LA	Local Agency
LCCA	Life Cycle Cost Analysis
LOS	Level of Service
MA	Mobile Attenuator
MDOT	Michigan Department of Transportation
MMUTCD	Michigan Manual of Uniform Traffic Control Devices
MOT	Maintenance of Traffic
MPH	Miles per Hour
MPO	Metropolitan Planning Organization

MSP	Michigan State Police
NCHRP	National Highway Research Program
NTCIP	National Transportation Communications for ITS Protocol
PAP	Performance Assessment Plan
PCMS	Portable Changeable Message Sign
PI	Phase Initiator
PIP	Public Information Plan
POB	Point of Beginning
POE	Point of Ending
PPE	Personal Protective Equipment
PPS	Planning Division / Project Planning Section
PR	Physical Reference
PRT	Peer Review Team
PTR	Permanent Traffic Records
PTS	Portable Traffic Signal
RPA	Regional Planning Agencies
RID	Reference Information Documents
RITIS	Regional Integrated Transportation Information System
RTF	Rural Task Force
SEMGOC	Southeast Council of Governments
SEMTOC	Southeast Michigan Transportation Operations Center
SHS	Standard Highway Signs
STOC	Statewide Transportation Operations Center
STA	Stopped Traffic Advisory
STP	Statewide Transportation Planning
TACT	Technical Alternate Concept Traffic (Plan)
TAR	Traffic Analysis Request
TCDS	Traffic Count Data Base System
TCO	Temporary Traffic Control Order
TDMS	Transportation Data Management System
TIM	Traffic Incident Management
TMA	Truck Mounted Attenuator
TMP	Transportation Management Plan
TMS	Transportation Management System
TOC	Traffic Operations Center
TRPM	Temporary Raised Pavement Markings
TRIM	Traffic Regulator's Instruction Manual
TSC	Transportation Service Center

TSSAT	Traffic and Safety Statewide Alignment Team
TTC	Temporary Traffic Control
TTCP	Temporary Traffic Control Plan
V / C	Volume to Capacity Ratio
VECP	Value Engineering Change Proposal
VPH	Vehicles per hour
VPHPL	Vehicles per hour per lane
WMTOC	West Michigan Transportation Operations Center
WZMU	Work Zone Management Unit
WZCZ	Work Zone Clear Zone
WZDE	Work Zone Delivery Engineer
WZTCP	Work Zone Traffic Control Plan
WZCPR	Work Zone Construction Peer Review
WZSM	Work Zone Safety and Mobility
WZSMM	Work Zone Safety and Mobility Manual

CHAPTER 1

INTRODUCTION

The Michigan transportation system is critical to supporting a vibrant economy by moving traffic and freight safely and efficiently. Growing congestion on Michigan roads with an increased need to perform rehabilitation and reconstruction is resulting in complex challenges to maintain work zone safety and mobility.

1.01 PURPOSE

The Work Zone Safety and Mobility (WZSM) Rule outlined in federal regulation, 23 CFR 630 Subpart J, requires a policy for the systematic consideration and management of work zone impacts on all federal aid highway projects across all stages of project planning, development, construction and operations.

The WZSM Policy (Michigan Department of Transportation (MDOT) Guidance Document 10177, dated August 24, 2007) was established in accordance with the WZSM Rule outlined in 23 CFR 630 Subpart J, to improve safety and mobility in work zones by reducing congestion and traffic incidents. The policy is in agreement with, and does not supersede, State Transportation Commission Policy 10015, dated September 25, 1996.

The primary goals of the WZSM Rule and WZSM Policy are to reduce crashes and manage congestion due to work zones.

To accomplish these goals, a Transportation Management Plan (TMP) is necessary for consistent consideration of the safety and mobility impacts of work zones, and the development of strategies and plans to reduce work zone impacts on all projects.

A TMP is a dynamic document that provides strategies, elements, and details for managing WZSM impacts during construction, maintenance, permits, and local agency work zones. The TMP is updated and revised throughout the life of the project.

MDOT is committed to providing work zones with the highest level of safety and mobility possible, beginning with project planning and extending through construction and operations. Management and staff are responsible for ensuring the policy is implemented and sustained for safe and efficient travel throughout the State of Michigan.

The specific processes, procedures, and guidelines to support the implementation of the policy are developed and communicated herein. This manual also includes methods for the analysis of crash data, mobility analysis, and work zone process review procedures.

Variations from the policy and this manual may be considered, evaluated, and incorporated into specific projects on a case-by-case basis. Contact the Work Zone Delivery Engineer (WZDE) to determine if a variation may be acceptable.

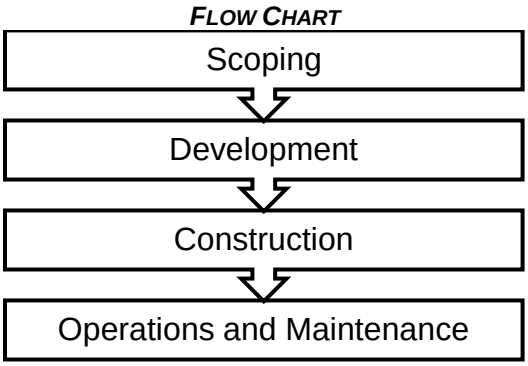
1.02 PROCESS (UPDATED 12/3/2020)

The TMP is introduced early in the project's life and is expanded and updated throughout the life of the project. The region / Transportation Service Center (TSC) staff determine during the early stages if a project is potentially significant or non-significant in relation to mobility impacts or contracting methods.

Projects are considered *significant* when they exceed the mobility threshold for the project or are developed using a contracting method as defined in Section 2.01 Project Significance.

The data and analysis included in the TMP varies depending on the active stage of the project. The typical project stages are summarized on **Exhibit 1-1**.

EXHIBIT 1-1: PROJECT DEVELOPMENT FLOW CHART



The process defined in the policy and this manual applies to all state trunklines regardless of the type of roadway or bridge facility, and will apply to construction, maintenance and permitted activity work zones. Each type of work zone should be analyzed in the same manner to provide consistency for travelers in Michigan. The project development process is shown in the Project Development Flow Chart in Appendix A and summarized herein. Additional information on the project development process is provided in Road Design Manual (Chapter 14-Procedures).

1.02.01 Scoping Transportation Management Plan (TMP)

Projects should be evaluated for safety and mobility impacts for all road users, including non-motorized users. The scoping TMP, if utilized, must ensure the constructability of the project and propose mitigation strategies as necessary. This work should be set-up with the job when it is programmed to ensure Planisware tasks are up-to-date.

If provided, the scoping TMP should be reviewed to ensure the project limits, proposed work type, and corresponding construction alternatives are accurate. The review should take place at the local office level to verify all items included are accurate and up-to-date.

1.02.02 Development Transportation Management Plan (TMP) (Updated 12/3/2020)

The Development phase includes preliminary engineering activities initiated for the project and updates to the analysis performed in the scoping TMP.

The scoping TMP is reviewed to ensure that the proposed work type and corresponding construction alternatives are accurate and updated in the development TMP.

The **Development TMP** must be submitted for review, on *significant* projects only, to the Region Operations Engineer, *after* the Plan Review and *prior* to the Final Project Coordination (FPC) meeting. The TMP must be submitted with an appropriate link that directs the review team to the appropriate files. Any updates to the TMP material after submittal should be sent to the Region Operations Engineer.

A. Agency Coordination

Local agency officials, statewide crews and MDOT maintenance coordinators should be contacted and encouraged to attend the Plan Review, OEC Review, and preconstruction meetings to provide input regarding schedules and coordination issues. The discussion should include a review of all aspects of the TMP to determine any necessary adjustments.

TSC staff will work with local agency officials on construction schedules, coordination issues, and to obtain required permits (such as noise variances, night work, etc.), prior to construction.

1.02.03 Peer Review Team (PRT) (Updated 12/3/2020)

To reduce delay on significant projects, all reasonable mitigation measures should be assessed to keep the delay below the project significance threshold limit as defined in Section 2.01 Project Significance. The project must be submitted to the PRT (Peer Review Team) for review when all reasonable mitigation has been implemented and the project exceeds the significance policy thresholds. The Peer Review Team (PRT) form, can be used for these reviews and can be found in Appendix J and the MDOT Forms Repository.

The PRT will be established to conduct independent reviews of projects and provide recommendations for review and approval before implementation. The team should include personnel independent of the TSC where the project was developed, and may include:

- Region Engineer
- TSC Manager
- WZMU
- Design Engineer
- Project Manager
- Construction Engineer
- Traffic and Safety Engineer
- Operations Engineer

Project reviews will be conducted as needed. Region personnel should contact the WZMU to invite a representative to the TMP review. It is the responsibility of the Region Operations Engineer or their designated representative to schedule and coordinate PRT meetings. It is recommended but not required that at least one person on the review team is from an outside region of similar traffic volumes to the project location.

1.02.04 Peer Review Team (PRT) Submittal Process (Updated 12/3/2020)

A TMP for a significant project must be submitted for review to the Region Operations Engineer, *after* the Plan Review, and *prior* to the Final Project Coordination (FPC) meeting. The TMP should be submitted with an appropriate link that directs the review team to all the appropriate files.

If documents within or related to the TMP are modified or updated after the TMP has been submitted and before the completed review, the submitter should notify the PRT of the changes. The PRT will need a point of contact for questions during the TMP review. This can be determined once the review date and time is scheduled.

1.02.05 Construction Transportation Management Plan (TMP)

The Construction TMP includes a review and update of the Development TMP and the Work Zone Traffic Control Plan (WZTCP).

The TMP should be reviewed prior to implementation to verify that field adjustments are not required. The TMP may also be discussed during the pre-construction meeting with the contractor and the local office overseeing the project to ensure all aspects of the plan are understood by all parties.

A. Transportation Management Plan (TMP) Implementation

The Construction Engineer overseeing the project is responsible for ensuring all aspects of the TMP are implemented in accordance with the WZSM Policy during the construction of the project.

Statewide, regional, and local maintenance personnel should be notified when construction, lane, roadway, or bridge closures are planned or implemented within their jurisdiction. Maintenance and permit projects may be conducted within the work zone. The Local Agency should be notified of on-going MDOT projects within their jurisdiction.

Work zone management occurs during the construction, maintenance or permitted activity construction phases. The TMP provisions should be implemented. The work zone should be monitored, measured, and documented using field observation and other pertinent methods.

B. Work Zone Construction Peer Review (WZCPR)

A WZCPR is a project field review of safety and mobility issues conducted to offer guidance and advice for improving safety and mobility on construction projects. Peer team reviews should be conducted after the local office has implemented mitigation measures and is still experiencing either mobility thresholds or crash rates that are exceeding the anticipated design analysis. The WZCPR Team will submit their findings and recommendations to the Region Engineer for review. The review will also be used to ensure consistent statewide mobility treatments and findings may be used as reference for crash mitigations for future projects.

Members of the WZCPR Team should consist of multidisciplinary personnel, similar to that of the PRT to ensure all aspects of the project are considered during the review. The team should be led by a member of the Work Zone Management Unit (WZMU), with at least one construction representative of the project under review.

1.02.06 Design Build Transportation Management Plan (TMP) Reviews (Updated 12/3/2020)

Design build projects require a modification to the traditional method for developing and reviewing a TMP. Therefore, the process will be modified as noted herein and referred to as a DB TMP.

The TMP review for a DB project should take place prior to the contract advertisement. The requirements detailed in the Design Build Book 2 (Project Requirements) Section 18 (Maintenance of Traffic) will be reviewed as the DB TMP. The following positions are considerations to be present for the DB TMP review:

- TSC Manager
- Work Zone Delivery Engineer, or designated representative(s)
- MDOT Project Manager or designated representative(Chair)
- MDOT Deputy Project Manager
- MDOT Construction Engineer
- Region or TSC Operation Engineer
- Region or TSC Traffic and Safety Engineer/Technician

Personnel from the Region or TSC in which the project is in should be used to reduce the review time required by staff due to project awareness.

The TSC Project Manager or a designated representative will Chair the review team and approve the contents of Design Build Book 2 (Project Requirements) Section 18 (Maintenance of Traffic). The submittals required per section 18.4 Deliverables, once reviewed and approved will be considered official documentation of the TMP. Plans must be approved by MDOT prior to any restriction in traffic or pedestrian access. These documents shall be signed and sealed by the Design Lead Traffic Engineer and signed by the Maintenance of Traffic Manager. These documents can be approved separately and are not required to be all inclusive in one submittal.

1.02.07 ATC Transportation Management Plan (TMP) Reviews (Added 12/3/2020)

Alternate Technical Concept (ATC) projects allows contractors the opportunity to propose changes to an advertised project that are equal to, or better than the advertised design. For this reason, the standard PRT and TMP process is modified as detailed herein for these types of projects. The required documents for this process will be referred to as an Innovative TMP.

During the development of an ATC project MDOT is responsible for selecting a base MOT design. To document any concerns during development, the Template Alternate Concept Traffic Plan (TACT Plan)will be required to be filled out and placed in the RID (Reference Information Documents). Contact the WZDE for information the current TACT Plan Process.

During the advertising period contractors will be able to submit alternate designs for review and approval as detailed in the MDOT ATC Procedure Guide. If approved, contractors can submit a bid based on that approved MOT design. The review and approval of the ATC's submitted by the contractor will qualify as the Innovative TMP review. The review team can be made up of members

from the local TSC. The low bid and project award will determine which alternative was deemed most applicable for the project.

If the MDOT base design is selected, then the TACT Plan, and the base MOT design will be considered the official Innovative TMP for the project files. If another MOT alternative is awarded the approved submittal will be added to the TACT Plan as an addendum and these documents will be considered the official Innovative TMP.

1.03 OPERATIONS AND MAINTENANCE (UPDATED 12/3/2020)

It is the responsibility of the operations engineer or a designated contact person to ensure that all state and contract maintenance activity is conducted in accordance with the WZSM Policy and Manual.

This includes the development of a TMP to appropriately mitigate and communicate any mobility and congestion issues within or adjacent to the work zone.

The maintenance and permitted activity work zones TMP should include the appropriate maintaining traffic details, work zone devices, and work requirements to address work zone safety and mobility impacts. Attachments to the TMP should also include analyses performed to determine time restrictions. Specific attention should be focused on the initial implementation of temporary traffic control and all temporary traffic control changes during staged construction.

Region/TSC Traffic and Safety staff may recommend times and days of the week to perform maintenance activities to reduce potential work zone impacts. Short duration (<3 days) maintenance activities that are scheduled to occur may be modified to accommodate local needs and reduce any potential work zone impacts to safety and mobility.

- A TMP is only required for maintenance work if that work is considered long-term stationary work (>3 days), as defined by the MMUTCD.

- Mobile activities should be reviewed with the Region / TSC Operations Engineer to determine the necessary level of documentation.

- Coordination with the Region/TSC Operations Engineer and the Traffic and Safety Engineer is required and mitigation measures need to be developed as part of the TMP.

1.03.01 Restricted Routes

The MDOT Mobility Map includes mobility time restrictions for MDOT facilities. Routes with mobility time restrictions may require a TMP if long-term stationary (>3 days) work activities occur during restricted hours and the project impacts are significant, according to Section 2.01 Project Significance.

1.03.02 Non-Restricted Routes

Routes that do not have time restrictions for work activities require advanced notice to the Operations Engineer or the designated contact person. The required Temporary Traffic Control Plan (TTCP) should be documented and discussed with the Region/TSC.

1.03.03 Emergency Maintenance (Updated 12/3/2020)

Emergency maintenance work is often of immediate nature and planning time is limited. To reduce impacts, maintenance staff should ensure the appropriate maintaining traffic details, temporary traffic control devices, work zone requirements, and public communications are implemented quickly. It is recommended that maintenance staff contact the TSC for assistance with the implementation of these items/actions.

The safety and mobility of the traveling public is still a primary factor in determining the TTCP for emergency work, but due to the limited timing and nature of the emergency work a formal TMP is not required. It is recommended that a meeting is held to discuss the impacts to traffic on emergency operations that are planned to have a duration of longer than 3 days.

1.04 UTILITIES AND PERMITS

Construction permit operations must be coordinated with other projects along the corridor or within the Construction Influence Area (CIA). Adjustments must be made during construction if work zone monitoring indicates the travel time or crashes have increased. Adjustments should be documented in the TMP. If work operations are unable to be performed outside of restrictions, the permit applicant or representative should submit a TTCP within the Construction Permit System. Contact the local MDOT Construction Permit Office for additional information.

1.04.01 Restricted Routes

See section 1.03.01

1.04.02 Non-Restricted Routes

See Section 1.03.02

1.04.03 Emergency Operations (Updated 12/3/2020)

Access to a site during an emergency should be by the most expeditious route. Work is to be completed in a manner which provides the traveling public with the maximum safety possible and minimizes traffic distribution.

MDOT and the law enforcement authority must be notified of emergency operations as soon as possible. The facility owner must also advise MDOT, prior to performance of work within the right-of-way. Should an emergency operation take place outside of MDOT work hours, the permittee must advise MDOT at the beginning of the first day, inside of MDOT work hours. MDOT may require a permit after the emergency work is complete, a formal TMP for emergency work is not required for reasons as stated in section 1.03.03.

1.05 TRAINING

Federal regulations require that persons involved in implementing the Work Zone Mobility and Safety Policy are trained at a level consistent with their responsibility. Training is required based on an individual's role and responsibility in implementing the policy in Michigan. This includes agencies, consultants, and contractors' staff involved in implementing the policy.

1.05.01 Annual Work Zone Training

The WZMU performs yearly work zone training updates during off-peak construction times. This training covers best practices and lessons learned from the prior year's construction review. In addition, any new or upcoming policies are discussed in detail. It is recommended that MDOT and consultants attend this training. To request training dates and times, please contact the WZMU.

1.05.02 TMP Training

A two-day classroom training is available and designed for all levels of experience. New methods and tools are continuously developed for work zones. The training is highly recommended for anyone developing or overseeing a TMP. To attend training contact the WZMU.

1.05.03 Traffic Regulator Training

Individuals involved in traffic regulating operations for work zones must be trained in traffic regulating. Training must occur no more than 12 months before performing traffic regulating operations.

At a minimum training should consist of viewing the video How to Safely Regulate Traffic in Michigan and reading the current MDOT handbook, Traffic Regulator's Instruction Manual.

Additional information on traffic regulator procedures and conduct is available through the following resources:

- www.michigan.gov/mdotworkzones
- MMUTCD Chapter 6 E
- 2012 Standard Specifications for Construction (Sections 812 and 922)

CHAPTER 2

TRANSPORTATION MANAGEMENT PLAN (TMP)

All construction projects require a TMP which is introduced early in the project and is expanded and updated throughout the life of the project. The data and analysis included in the TMP varies depending on the active project phase and project significance.

2.01 PROJECT SIGNIFICANCE (Updated 12/3/2020)

The Region and TSC staff will determine project significance, based on predicted mobility impacts, or contracting methods.

Significant Project: can be defined as one of the following:

- A project predicted to result in **greater than 10 minutes** of additional work zone delay, over normal conditions for the entire duration of the project.
- A project let as a Design Build
- A project let with an ATC for MOT.

Projects determined to be potentially significant require additional mobility analysis.

The level of detail included in the TMP is determined by the MDOT project manager. The impacts should be the determining factor in development of the project outreach and design.

A TMP on a significant project must include the following four (4) sections:

1. Temporary Traffic Control Plan (TTCP)

2. Traffic Operations Plan (TOP)

3. Public Information Plan (PIP)

4. Performance Assessment Plan (PAP)

A TMP on a non-significant project must include a TTCP, and the TSC must consider including the TOP, PIP, and PAP based on the project type, location and impacts.

An outline of the TMP development stages is shown in Appendix A: Project Development Process.

A Template TMP for both significant and non-significant projects are provided in appendix C.

2.01.01 Design Build Project Significance (Added 12/3/2020)

Design build projects are considered significant and must have a DB TMP. Requirements for this process are detailed in section 1.02.06. A sample of a design build TMP is included in Appendix L

2.01.02 ATC Project Significance (Added 12/3/2020)

ATC projects are considered significant and must have an Innovative TMP. Requirements for this process are detailed in section 1.02.07. The TACT Plan for ATC projects can be obtained by contacting the WZMU.

2.01.03 Local Agency Projects Significance (Added 12/3/2020)

Local Agency projects follow a separate process that is detailed in Chapter 7. A checklist and guidance for what the requirements are for TMPs Local Agency projects are detailed in that section.

2.02 TEMPORARY TRAFFIC CONTROL PLAN (TTCP)

A TTCP is required for all projects and contains maintenance of traffic information. The TTCP must include, maintaining traffic plans, details, special provisions, and contract documents (i.e. notice to bidder, progress clause, coordination clause, etc.). The Special Provision that describes the construction staging for the project is commonly called *The Special Provision for Maintaining Traffic*.

Items to include in the TTCP vary by project phase, mobility impact and are summarized in Appendix A Project Development Process.

2.02.01 Maintaining Traffic Typicals

The TTCP must include or reference all applicable maintaining traffic typical plans. The typical sections vary by work zone type and location. MDOT Work Zone Typicals may be found at:

- Maintaining Traffic Typicals
- Michigan Manual of Uniform Traffic Control Devices (MMUTCD Part 6)

Work zones may require further development of sample typical plans to address all project features. Plan sheets to cover these situations should be developed.

Work zones for construction, maintenance operations and other permitted activities should be implemented in the same manner for consistency.

2.02.02 Detour Routes

Detours and potential alternate routes during construction should be identified in the TTCP. Metropolitan Planning Organization (MPO) or Bureau of Transportation Planning

(BTP) statewide travel demand models can be used for corridor and network level impact assessment, to identify potential alternate routes, and assess detour options.

To identify potential detours and alternate routes, Region TSC staff are responsible for project coordination discussions with other transportation agencies in the vicinity of the proposed MDOT project.

If detours and alternate routes are necessary on non-MDOT roadways, discussions with affected local road agencies must occur to verify routes are capable of accommodating additional traffic volumes. Additional detour route design information and requirements are provided in Section 6.04 Detours and Alternate Routes.

2.02.03 Multi-Modal Considerations

Potential Transit, motorized, non-motorized and shared-use facility conflicts during construction should be anticipated and addressed in the TTCP. Construction activity conflicts should be reviewed, documented and mitigated in the TTCP. The TTCP should provide reasonably safe, convenient, and traversable paths that replicate, as practical, the most desirable characteristics of the existing facilities.

Transit drop-off / pick-up locations and activities must be addressed with the transit agency which may include a temporary site relocation.

Additional information and items to consider when developing the TTCP for pedestrians and bicycles are provided in:

- Chapter 5: Non-Motorized Work Zone Safety and Mobility
- Appendix A-Project Development Process

2.02.04 Special Provision for Maintaining Traffic (Updated 12/3/2020)

Project specific traffic restrictions and a suggested sequence of operations for traffic control should be provided in the special provision.

The *Special Provision for Maintaining Traffic* defines the TTCP for the Contractor, and may include:

- Detailed construction staging
- Maintaining traffic restrictions
- Project work
- Traffic control devices
- Construction influence area
- Temporary signing and pavement marking

- Measurement and payment of traffic items

- Estimate of temporary traffic control quantities

Work zone safety and mobility is heavily impacted during the commencement of traffic pattern modifications and the initial placement of temporary traffic control devices. These operations are ***extremely critical*** for overall work zone safety. Additional planning should be considered and documented in the TTCP.

Project staff should document which days of the week and times of the day, are the most conducive to altering or changing traffic patterns. This may reduce the impact of the initial traffic control changes and increase work zone safety.

It is the Contractor's responsibility to perform the construction activities and maintain traffic for the project according to the *Special Provision for Maintaining Traffic* and the Maintenance of Traffic (MOT) plans, unless otherwise approved by MDOT. Worker and motorist safety must be addressed when developing a plan to modify traffic conditions.

A. Boilerplate Document (Added 12/3/2020)

The MOT boilerplate, which is a template document for the creation of MOT Special Provisions, can be found here in Projectwise. The instructions for the document can be found here in the same folder. The MOT boilerplate is intended as a tool for engineers to use to help design MOTs on their projects and work towards consistency on a statewide level. The boilerplate language is to be edited so that only project-relevant language is used.

2.02.05 Preliminary MOT Cost Estimate

Cost estimates should be provided for alternative MOT options investigated as part of the TMP. These figures may justify the selection of the appropriate MOT. The scope and complexity of a project will dictate the level of detail needed in the estimating of alternatives.

Region Engineer notification is required if estimated maintaining traffic costs **exceed 25%** of the total project cost.

2.02.06 Internal Traffic Control Plan (ITCP) (Updated 12/3/2020)

The objective of the ITCP is to provide a safe traffic pattern and access plan for the contractor, equipment and materials, improving the overall safety of the work zone.

The ITCP is developed by the Contractor prior to beginning work on the project as detailed in the *Special Provision for Maintaining Traffic* and in the *Standard Specifications for Construction*, section 104.11B. The ITCP is a contract document and its development must incorporate all project specific requirements and restrictions found in the MOT SP.

The MOT will require either a Type A or Type B ITCP. Type A ITCPs should include the following information:

- Proposes ingress and egress locations for construction equipment and vehicles.
- Details Traffic control devices to warn the motoring public of ingress / egress locations.
- Outlines methods to ensure compliance with ITCP.
- Minimizes conflicts between construction vehicles and motorists and maintains overall safety.
- ITCP submitted at the preconstruction meeting.

Type B ITCPs should meet the following requirements:

- Proposes ingress and egress locations for construction equipment and vehicles.
- Details Traffic control devices to warn the motoring public of ingress / egress locations.
- Outlines methods to ensure compliance with ITCP.
- Minimizes conflicts between construction vehicles and motorists and maintains overall safety.
- Must include a minimum 600 foot acceleration and deceleration areas with a paved surface for ingress and egress locations.
- Includes a hauling schedule, that stays within the listed hauling restrictions.
- The ITCP submitted at least 14 days prior to all stage changes or major changes in traffic pattern.

A. Review

The Contractor must develop and submit for review an ITCP in accordance with the MOT to reduce conflicts within the work zone.

A plan for further communication of the provisions of the ITCP and the overall construction safety plan must be discussed at the pre-construction meeting. This includes briefing truck drivers on the following points:

- Accessing the project site

- Path to follow while traveling within the site.
- Where to stop for staging
- How a spotter will instruct them when working near other equipment
- Procedures for leaving the project area and re-entering traffic

B. Construction

The ITCP should be reviewed and updated on a regular basis at project safety meetings throughout the life of the project. The updated ITCP should be distributed to all personnel working on the project, including inspectors and all sub-contractors.

The prime contractor, safety officer or designated person for each work shift is responsible for monitoring and correcting non-compliant behavior.

2.02.07 Incentives / Disincentives (I/D)

I/D clauses may be used for a multitude of reasons not related to user delay. If the focus of use is user delay related, the I/D amount should be based on user delay costs.

The Mobility Analysis tools may be used to determine if an I/D clause is warranted. If warranted the tools can be used to estimate user costs.

The contract I/D should be included in the Progress Clause and should be noted in the TMP.

2.02.08 Temporary Traffic Control Plan Strategies (TTCP)

The following TTCP strategies may be useful for mitigating impacts on construction projects. They include strategies for use in the following categories:

- Operations
- Work restrictions
- Contracting Methods
- Coordination
- Traffic Control

  Large complex projects may incorporate a number of these strategies. Options listed below should be considered by project offices and engineering judgement should be utilized when determining appropriate strategies.

2.02.09 Alternatives Analysis

As part of the scoping and Call for Projects process, the proposed project work types' and corresponding construction alternatives should be analyzed and evaluated to determine the recommended scope of work for the project. Each work type and construction alternative will require a review of the appropriate TTCP, taking into consideration existing operational factors within the project limits.

The Associate Region Development Engineer approves the proposed work type. The construction alternatives including the approved project concept should be analyzed to determine the impact of the project on the existing roadway and adjacent corridors. Compare the results of the analysis with the existing conditions for use in the development of the TTCP.

On larger projects having a public survey to determine which method the locals would prefer is also an effective option. Public buy-in may allow for a more aggressive schedule, larger areas closed, but less construction time. If there are two equivalent methods, the public opinion is an item that can be used to make a final selection.

The alternative analysis should consider including the items summarized in Section 2.03.01 Work Zone Mobility Analysis.

Exhibit 2-1: Temporary Traffic Control Plan Strategies: Operations

• Facility Closure: full, partial, short term, ramps, approaches, detours, alternate routes
• Reduced shoulder and lane widths to maintain number of lanes
• Reduced length of work zone lane closures or impact area, segmenting work zone
• Lane closure to provide worker safety, increased lateral buffer
• Lane shift to shoulder / median to maintain number of lanes
• Temporary median crossovers in lieu of part-width construction activities (allows full work access to one-half of roadway)
• Split / Merge
• Temporary access: road approaches, work zone access, ramps
• Temporary connections: ramps, offset intersections
• Temporary or permanent widening to maintain traffic
• Overbuilding: beyond normal project needs to maintain additional traffic
• Alternating traffic on one-lane roadway
• One-way detour
• Reversible lanes (moveable barrier, signing, marking, etc…)
• Signal timing modifications within the project work zone and/or alternate and detour routes
• Pedestrian detour or accommodations
• Posted alternate routes
• Geometric and capacity improvements within the project limits or on alternate/detour routes (e.g. additional turn lanes, curb improvements, pavement markings, widening)
• Vehicle restrictions (trucks, oversize, local traffic, etc.)
• Emergency vehicle access
• Emergency pullouts for disabled vehicles or enforcement
• Alternative bridge designs: super girders, false work restrictions, temporary structures, bridge slide, accelerated bridge construction
• Existing rumble strip modifications as part of a traffic shift.
• Consider stage limits on arterial projects to minimize impacts to cross streets

EXHIBIT 2-2: TEMPORARY TRAFFIC CONTROL PLAN STRATEGIES: WORK RESTRICTIONS

• Night work requirements
• Weekend work requirements
• Weekday off-peak
• Hourly restrictions (e.g., no work or lane closures from 4:00 pm to 6:00 pm)
• Staged traffic control: moving work operations or unlimited work operation
• Accelerated work schedules: impact duration reduction
• Number of days to complete with full closure or significant delay (as defined in Section 2.01 Project Significance)

EXHIBIT 2-3: TEMPORARY TRAFFIC CONTROL PLAN STRATEGIES: CONTRACTING METHODS

• Incentive / Disincentive (I / D) clauses for early completion or open to traffic dates
• Lane rental
• Ramp rental
• Expedited schedules
• Innovative construction (pre-cast, rapid cure)
• Performance based traffic control: contractor incentives for efficiency and safety
• No Excuse project completion / open to traffic dates

EXHIBIT 2-4: TEMPORARY TRAFFIC CONTROL PLAN STRATEGIES: COORDINATION

• MDOT projects in area
• Local projects in area
• Local special events
• Large traffic generators
• Utility coordination
• Railroad coordination
• Permit coordination
• Incident response patrols (towing): delay reduction through quick response
• Law enforcement patrols: safety issues, speeding, driving under the influence (DUI), aggressive drivers

EXHIBIT 2-5: TEMPORARY TRAFFIC CONTROL PLAN STRATEGIES: TRAFFIC CONTROL

• Temporary signs (Warning, Regulatory, Guide, and Information Signs)
• Changeable message signs (both portable and static)
• Lighted arrow panels
• Channelizing devices (drums, 42" channelizing devices)
• Temporary pavement markings
• Traffic regulators
• Uniformed police officers for traffic control
• Temporary traffic signals
• Lighting devices for equipment or work zone
• Temporary barrier
• Mobile Attenuators
• Temporary rumble strips
• Work zone ITS traffic management: driver information, Stopped Traffic Advisory, demand management, late merge / early merge
• ITS devices and strategies
• Movable barrier systems or contra flow activities
• Temporary delineators/tubular markers
• Water-Filled Barrier

2.03 TRAFFIC OPERATIONS PLAN (TOP)

The TOP includes strategies and mitigation measures for operation and management of the work zone, adjacent network corridors and the facilities impacted by the work zone, including all transportation modes (roadway, transit, freight, rail, air, and pedestrians).

2.03.01 Work Zone Mobility Analysis (Updated 1/20/2020)

The work zone mobility analysis is detailed in Chapter 3 Mobility Analysis. The following information is necessary to perform the mobility analyses which should be included in the TOP.

A. Traffic Information

Most traffic information utilized during scoping, planning, and development phases can be found on the Transportation Data Management System (TDMS). Public traffic data information may be found through MDOT and local agencies. Contact the local MPO for additional resources, if not detailed below:

- MDOT TDMS
- RITIS
- GVMC TCDS
- Tri-County RPC - MPO TCDS
- SEMCOG TCDS
- KATS TCDS

Traffic data elements that may be available on these sites include:

- Traffic Data
  - Average Daily Traffic (ADT)
  - Commercial Annual Average Daily Traffic (CAADT)
  - Design Hour Volume (DHV) Percentage
  - Directional Distribution
  - Growth Rate
  - Hourly traffic volumes
  - Hourly vehicle classification volumes

- Permanent Traffic Records (PTR)
    - Hourly Volumes
    - Daily Volumes
    - Monthly and annual reports
    - Vehicle classification (limited locations)
    - Average speeds and speed distributions(limited locations)
- Operational Type Traffic Studies
    - Travel time (very limited)
    - Turning movements

If not available through TDMS or other sources, the traffic data necessary to support the analysis may be requested from BTP, Asset Management Division, Data Collection Section.

Complete MDOT Form 1776, Traffic Survey Request. It is important to define the traffic data needs early in the process to provide time to collect the data. Form 1776 is used to request for traffic data collection to be done at a given location (Turning movement or tube counts/class counts, for instance). The requestor will have to process the data.

If the necessary information is not available, the project manager may request additional data with MDOT Form 1730 Traffic Analysis Request.(TAR). Form 1730 is filled out by a planner who will interpret data/check for existing data and make assumptions to find out the required information.

The TAR includes:

- Traffic Projections
    - Project Route
    - Detour Route
- Traffic Data
    - ADT
    - CAADT
    - Percent CCADT

- Commercial DDHV
- Directional ADT
- 30th High Hour Total (DHV)
- 30th High Hour Directional (DDHV)
- AM Peak Hour Volume and Time
- PM Peak Hour Volume and Time
- Work Zone Traffic Diversion
- Vehicle Classification
- ESALs
- Medium/Heavy Trucks
- 24-Hour Traffic Distribution

B. Travel Time Analysis

The travel time analysis is dependent upon the type of roadway facility. Each roadway facility must be evaluated for the length of the project for existing conditions. Traffic volumes, speed, commercial vehicles, and roadway conditions may vary through the project corridor. It may be necessary to evaluate the roadway in sections to determine the total travel time.

The analysis must include the delay incurred at intersections (signalized and un-signalized) where applicable and must be performed for the existing conditions.

The travel time analysis must also include the peak periods of the day and the average off-peak hour for an average day ideally, during the construction season. Additional peak hour analysis may be necessary based on the site conditions and existing or proposed work zone operations. See Section 3.01 Travel Time for additional information regarding travel time analysis.

Regional Integrated Transportation Information System (RITIS) data may be used to supplement travel time runs for areas that have data available. The results should be checked against actual travel time runs.

During the scoping process, work zone travel time delay must be estimated. Travel time must be estimated for the work zone during construction and compared with existing conditions.

As the construction staging and existing operational factors are refined, the project must be confirmed for its significance according to Section 2.01 Project Significance.

C. Queue Lengths Analysis

Queue lengths provide a quantitative measure of when the demand exceeds capacity and a queue forms. Spreadsheet tools or software are helpful in performing the computation of queue delay since the accumulation and dissipation of queues may occur across multiple time periods. For additional information, see Section 3.03 Mobility Analysis Tools.

D. Operational Factors

The existing operational factors must be reviewed and documented in the TMP. The factors are necessary for determining work zone alternatives and impacts within the construction influence area.

Existing operational factors to be considered, include, but are not limited to the following:

- **Access**
  - Development Site Access
  - Parking Access
  - Emergency Services
  - Transit Routes
  - Local Considerations
  - Local Agency Projects
  - Other MDOT Projects
  - Noise / Work Restrictions
  - Schools
  - Special Events

- **Roadway Considerations**
  - Geometry / Lane Configurations
  - Height Clearance

- Over-width Clearance
- Railroads
- Roadside Hazards
- Traffic Signals
- Utilities

E. User Delay Costs

The user delay cost represents a portion of cost that results from people, goods, and services being delayed in work zone traffic. This information may be used to evaluate MOT alternatives and monetary contractual obligations, such as Liquidated Damages, for other departmental costs.

2.04 WORK ZONE CRASH ANALYSIS

An existing base line crash analysis is performed as part of the design process. In addition, a similar work zone set-up from a previous project should be reviewed to determine if a crash pattern existed and if mitigation measures can be utilized. If a similar location cannot be found, looking at the same work type on a different roadway type may provide valuable information. If you are not aware of a project for comparison, contact the WZMU.

Most work zone crashes are congestion related. Typical work zone crashes due to this condition are rear end crashes and are a result of traffic queues. Other contributions to work zone crashes are due to lane width restrictions and lane shifts in close proximity to fixed objects. The TTCP should include the proper traffic control devices to warn motorists of changes in road conditions.

2.05 DESIGN CRASH ANALYSIS

A detailed crash analysis should be completed for the normal roadway operation and for the various proposed construction staging options. Detour and alternate routes should be included in the analysis.

To perform an analysis, the Region/TSC Traffic & Safety Operations Engineer should perform the following steps:

- Identify a project similar location, size, traffic type and traffic control design that is already constructed.
- Determine the mile points of the project. Include the advance signing sequence and additional mileage to capture potential back of queue crashes.
- Retrieve crash data related to similar projects.

- Determine an average crash rate using the previous three years during the anticipated construction times.

- Determine what crashes occurred and where they occurred due to the work zone by reviewing individual crash reports.

  - *Are there correctible patterns or locations?*

- Determine what crashes occurred in the work zone not related to work zone activities.

  - *Are there correctible patterns or locations?*

- If no pattern exists, typical crash patterns can be expected to develop at interchanges, ingress/egress points, contractor access points and lane closures or shift locations.

  - *Are established best practices in use by MDOT that could be employed to reduce expected crash patterns?*

Following the review, determine if best practices or policies developed for a similar project exists and if relevant, apply it to the proposed project.

Designers are encouraged to investigate mitigation techniques employed by other TSCs for similar projects. The websites provided in Appendix G (Resources) and the list of common strategies and tools to reduce crashes in work zones in Section 4.03.04 Work Zone Crash Reduction Strategies and Mitigations may also offer potential mitigation techniques.

It is each region's responsibility to retain the information, analysis, and mitigation measures in project files.

Crash data is available using Roadsoft. The data may be obtained by contacting the Bureau of Development, Traffic and Safety Section. A delay may exist in the posting of the crash data in Roadsoft.

The safety goal for a work zone is to minimize the crash rate as much as possible. It may be possible to reduce the overall crash rates on roads under construction by implementing crash reducing maintaining traffic strategies depicted in Section 2.10.03 Work Zone Crashes.

2.05.01 Agency Coordination

MDOT should identify and contact local agencies during the design process to discuss MOT plans, special provisions and to further define the TOP.

The approved Five-Year Program includes initial project schedules from which the Region, BTP, and STP staff may begin mobility discussions with other road agencies and affected local government units (cities, villages, townships, Sovereign Nations, etc.) through the MPOs, Rural Task Force (RTF) and Regional Planning Agencies (RPA). Region or TSC

staff are responsible for leading project coordination discussions with other transportation agencies in the vicinity of proposed MDOT projects.

Discussions should include potential detours and alternate routes during construction to avoid conflicting local and trunkline work on parallel and adjacent routes. If potential conflicts are noted, region or TSC staff may need to contact the BTP for assistance in determining the project influence area and scope of roadways impacted, for projects determined significant as defined in Section 2.01 Project Significance.

The Region Traffic Safety & Operations Engineer should ensure the TMP considers the impacts of other projects in development along the corridor or within the CIA of the project.

Contact the BTP to coordinate network and corridor modeling for high impact projects (determined by PM). Travel demand models provided by the MPO, BTP, or consultant may be used to evaluate the following:

- Corridor and network level impact assessment
- Identify potential alternate routes
- Review detour route alternatives

The following local, regional, state, national and international agencies that may be included in discussions regarding the TOP:

- Local Government
- Local Police & Public Safety Department
- County Sheriff Department
- Michigan State Police
- Local Fire Department
- Medical Emergency Services
- Dispatch Centers
- Local Public Transit
- Regional Public Transit
- Railroads
- U.S. Customs and Border Protection
- Sovereign Nations

2.06 TRAFFIC OPERATIONS PLAN STRATEGIES

To reduce delay on significant projects, reasonable mitigation measures should be assessed to keep the delay below the threshold limits. TOP strategies may be useful when considering mitigating impacts on non-significant projects. They include strategies for use in the following categories:

- Demand Management
- Work Zone Safety
- Traffic Incident Management (TIM)

See Exhibits below for additional details.

EXHIBIT 2-6: TRAFFIC OPERATIONS PLAN STRATEGIES: DEMAND MANAGEMENT

• Transit service improvements
• Transit incentives
• Driver incentives: additional transit use and alternate route use
• Shuttle services
• Ridesharing / carpool programs and/or incentives
• Park and ride promotion strategies
• High occupancy vehicle (HOV) lanes
• Ramp metering
• Variable work hours
• Telecommuting

Exhibit 2-7: Traffic Operations Plan Strategies: Work Zone Safety

• ITS (including real time work zone systems)
• Attenuators (impact and truck-mounted)
• Bus turnouts
• Coordination with adjacent construction site(s)
• Freeway Courtesy Patrol
• Dynamic lane closure system
• Reflective panel for sign supports
• Moveable traffic barrier systems
• Off-site street and intersection improvements
• Parking restrictions
• Ramp closures
• Reversible lanes
• Road Safety Audits
• Temporary Rumble strips
• Safety award/Incentives
• Safety supervisors/inspectors
• Safety training
• Separate truck lane(s)
• Signal timing / coordination improvements
• Speed limit reductions
• Temporary traffic signals
• TMP monitor / inspection team
• Delineators / vertical panels / channelizing devices
• Turn restrictions
• Vehicle height / width / weight restrictions
• Work Zone Reviews
• Emergency Maintenance Repairs

EXHIBIT 2-8: TRAFFIC OPERATIONS PLAN STRATEGIES: TRAFFIC INCIDENT MANAGEMENT

• ITS for traffic monitoring/management
• TOC – coordination
• Freeway Courtesy Patrol
• Emergency responders coordination (first responders)
• Surveillance (closed circuit cameras, loop detectors)
• Enhanced mile-post markers
• Traffic screens
• Emergency turnarounds / access gates
• Emergency pull-offs for disabled vehicles
• Tow service patrol
• Media coordination
• Designated local detour routes / alternate route plans
• Contract support for TIM
• Incident / emergency management coordinator
• Incident / emergency response plan
• Dedicated funding for police enforcement
• Contingency plans (stand-by equipment and personnel)
• Traffic Responsive Signal Control Plans
• Dynamic Message Signs
• Call boxes

2.07 PUBLIC INFORMATION PLAN (PIP)

The PIP includes public/stakeholder information and communication strategies that will begin during the planning and design phases as well as during construction or operations activities. The PIP includes the most efficient method of communicating this information. The PIP is intended to create an organized and systematic process to communicate work zone information to the traveling public and respective stakeholders.

Information to the road user on routes, delay, and road information are typical applications. Additional information should include updates on active work and/or worker proximity.

Work zone impacts to pedestrians and bicyclist facilities should be incorporated in the project PIP. A pedestrian or bicyclist specific plan may be needed. Additional information is provided in Chapter 5: Non-Motorized Work Zone Safety and Mobility. Public meetings held for the project are often ideal places to incorporate a pedestrian/bicycle access component to address the concerns of the larger community.

A PIP is important for long-term, significant projects as defined in Section 2.01 Project Significance. The PIP should target the general public along with representatives from schools, community centers, parks, transit, and businesses in the area to alert them of upcoming changes and to advise them of the efforts taken to accommodate pedestrian needs.

2.07.01 Communication Plan (Updated 12/3/2020)

The PIP must be finalized based on the agreed project scope in coordination with the region communication representative, ensuring that project, corridor, and network ramifications are considered. The region communication representative should be an active member in the development and implementation of the PIP.

Design Build and Innovative Contracting projects, by nature, have a more expedited schedule. Conversations with the region communication representative should occur at the earliest possible convenience to ensure positive outcomes. Once a final MOT method is determined the PIP should be updated to address any changes or modifications.

A. Public/Stakeholder Information

It is necessary to communicate project information with both the public and stakeholders to maintain a safe work zone and efficient travel. The communicated information should include but is not limited to:

- Construction timeline
- Active work area dates and times
- Staged traffic changes with dates, times, and project specifics
- Brief work description
- Emergency events notification
- Alternate and detour routes

2.07.02 Communication Methods & Strategies

Communication of project information to the affected groups must be discussed in the PIP. There are several different communication methods and will vary by project type and location. It is recommended that the project specifics are communicated prior to construction and to establish relationships that will assist during construction.

EXHIBIT 2-9: PUBLIC INFORMATION PLAN STRATEGIES: PUBLIC AWARENESS

• Brochures and mailers
• Paid advertisements
• Public information center
• Telephone hotline
• Work zone education and safety campaign
• Media press release (newspapers, TV, radio, etc.)
• Social Media (Facebook, Twitter, YouTube, etc.)
• List on MDOT Road Construction map
• Public information meetings
• Lane closure website (MI Drive)
• Advanced global area signing
• Establish Email Listserv for project (include law enforcement, emergency services, local agencies and other contractors within the influence area)
• Stakeholder updates/meetings
• Visual information (videos, presentations) for meetings and web-based viewing
• Project specific website

EXHIBIT 2-10: PUBLIC INFORMATION PLAN STRATEGIES: MOTORIST

• Public Radio
• Portable changeable message signs & Dynamic Message Signs
• Global Informational Signage
• Freight travel information (Great Lakes Regional Transportation Operations Center (GLRTOC), MDOT Transport Permit Unit)

2.08 PERFORMANCE ASSESSMENT PLAN (PAP) (UPDATED 12/3/2020)

Once the project is under construction, the PAP includes documentation of traffic delays, travel times, queues, volumes, and associated information. The information will assist in the verification of data and if additional measures must be taken to amend the TMP. Traffic incidents (crashes, load spills, natural disasters, etc.) should be documented and analyzed to determine if work zone hazards have developed that require action.

The TSC Traffic & Safety Operations Engineer should be made aware of all traffic incidents in the work zone

Work zone safety and mobility should be monitored, measured, and documented during the construction phase of each significant project to verify the mitigation measures and strategies are performing as expected, as stated in the TMP. The TMP will be used as the basis for the project specific PAP.

2.09 FHWA FINAL RULE (UPDATED 12/3/2020)

Agencies are required to use work zone data at the project and process levels to manage and improve work zone safety and mobility per the provision in Section 630.1008(c) of the FHWA Work Zone Safety and Mobility Rule.

- The project-level requires agencies to use field observations, available work zone crash data, and operational information to manage the work zone impacts of individual projects while projects are under construction.

- The process-level requires agencies to analyze work zone crash and operational data from multiple projects to improve agency processes and procedures, and in turn continually pursue the improvement of overall work zone safety and mobility.

- Recommends that agencies maintain elements of the data and information resources that are necessary to support the use of work zone data for the above activities.

Work zone data is necessary to make an informed assessment of the effectiveness of efforts to manage work zones safety and mobility impacts. Work zone field data, which includes but is not limited to volume data, diversion rates, crash rates, site observations, shy distances, etc. It also enables agencies to assess how well planning and design estimates of anticipated impacts match what happens in the field. Work zone data should support performance assessments at both the project and program-levels. Available data and information provide the basis for assessing performance and taking appropriate actions to improve performance on individual projects as well as overall processes and procedures.

Each region is responsible for retaining information, analysis, and mitigation measures used in the project files.

2.10 WORK ZONE MONITORING

Traffic conditions in work zones should be monitored as determined by each region to verify assumptions and projections made during project development. Documentation of the findings and impacts of various techniques used to mitigate impacts will assist in the selection of mobility mitigation measures for future projects.

If monitoring of the work zone indicates that the actual delay times or crash rates have exceeded the anticipated thresholds, adjustments to the TOP need to be considered. When traffic operations, either directly within the project or along adjacent routes within the CIA, are not responding to the measures being implemented, additional changes need to be considered. Changes made to the TTCP or the TOP during any stage of the project may result in reevaluation. The cost and effectiveness of proposed TMP changes should be evaluated based on the mobility policy threshold criteria and all cost modifications should be approved by the Construction Engineer before implementation.

The following items may be used to document project incidents and activities:

- IDR's
- Evaluation reports
- Crash reports
- Traffic measuring devices (loops, tubes, radar, RITIS, etc.)
- Video cameras
- Additional devices or methods

2.10.01 Work Zone Field Reviews (Updated 12/3/2020)

Effective traffic control requires work zone reviews, during both daytime and nighttime conditions. The frequency of reviews for each project should be determined by the local office. The WZMU should provide at least one review per TSC per construction season, for consistency and alignment. The Work Zone Audit Report (Form 0397) should be used by personnel for work zone reviews.

Recommended adjustments to the TTCP during construction should be referred to the Construction Engineer overseeing the project for consideration. Region/TSC Traffic & Safety personnel should also employ the form for periodic review of the temporary traffic control throughout the duration of the project.

Project staff should be actively engaged with local and state law enforcement agencies, and emergency service providers to assure open communications concerning mobility and TIM.

Crash reports should be obtained as soon as they become available. Work zone crashes should be closely monitored and documented. A crash analysis should be performed to determine if corrective action is needed.

2.10.02 Work Zone Delay

Field measurements of actual travel times and delays should be continuously documented throughout the life of the project to assess mobility in the work zone.

If the field measurements show the anticipated design thresholds are exceeded, the Construction Engineer overseeing the project should consider further mitigation. If delays continue to exceed anticipated threshold levels, a Work Zone Construction Peer Review should also be considered.

Each region is responsible for updating and maintaining the information needed for their projects. The information may be utilized for evaluating project and program level effectiveness.

A. Travel Time Delay

The following report may be used for recording work zone travel time delay before, during and after each stage of construction. Work Zone Travel Time Delay Form. The worksheet includes evaluation of the following work zone delay criterion:

- Throughput
- Delays
- Unit travel times (i.e., minutes per mile traveled, also expressed as an average travel speed over the length of the roadway segment)
- Travel time reliability
- Traffic queues
- Additional travel time delay calculations may be performed using RITIS, Bluetooth, or other tools included in Section 3.03 Mobility Analysis Tools.

2.10.03 Work Zone Crashes

Work zone crashes should be documented and an analysis should be conducted. The data must include:

- Traffic crashes
- Crashes involving workers
- Non-motorized traffic

Lead workers, supervisors and/or contractors should communicate with the emergency personnel who respond to crashes within a work zone. Staff should consult with the Region/TSC Traffic & Safety Engineer and the WZCPR Team concerning potential adjustments to the work zone. This information will be used to improve safety on future projects.

Adjustments should be documented for future reference to mitigate work zone delays and crashes. Personnel may request and meet with the Region/TSC Traffic & Safety Operations Engineer to discuss the specific crash history for any route, segment or facility during work zone planning.

2.10.04 Work Zone Crashes during Construction (Updated 12/3/2020)

Monitoring work zone crashes during the project and reviewing potential corrective actions may help reduce or eliminate crashes. The Construction Engineer should assign a staff member to monitor work zone crashes during the project. Crash reviews may also indicate no corrective action is needed. The monitor should establish open communication with law enforcement agencies that patrol the project and request notification of crashes and collect crash report information as soon as it is available.

Project staff should provide project information to towing companies or provide a towing service on the project to keep roadways clear. Towing services should be included in the TTCP design when shoulder width is limited or when no emergency pull-offs exist.

The project staff should work with emergency service, and first responders to develop incident response plans. Incident responders are responsible for the protection of the incident area. Incident response plans should contain provisions to initiate site protection with the goal of reopening the lanes or roadway as safely and quickly as possible.

On-site inspections and constructive input by staff, not specifically assigned to the project, should be encouraged. Those less familiar may observe additional items that benefit the project.

Project staff should notify the Work Zone Unit within 12 hours of a known fatal or potentially fatal (type k) crash within a work zone or queue related to a work zone. The project office should notify the Work Zone Unit within 24 hours of a serious (type A) crash if the crash injures a worker, or damages contractor equipment (ie, PCMS boards, arrow boards, etc..). The Work Zone Unit monitors and reports fatal and serious work zone crashes to determine if crashes can be avoidable in the future. Notification can be made by phone call, e-mail, or text.

Modifications or changes to the work zone based on field feedback should be shared with the design staff. This allows the items to be addressed in future work zone designs.

When issues occur that cannot be corrected at the project level, assistance can be requested from the WZMU or a Work Zone Construction Peer Review as detailed in section 1.02.05.B.

2.10.05 Program Performance Measures (Updated 12/3/2020)

Performance measures are evaluated to ensure successful implementation and continual improvement of MDOT's Work Zone Safety and Mobility Policy. The construction phase and the post construction season evaluation are the focus of these measures.

The WZMU will share (when available) data collection techniques and best practices utilized throughout MDOT regions to standardize the mobility analyses and post-season assessments process, to ensure efficiency and effectiveness.

2.10.06 Process Review (Updated 12/3/2020)

On a biennial basis, a process review must also be conducted that includes an overall assessment of the WZSM Policy. This review will be administered by the WZMU and will be provided to the FHWA, Michigan Division, to provide an assessment of policy implementation with respect to Federal WZSM Rule. Suggested improvements to the manual may also be included in the report.

2.10.07 Statewide Project Review

Statewide level measures may include evaluation of how many or what percentage of significant projects meet policy goals. The following items should be considered for program reviews:

- **Travel Time Delay**
  How many projects were able to meet the 10 minutes work zone delay threshold?

- **TMP**
  How many projects were in substantial compliance with TMP requirements?

- **Work Zone Compliance**
  How many projects received satisfactory work zone safety review ratings?

- **Work Zone Crashes**
  How many projects experienced a change in crash patterns (and/or rates) both positive and negative, during the project duration?

Program review results may be used to determine focus areas for the biennial process review and will help evaluate project significance thresholds. Calibrating the customer's perception of what is tolerable compared to the established threshold may vary by region or area.

2.10.08 Travel Time Delay (Updated 12/3/2020)

Travel time delay is the most understandable and quantifiable parameter to the motorist and is considered the primary program-level measure for achieving mobility goals.

Tolerable delays within a work zone have been established according to the mobility thresholds as defined in Section 2.01 Project Significance. The success of the WZSM

Policy depends directly on how often a motorist actually experiences work zone impacts that are perceived as intolerable.

Actual travel time delays should be periodically measured by field personnel during typical peak traffic periods. A sample field data collection sheet is provided in Appendix D. Software can be used for determining time delays, however those measurements should be verified by field measurements from personnel on the ground.

For high-volume sections, automated devices may also be utilized for data collection, to determine travel times. For more information, refer to Section 3.03 Mobility Analysis Tools.

Travel time measurements serve two primary purposes:

- Monitor and ensure vehicle delays remain at or below predicted delay levels.
- When a project delay exceeds the anticipated work zone delay, the Construction Engineer should be notified and mitigation measures assessed and implemented.

2.10.09 Work Zone Compliance

A work zone survey may be distributed on an annual basis by the WZMU to each region to determine focus areas for the following construction season.

Each region should review ongoing projects and make necessary adjustments during the construction season. For each project review, a standardized report (Form 0397) may be completed that will yield the following determination.

- Was the work zone in substantial compliance with the provisions of the contract documents or agreements during the review?

2.10.10 Statewide Work Zone Crash Evaluation

The WZMU will perform a yearly high level work zone crash analysis. Each Region may compile a summary report of work zone crash data for submittal to the WZMU for analysis. The summary may display the number (or percentage) of projects that showed an increase or decrease in crashes during construction from pre-construction conditions.

Crash data from the period beginning on the start date of the construction project and ending on the completion date of the project, may be compared to crash data from the same period for the previous three years. This detailed review is a best practice and should be considered when the overall volume of crashes increases for the region compared to the previous year.

Assistance may be available from the WZMU if all the required project information (dates and locations) is provided. Noticeable and noteworthy trends detailing when and where crashes have increased will be presented during work zone safety trainings. For more detail, refer to Section 2.04 Crash Analysis for more detail).

2.10.11 Customer Feedback and Perception

Customer feedback is essential for assessing whether the current project significance thresholds match what motorist consider tolerable as defined in Section 2.01 Project Significance. The effectiveness of the policy will also be assessed and may be calibrated to what motorists consider tolerable

2.10.12 Project Review

The provision pertaining to use of work zone data is provided in Section 630.1008(c) of the WZSM Rule. It requires agencies to continually pursue improvement of work zone safety and mobility by analyzing work zone crash and operational data from multiple projects to improve agency processes and procedures.

Work zone data may be used to conduct post-construction evaluations, support process reviews, develop lessons learned, and ultimately improve agency policies and procedures. This data is typically available during project implementation and must be documented for post-construction analyses. It should include project contacts, supporting data, analysis techniques and results, work zone monitoring data, work zone reviews, and other related information. Project-level performance measures are summarized as follows:

- Roadway type
- Total delay field measurements
- Work zone audit reports
- Traffic crashes
- Public Feedback

CHAPTER 3

MOBILITY ANALYSIS

The mobility analysis process should be applied to all projects and related activities to determine work zone mobility impacts needing further review, mitigation, or approval. The mobility analysis is vital and should be initiated during the planning phase. Significance threshold is based on work zone travel time delay as defined in Section 2.01 Project Significance.

The most common tool used at MDOT for mobility analysis is a Construction Congestion Cost (CO^3) tool. CO^3 is used for uninterrupted flow, including traffic regulator operations. Other methods can also be used to supplement the mobility analysis.

3.01 TRAVEL TIME

The travel time delay should be estimated for the work zone to determine project significance as defined in Section 2.01 Project Significance. Consideration should be given to:

- Speed delay: Results from the reduced travel speed in the work zone, in comparison to the existing condition. This is affected by the temporary speed limit and by the capacity of the work zone.

- Queue delay: Additional time vehicles spend waiting in a queue. This is a result of the accumulation of vehicles upstream of a capacity reduction (i.e. a lane closure) when the demand exceeds the capacity.

- Control delay: Interruptions in traffic flow caused by temporary traffic control devices.

  Interruptions occur on all roadway types and include planned events (i.e. traffic regulators, temporary signals, temporary traffic stoppages).

Past experience should also be a factor when estimating travel times. Diversion rate of past projects in similar locations should be utilized to refine your estimation of work zone delay.

3.01.01 Un-interrupted Flow Facilities

Computing travel time for uninterrupted flow facilities (i.e. freeways or non-freeway without stop controlled or signal controlled intersections) consists of determining the speed delay and the queue delay.

A. Capacity Determination – Freeway

Table 3-1 Base Mainline Capacity and Table 3-2 Capacity Adjustment Factors should be used to estimate the capacity for each open lane. Apply factors known to adjust the base work zone capacity.

To begin the development of traffic control options, determine the number of lanes needed to handle the expected demand. An early check of available roadway capacity is critical as the vast majority of additional delay due to a work zone occurs when demand exceeds capacity for any appreciable length of time. The Highway Capacity Manual (HCM) Equation 10-9 can be used to determine the resulting adjusted capacity of the roadway lane:

$$\boldsymbol{C_a} = \{[(\boldsymbol{C_b} + \boldsymbol{I_g} + \boldsymbol{I_{wt}} + \boldsymbol{I_{wa}}) \times \boldsymbol{f_{hv}} \times \boldsymbol{f_{lw}} \times \boldsymbol{f_{sc}}] \times \boldsymbol{N}\} - \boldsymbol{R}$$

Where:

$\boldsymbol{C_a}$ = adjusted mainline capacity - vehicles per hour (vph)

$\boldsymbol{C_b}$= base mainline capacity - vehicles per hour per lane (vphpl)

$\boldsymbol{I_g}$ = adjustment factor for geometrics (ranges from –150 to +250 vphpl, could be zero). Select multiple factors that apply depending on the conditions; apply the cumulative adjustment factor.

$\boldsymbol{I_{wt}}$ = adjustment factor for intensity of the work activity (ranges from –200 to +200 vphpl, could be zero). Select one factor.

$\boldsymbol{I_{wa}}$ = adjustment factor for location of the work activity (ranges from –150 to +200 vphpl). Select one factor.

$\boldsymbol{f_{hv}}$ = adjustment for heavy vehicles as defined in HCM Equation 10-8. Values have been provided for typical truck volume ranges

$\boldsymbol{f_{lw}}$ = adjustment for lane/shoulder widths

$\boldsymbol{f_{sc}}$ = adjustment for lane/shoulder side clearance

$\boldsymbol{N}$ = number of lanes open through the work zone

$\boldsymbol{R}$ = manual adjustment for entrance ramps (vph).

The adjustment factor for work zone geometrics may be considered cumulatively. For example, work zone geometry when traffic uses a crossover and requires a traffic shift >3 feet would apply the cumulative effect of each condition as a part of the adjustment factor.

When determining the factors engineering judgement should be used to determine if the factors should be applied cumulatively.
The base mainline capacity ***(C_b)*** and work zone capacity adjustment factors are provided in the tables below.

Table 3-1: Base Mainline Capacity

Number of Lanes		Starting Capacity per Lane
Normal	Open	C_b
3	1	1400
2	1	1550
5	2	1600
4	2	1700
3	2	1700
4	3	1750

*Table 3-2: Capacity Adjustment Factors****

Work Zone Conditions**	Capacity Adjustment Factors*		
Geometry: traffic uses crossover	I_g	Subtract	150 vphpl
Geometry: traffic driving on shoulder		Subtract	150 vphpl
Geometry: traffic shift (>3 feet)		Subtract	100 vphpl
Geometry: work activity adjacent, protected with temporary barrier		Add	250 vphpl
Geometry: work activity adjacent (< 15 feet), protected by channelizing devices		Subtract	100 vphpl
Work Type: pavement repairs (concrete or HMA)	I_{wt}	Subtract	200 vphpl
Work Type: rubblizing, reconstruction		Subtract	150 vphpl
Work Type: overhead activity (i.e. bridge work – painting, patching)		Subtract	150 vphpl
Work Type: cold milling, paving (concrete or HMA)		Subtract	100 vphpl
Work Type: guardrail or barrier		Add	50 vphpl
Work Type: signing installation		Add	50 vphpl
Work Type: occurs > 20 feet away		Add	100 vphpl
Work Activity: adjacent lane distance < 12 feet	I_{wa}	Subtract	100 vphpl
Work Activity: adjacent lane distance > 12 feet , < 20 feet		Subtract	50 vphpl
Work Activity: adjacent lane distance > 20 feet away		Add	150 vphpl
Work Activity: separated by median		Add	50 vphpl
12' lane width	f_{LW}	Multiply	1.00
11' lane width		Multiply	0.95
10' lane width		Multiply	0.90
Restricted one side	f_{SC}	Multiply	0.95
Restricted both sides		Multiply	0.90
Trucks 0% to 5%	f_{HV}	Multiply	1.00
Trucks >5% to ≤10%		Multiply	0.98
Trucks >10% to ≤15%		Multiply	0.95
Trucks >15% to ≤20%		Multiply	0.93
Trucks >20%		Multiply	0.90
Entrance ramp within 1,500 feet downstream from the end of the lane closure taper	R	Subtract	Hourly ramp volume (max 600 vph)

* When calculating C_a the final result should range from 1,100 VPHPL to 2,000 VPHPL. If the result comes back outside of this range please contact MDOT's Work Zone Delivery Engineer for approval.

** If multiple work zone conditions occur, use engineering judgement to determine which factors to use. The final number must fall within the range of the largest values for that adjustment factor.

*** Please send verified delay measurements to the WZMU. This will allow for adjustments to the numbers based on real world experiences.

Example 3.1: Freeway
A construction project is planned for a two-lane freeway portion of US-127. The project will last for several months and involves complete reconstruction of the roadway and several bridges on each bound. One lane of traffic is proposed to be maintained in each direction by using temporary crossovers. Maintained traffic must drive on the shoulder. Lane widths will be reduced to 11 feet, with temporary concrete barrier separating opposing traffic. The traffic characteristics consist of 7% trucks. Calculate Lane capacity.

Solution 3.1: Freeway
The lane capacity is computed by starting with the base capacity (C_b) for a 2 lane freeway to a 1 lane freeway 1550 vphpl. The adjustment factor applied for geometry includes use of a crossover, with a >3 foot shift, and traffic driving on the shoulder. Since we are only allowed to use one factor I_g=-100 (could range from 100 to 150). Although the work type is reconstruction, it is not in close proximity to the maintained traffic since it occurs on the closed bound of the freeway (I_{wt}=100). The adjustment factors applied for work activity (I_{wa}=50), lane width (f_{lw}=0.95), side clearance (f_{sc}=0.95), and percent trucks (f_{hv}=0.98). The adjusted capacity is:

$$\boldsymbol{C_a} = [(1550 - 100 + 100 + 50) \times 0.95 \times 0.95 \times 0.98] = 1415\ \boldsymbol{vph}$$

Example 3.2: Freeway
A construction project is planned for an urban three lane freeway portion of I-696. The project will last a few months and involves replacement of median barrier and lighting fixtures. The median lane will be closed in each direction during some parts of the day using channelizing devices. The work activity is less than 12 feet from traffic. The traffic characteristics consist of 15% trucks. Calculate lane capacity.

Solution 3.2: Freeway
The lane capacity is computed by starting with the base capacity (C_b) for a 3 lane freeway to a 2 lane freeway 1700 vphpl. Adjustments are applied for close proximity intense work activity (I_g=-100), (I_{wt}=50), (I_{wa}=-150), side clearance (f_{sc}=0.95), percentage trucks (f_{hv}=0.95). The adjusted capacity for two open lanes is:

$$\boldsymbol{C_a} = \{[(1700 - 100 + 50 - 100) \times 0.95 \times 0.95] \times 2\}$$
$$= \boldsymbol{or\ 2798\ vph}\ or\ \boldsymbol{1399\ vplph}$$

B. Traffic Demand Determination

An estimation of the hourly traffic demand is necessary to proceed with travel time delay and queue estimations. Existing traffic volume data is regularly collected on most state trunklines. Information regarding traffic data is provided in Section 2.03.01.A Traffic Information.

The level of detail of traffic volume data depends on the level of analysis. Hourly traffic volume data is necessary to accurately evaluate mobility impacts on facilities that may have fluctuations in traffic demand throughout the day. This is of particular importance if the temporary traffic control plan considers implementing traffic restrictions or lane closures only during certain portions of the day.

Weekend and weekday volumes are necessary when determining week day restrictions. Reviewing traffic volumes from the same time frame is important to make sure the traffic patterns are similar. This is amplified when dealing with an area that has a yearly traffic generator such as a school or seasonal traffic.

C. Speed Delay

The speed delay component of travel time delay is affected by the temporary speed limit and by the capacity conditions of the work zone. As a base line, the initial travel time (before construction work) should be computed or measured. Most roadways that operate at less than capacity, the initial travel time may be estimated by dividing the segment length by the existing posted speed limit. It should be recognized, however, in areas where recurring congestion is present, the existing travel time should be inclusive of recurring congestion due to near or at capacity operations.

Measured operating speed may be available on RITIS. Existing travel time runs should be completed to verify the existing conditions.

The proposed posted temporary speed limit should be considered the maximum operating speed during construction activities. It is important to consider the presence of special reduced speed limits in Michigan, such as the “45 MPH Where Workers Present” condition. The actual operating speed within a work zone may still be less than the posted work zone speed depending on the capacity conditions and worker location.

The relative nearness of the traffic demand to capacity is related using the V /C ratio. The V/C ratio may be used as a performance measure for the work zone operations.

The speed delay attributable to the work zone can be computed as the difference in the travel time during construction and before construction. The following formula may be used to compute speed delay:

$$\boldsymbol{t} = \boldsymbol{D} \times \left(\frac{\mathbf{1}}{\boldsymbol{U_{wz}}} - \frac{\mathbf{1}}{\boldsymbol{U_i}}\right) \times \mathbf{60}$$

Where:

t = speed delay (min)

D = work zone length, from reduce speed signing to return to existing roadway speed (miles)

$\mathbf{U_{wz}}$ = operating work zone speed (mph);

$\mathbf{U_i}$ = existing posted or operating speed before construction (mph)

D. Queue Delay

A queue is an accumulation of vehicles for each time period in which the arrivals, or demand, exceeds the departures, or capacity. The queue delay component of travel delay is estimated only when the demand exceeds capacity and a queue forms. When the demand traveling through the work zone is less than or equal to capacity, no queue is formed and no queue delay is encountered.

Spreadsheet tools or software are helpful in performing the computation of queue delay, since the accumulation and dissipation of queues may occur across multiple time periods. The delay encountered at a queue is estimated using the volume of vehicles accumulated in the queue and the capacity at which the queue is serviced.
The following formula can be used to compute the delay time for a vehicle at the back of the queue:

$$\boldsymbol{t} = \left(\frac{\boldsymbol{Q}}{\boldsymbol{C_a}}\right) \times \mathbf{60}$$

Where:

t = queue delay (min)

Q = # of vehicles in queue (# of veh)

$\mathbf{C_a}$ = adjusted mainline capacity (vph)

Example 3.3:
Urban Freeway, Queue Delay

Building from Example 3.2, the demand on this urban freeway is 3000 vph. The work zone is 5 miles long and the existing posted speed is 70 mph. During Construction the work zone will be signed for:

45 MPH

Where Workers Present.Calculate the queue delay.

Solution 3.3:
Urban Freeway, Queue Delay

The adjusted mainline capacity estimated earlier is 2798 vph. The accumulated queue for the time period (hour) is the demand that exceeds the capacity.

$$\boldsymbol{Q} = 3000 - 2798 = 202\, veh$$

The queue delay is:

$$\boldsymbol{t} = \frac{202}{2798} \times 60 = 4.33\, \boldsymbol{min}$$

Table 3-3: Per Lane Capacity for Signalized Flow

Lane Characteristics			No Turns		50% Turns*		100% Turns* or Right-turn lane		U-turn crossover
Lane Width (feet)			12	10	12	10	12	10	N/A
Green Time	40%	Unrestricted	620	550	560	500	520	450	530
		Restricted	580	510	520	460	480	420	490
	50%	Unrestricted	850	750	770	680	710	620	670
		Restricted	800	700	730	640	670	590	630
	60%	Unrestricted	1040	910	940	830	870	760	810
		Restricted	970	850	880	780	810	710	760

Assumptions for Table 3-3: 5% trucks, level terrain, urban area

* Assumes no left turns through opposing traffic from lane analyzed. Left turns with opposing traffic merit special consideration. If no opposing traffic exists, left turns are treated as right turns. For example: no opposing traffic, 30% rights & 20% lefts , use table values for 50% turns.

3.01.02 Traffic Regulator Operation (Updated 12/3/2020)

Traffic regulator operations, on the mainline traffic with alternating flow, should be evaluated based on travel time delay. The travel time delay calculation is determined using the Construction, Congestion, Cost Software (CO3) Flag Spreadsheet. The capacity of a traffic regulator operation is directly related to the posted work zone speed, volume of traffic, and the length of the traffic regulator zone.

The chart and graphs provided in Appendix B: Mobility Analysis Tools present capacity during traffic regulating on two-lane roadways. Once this determination is made, it can be used in the CO3 analysis to evaluate the travel time delay associated with work zone lengths. The value, as determined by the chart and the CO3 analysis, should be specified in the TMP. The length of the work zone and other design restrictions must also be placed in the Special Provision for Maintaining Traffic.

Example 3.4:
Traffic Regulator

A seven mile milling and resurfacing construction project is scheduled on a two lane, two-way portion of M-44. Construction operations allow for traffic regulator control to maintain one lane, alternating during working hours, and two lanes open during non-working hours. The existing posted speed is 55 mph and the work zone will be signed for 45 mph.

Calculate the design hour volume (DHV) and delay for a traffic regulator set up.

Solution 3.4:
Traffic Regulator

Traffic count information for this location can be found at MDOT TDMS. The TDMS data indicates that the AADT is 5,950 vehicles for this segment. This traffic volume is cumulative of both directions of travel. If a breakdown of hourly traffic is available it must be used or the AADT number needs to be converted using the design hour volume (DHV) in vph.

Multiply the AADT by the DHV % to obtain the DHV. TDMS indicates that the DHV% for this segment is 12%:

$$(\mathbf{5,950}\ \boldsymbol{veh}) \times (\mathbf{12\%}\ \boldsymbol{DHV}) = \mathbf{714}\ \boldsymbol{vph}$$

Use the table for Appendix H. Capacity in Traffic Regulator Zones to determine the maximum allowable length of the work zone given the 45 mph speed limit. The design hour has 714 vph. Utilizing the table for Appendix H. Capacity in Traffic Regulator Zones traffic regulation operation will result in delays of 10 minutes or less (714 is less than 725 which is capacity at 2.0 miles). Confirm hourly volume calculation with hourly traffic volumes if available.

The work zone length should be further evaluated using the CO3 Flagging to confirm travel time delays do not exceed 10 minutes. The allowable length of the lane closure must be specified in the Traffic Restrictions in the Special Provision for Maintaining Traffic.

3.01.03 Temporary Traffic Signals

Temporary traffic signals are often included in construction projects. They are categorized into two types, portable and fixed (pole mounted).

Portable signals may be necessary on projects when only one lane of traffic can be maintained at a time and traffic regulating operations are not recommended. On projects that extend over 30 days, the option of connecting to a power source is not required but should be considered. When a portable signal remains in place and all lanes are open, the signal should be removed or placed in yellow flash mode.

If possible, driveways or side streets within the temporary signal heads should be avoided. If unavoidable, contact the WZDE for potential solutions.

The Maintenance/Operations Services Section should be contacted on projects that require a temporary pole mounted traffic signal. The Mantenance/Operations Services Section does not typically provide timing permits for temporary portable traffic signals, but may assist in finding a power source.

Signal time modifications should be considered during planning stages to improve the work zone traffic flow. Field reviews and adjustments during construction should be made as required to improve the traffic flow. Signal head location, timing, detection, and pedestrian volumes should all be considered when making modifications.

Signal timing for temporary traffic signals used to alternate traffic in a single lane consists of the following intervals:

- Green Interval - should be selected to match traffic demand
- All Red and Yellow Intervals - per direction, based on travel speed and distance between stop bars
- Electronic Traffic Control Device Guidelines should be utilized for additional information

The stop bars are typically 50 feet from the temporary signal heads. Adjustment in the field may be necessary to maintain adequate visibility. The duration of the *All Red* Interval (for each direction) can be computed using the following equation:

$$\boldsymbol{R} = \left(\frac{\boldsymbol{D}}{\mathbf{1.47} \times \boldsymbol{S}}\right)$$

Where:

R = All Red Interval (sec)

D = Distance between stop bars **(feet)**

***S* = Speed limit though work zone (mph).**

3.01.04 Interrupted Flow Facilities

The travel time computation for interrupted flow facilities, such as two lane or multilane highways with stop controlled or signalized intersections, should be inclusive of speed delay, queue delay, and control delay.

The complexity of calculating control delay at intersections is magnified when intersection operations are changed within the work zone. This could include a reduction in the number of lanes available, or changes in the phasing of traffic signals. Software tools are recommended to determine travel time for interrupted flow facilities, due to their complexity. Software tools such as Synchro and SimTraffic provide a good estimation of travel time delay during construction.

A. Control Delay Signalized Intersections

The control delay can be estimated by using Synchro, SimTraffic, or manually using the methodology presented in the HCM for work zones with a single isolated signalized intersection. Control delay consists of two components: uniform delay, and incremental delay.

Control delay is computed using the following equation:

$$\boldsymbol{d = d_1 + d_2}$$

Where:

$\mathbf{d_1}$ = uniform delay (sec/veh)

$\mathbf{d_2}$ = incremental delay (sec/veh)

Uniform delay accounts for arrival demand in the subject lane group that is uniformly distributed over time.

The uniform delay $\mathbf{d_1}$ is computed using the following equation:

$$\boldsymbol{d_1 = \frac{0.5C(1 - {}^{g}/_{C})^2}{1 - [min(1, X)\,{}^{g}/_{C}]}}$$

Where:

C = cycle length (sec);

g = green time for analyzed phase (sec)

X = V/C ratio

The notation **min (1,X)** used in the equation indicates that the smaller of the two values is used.

Incremental delay accounts for random variation in arrivals and delay caused by demand exceeding capacity during the analysis period. The incremental delay $\mathbf{d_2}$ is computed using the following equation:

$$d_2 = 900T\left[(X-1)+\sqrt{(X-1)^2+\frac{4X}{cT}}\right]$$

Where:

c = lane group capacity (VPH)

T = analysis period duration (hr)

It should be noted that while the equation for incremental delay is purportedly valid for all values of X, including highly oversaturated lane groups, enormous delays will be predicted for situations where X > 1.0 meaning demand exceeds capacity. Therefore, it is recommended that software tools are used to calculate control delay in situations when the computed X > 1.0.

The capacity value for the signalized lane group is necessary for both components of the control delay formula. Each lane group has a different capacity value, depending on the arrangement of turns permitted from the lane group. Capacity values may obtained from Table 3-3.

Example 3.5:
Control Delay Signalized Intersection

A detour of M-20 will add 650 VPH as right turns to a signalized intersection with an existing traffic volume of 200 veh/hr. The lane group consists of a shared left-right-through lane. The signal will be timed for 60% green for the analyzed movement, and the cycle length will be 80 seconds. Calculate total control delay.

Solution 3.5:
Control Delay Signalized Intersection

The lane group capacity is found from Table 3-4 based on 60% green time and unrestricted 12 feet lanes for 100% Turns. The estimated lane group capacity is 870 veh/hr.

The term for $g/_C$ is already known to be 60% or 0.60.

The V/C ratio is calculated as:

$$\boldsymbol{X} = \frac{850}{870} = \mathbf{0.98}$$

The term for uniform delay d_1 is

$$\boldsymbol{d_1} = \frac{\mathbf{0.5} * \mathbf{80}(\mathbf{1} - \mathbf{0.6})^{\mathbf{2}}}{\mathbf{1} - [\mathbf{0.98} * \mathbf{0.6}]} = \mathbf{15.5}\ \boldsymbol{sec}$$

The term for incremental delay d_2 is computed for the time interval for one hour, thus T = 1 in the following equation:

$$\boldsymbol{d_2} = \mathbf{900} * \mathbf{1}\left[(\mathbf{0.98} - \mathbf{1}) + \sqrt{(\mathbf{0.98} - \mathbf{1})^{\mathbf{2}} + \frac{\mathbf{4} * \mathbf{0.98}}{\mathbf{870} * \mathbf{1}}}\right] = \mathbf{45}\ \boldsymbol{sec}$$

The total control delay for this lane group is

$$\mathbf{d} = 15.5 + 45 = \mathbf{60.5\ sec}$$

B. Travel Time Determination

Similar to uninterrupted flow facilities, the initial travel time (before construction) should be computed or measured. Existing travel time runs may be completed to verify the existing conditions, especially to validate the existing travel time reported from software tools. The travel time estimates may be performed using various techniques summarized in Section 3.03.07 Travel Demand Models and Tools.

3.01.05 Detour Routes

The determination of travel time delay for detour routes includes a comparison of the initial travel time on the original route (before construction) compared to the travel time during construction. The capacity conditions along the detour route will be important to consider, especially regarding the amount of traffic diverted to the detour route. If the detour route consists of traffic signals or other interrupted flow facilities, an evaluation of the intersection operations, including the detour traffic, may be necessary.

For detour routes with the necessary capacity to accommodate the diverted traffic volumes, the travel time along the detour route may be established as the travel distance divided by the average speed. A travel time run may be performed during the design development of the project to establish the anticipated detour travel time. Similarly, the detour travel time may be quickly determined using online map guidance tools, simply placing two points on a map, and routing the path along the detour route.

If intersection control delay is a particular concern for the detour route, the delay may be computed using software tools such as Synchro and added to the previously calculated detour travel time. This level of analysis should be completed when shutting off or detouring a major roadway movement, or the detour route is already at or above capacity, with existing traffic volumes.

3.02 OTHER MEASURES OF EFFECTIVENESS

Other measures of effectiveness such as V/C, LOS or performance measures, may be used to evaluate the mobility of the work zone. These measures can identify choke points or poorly performing features for targeted implementation of mitigation measures. V/C and LOS have been de-emphasized in their specific use for determining the significance of a work zone.

3.03 MOBILITY ANALYSIS TOOLS

Understanding the anticipated type and extent of work zone impacts, aids the development of effective TMPs. Analysis may necessitate the use of software tools depending on the degree of analysis required. Some tools were designed for work zone analysis while other traffic analysis tools, not specifically designed for work zones, can also be useful for analyzing work zone situations. This section discusses various tools available to perform the analyses required to develop and implement TMPs. Contact the WZMU for assistance with items in this section or if utilizing tools not included herein.

3.03.01 **Construction, Congestion, Cost (CO3)** (Updated 1/20/2020)

CO3 is a spreadsheet/software tool that estimates the magnitude and impacts of traffic congestion, including cost impacts on road users that can be expected during a construction project. CO3 measures congestion variables such as delay, diverted vehicles, and backup. In addition, a user can estimate and document project costs for alternative methods of maintaining traffic. The program allows for quantification of decreases to demand, such as diversions to alternate or detour routes.
MDOT provides additional information regarding the CO3 software including the most recent spreadsheets, user manual, and updated user cost inputs. These resources are available on the MDOT website: CO3 Spreadsheets and User Manual

CO3 is used in Michigan to estimate delay and user cost for work zones on uninterrupted flow facilities and traffic regulator operations. The program requires hourly traffic data inputs throughout the day which should be readily available at TDMS. The program allows the work zone capacity to be inputted for each hour of the day. An example summary view of the spreadsheet output is located in the Appendix B: Mobility Analysis Tools.

A. Important Notes Regarding CO3 Inputs

1. The “method travel distance” and “normal travel distance” are usually the same for a work zone which is open part width or with a route around (i.e. crossovers on a freeway). The only exception to this rule, is a full closure.

2. Inputs for “diversion” should be considered in context of a voluntary alternate route. The analyst should seek input from MDOT BTP, Region or TSC to determine an appropriate diversion rate.

3. The “normal travel speed” should be the existing posted speed limit. Speed delay calculations are always made in comparison to this number.

4. The speed delay threshold and range values should be entered for work zones that operate with a reduced speed limit at all times, and a lower speed limit during active work periods (i.e. 45 mph where workers present and 60 mph at all other times).

5. If only speed delay threshold values are filled in, then any time period with a capacity above this threshold will operate at the normal travel speed (i.e. 60 mph during working periods and 70 mph at all other times).

6. The speed when D~0, and speed, when D=C, values should be determined using the CO^3 Common Inputs sheet.

7. The adjusted capacity must be calculated using the method described in Section 3.01.02 A.

8. For work zones with hourly lane closure restrictions, the capacity may be modified to accurately reflect the capacity for each time period.

9. For training needs and additional questions please contact the WZMU.

10. The MDOT website for C03 has a number of resources that provides additional information and details on the required inputs.

3.03.02 Synchro and SIM Traffic

Synchro and SIM Traffic programs are frequently utilized by MDOT for signal timing and geometric design evaluations. Many validated network models exist and may be utilized for work zone evaluation. Outputs include travel times, levels of service, and other measures of effectiveness.

3.03.03 Synchro

Synchro is a macroscopic capacity analysis and optimization model which performs a straight-forward analytical capacity analysis allowing users to get a measure of delays, queues, etc. based on equations.

Synchro also optimizes signals in a network and uses the intersection capacity utilization method to determine capacity for signalized and un-signalized intersections. It supports

the HCM methodology and is recommended for determining the travel time on interrupted flow facilities.

A. Important Notes when using Synchro for Signalized Work Zones:

1. Between the existing scenario and the temporary configuration, the geometry must be updated to reflect the available lanes.

2. Any adjustments to traffic volumes or signal phasing and timing should be documented and applied where appropriate.

3. The *Link Speed* input should be set to represent the work zone posted speed limit. Synchro uses *Link Distance* and *Link Speed* to determine the *Running Time*.

4. The Arterial LOS report can be used to summarize travel time for a work zone treated as an arterial street. The LOS analysis provides a high level analysis and maybe used for planning and scoping purposes. Several dummy nodes must be added to the network to represent the boundaries of the work zone, since running time is only reported between signalized intersections. The dummy nodes can be coded for 100% green time which represent the entrance and exit for the work zone.

5. The summation of running time and signal (control) delay results in the Travel Time. This value should be compared with the existing scenario to determine the travel time increase predicted for the work zone.

3.03.04 SIMTraffic

SIMTraffic is a microscopic simulation model that simulates signalized and un-signalized intersections (including roundabouts) and the interaction that occurs between intersections.

A. Important Notes when using SIMTraffic for Signalized Work Zones:

1. The results of the SIMTraffic Arterial LOS report may differ from those presented in the Synchro report.

2. The SIMTraffic analysis includes several parameters that should be adjusted to simulate the intersections.

3. This microscopic Arterial LOS is recommended for significant and potential significant projects to identify operational issues.

4. Information for calibrating the SIMTraffic model is provided in MDOT's Electronic Traffic Control Device Guidelines.

3.03.05 Highway Capacity Manual (HCM) and Highway Capacity Software (HCS)

The Highway Capacity Manual (HCM) is a reference document that contains concepts, guidelines, and computational procedures for computing the capacity and LOS on various facility types. The HCM can be used for both planning and operational analyses. A

planning analysis gives measures of effectiveness such as time delay, average travel speed, LOS and V/C ratios. An operational analysis allows for diagnosing, testing, and designing mitigation measures.

Highway Capacity Software (HCS 2010) is a package of modules to implement the HCM procedures to compute capacity for various facility elements such as intersections, segments, and ramps. The software is macroscopic in scope and provides outputs with limited data input.

This software is used in Michigan to evaluate capacity situations for independent facility elements such as an entrance ramp merge point, or a stand-alone intersection. For traffic signal evaluation, Synchro is recommended.

3.03.06 PTV-VISSIM (Planung Transport Verkehr) Vissim (Verkehr In Städten – SIMulationsmodell)

PTV-VISSIM is a microscopic, time-step and behavior based simulation model developed to analyze roadways and transit operations. VISSIM simulates urban and highway traffic including pedestrians, bicyclists, and motorized vehicles. VISSIM can model integrated roadway networks found in a typical corridor as well as various modes consisting of general-purpose traffic, buses, HOV lanes, high occupancy toll lanes, rail, trucks, pedestrians, and bicyclists. Changeable message signs, ramp metering, incident diversion, transit signal priority, lane control signals, and dynamic lane control signs can also be modeled with VISSIM.

Note: VISSIM is data intensive and requires special expertise. It should be limited to situations in urbanized areas where impacted roadways are typically at capacity. The model requires graphical coding of a network and calibration variables. Additional information regarding this program and variables can be obtained from the MDOT Congestion and Mobility Unit.

3.03.07 Travel Demand Models and Tools

A. TransCAD

TransCAD is a Geographic Information System (GIS) based software tool used to implement travel demand modeling. Using the four-step transportation modeling process and TransCAD software, travel demand models are used to identify existing and future highway capacity deficiencies and analyze potential improvements. Travel demand modeling refers to the development of a series of mathematical relationships, specifically designed to simulate existing and forecasted travel patterns.

Travel demand models have been developed for large urban areas in Michigan for the governing MPO. A statewide model has also been developed to evaluate alternatives outside of urban area boundaries. Travel demand models replicate existing traffic, the effects of impedance to that traffic, and where and when future congestion will occur. They can also estimate the impact of congestion in terms of changes in the LOS or the amount of delay saved from future transportation improvements. This allows a comparison of the benefits of various transportation projects.

In complex situations or for high impact projects, these models should be used to evaluate the diversion of traffic from work zones due to lane closures or other impedances as well as identify routes that will be impacted by the work zone. The output from the travel demand model can be used to justify diversion rates used for alternate routes.

B. DynaSmart-P

DynaSmart-P is a dynamic traffic assignment analysis tool that may be used for regional work zone management. This program combines dynamic network assignment models used primarily with demand forecasting procedures for planning applications, and traffic simulation models and are, used mainly for traffic operations studies.

Potential applications include; assessing the impacts of alternate traffic control strategies for work zones, incidents, and special event management, and assessing the impacts of ITS technologies on the transportation networks. In addition, DynaSmart-P can evaluate congestion-pricing schemes for toll roads and produce traffic operations data for air quality analyses.

C. Regional Integrated Transportation Information Systems (RITIS)

RITIS is a tool used to compile, analyze, and archive speed and travel time data. RITIS includes many performance measures, dashboards, and visual analytics tools that help agencies gain real-time situational awareness, measure performance, and communicate information between agencies and the public.

RITIS utilizes real-time data feeds and automatically compiles and standardizes data obtained from multiple agencies to provide an enhanced overall view of the transportation network. Users can filter information specific to their project, road, or regional area. The RITIS tools allow users to identify incident hot-spots, analyze queue lengths and traffic congestion/bottlenecks, monitor speed and delays caused by incidents, work zones, weather, events, and other causes, and evaluates the effectiveness of transportation operations strategies. Agencies are able to view transportation and related emergency management information and use it to improve operations and emergency preparedness.

Data within RITIS is archived and may be downloaded exported to perform independent analyses. MDOT uses RITIS for before and after analysis of construction projects to aid in determining the effectiveness of the project on traffic operations. RITIS may also be used to provide information to third parties, the media, and other traveler information resources. Information about the tools within RITIS is available at: https://www.ritis.org/tools

Access to RITIS may be requested through the MDOT Project Manager. MDOT employees may gain access at no cost by visiting https://www.ritis.org/register/. A login ID is NOT needed to view reports generated within RITIS.

CHAPTER 4

WORK ZONE SAFETY

4.01 GENERAL

Work zones can create safety impacts. Different projects have different needs and the same levels of mitigation strategies are not appropriate for every project. When considering work zone management strategies that mitigate safety and mobility issues, it is important to consider constructability, cost and time.

Work zone management strategies are developed based on project characteristics through a detailed analysis of relevant information.

Examples of items to consider include:

- Traffic volume and roadway capacity
- Network availability (alternate routes)
- Traffic / user access
- Local and regional traffic impacts
- Project schedule/time (work days, work hour restrictions, critical work/material time, seasonal issues)
- Project site conditions (utilities, slopes, objects, drainage, etc)
- Project work operations (access, hauling)
- Project purpose and features (road encroachment impacts)
- Safety assessment (crash rate, workers, and road users)
- Previous projects in the area (performance assessments)

Construction needs to be accomplished while accommodating safety and mobility; ensuring worker and motorist safety.

Safety and mobility impacts are not restricted to the work zone location. They also include the construction influence area and adjacent or overlapping projects. Coordination between projects is necessary and should be addressed in the TMP. Strategies may need to be justified as MOT costs escalate.

A benefit cost analysis comparing road user costs to increased construction costs should be performed when multiple options are feasible. Safety benefits may be challenging to quantify but should be factored into the project design. Safety and mobility impact mitigation strategies are presented in more detail throughout this chapter.

4.02 CONSTRUCTION AND CONTRACT METHODS

The WZSM Policy ensures all work zone impacts are appropriately identified, mitigated, and managed on a systematic basis. Work zone and traffic management design strategies should provide the highest level of safety, mobility, and constructability.

A total road closure may be the best example of this approach. Generally, this is the safest, most mobile and constructible work zone approach. Workers and road users are separated and exposed to fewer hazards, road users are not delayed through a restrictive work zone, and construction may proceed without accommodating traffic.

A full closure may be a desirable starting point for some projects based on the project specifics. The time is dramatically reduced, and safety and overall quality of the project are improved. However not all project are candidates for this strategy for a number of reasons:

- Lack of alternate route capacity
- Lack of adequate detours
- Severe congestion throughout a widespread area
- Local traffic access to residences and businesses
- Other traffic management and cost issues

A more common and acceptable approach is a combination of short-term closures and partial width stages. This strategy uses a TTCP that positively separates and protects workers and road users, while accommodating efficient work operations and traffic mobility.

Some projects may benefit from efficiently staged and protected work operations versus routine lane closures that close and open each day.

When developing the TMP it is important to consider the constructability of the project based on the preferred MOT scheme. A TMP should be developed in conjunction with the construction staff to ensure projects are buildable and safe. This includes reviewing work schedules, production rates, and industry means and methods. If the preferred MOT places too many restrictions and limitations on constructability, there may be negative consequences to the costs and quality. Several construction and contracting strategies are listed in Chapter 2 Transportation Management Plan.

It is important to remember there are practical limits to work zone strategies. Mobility and safety benefits that are relatively short term may not be practical if the cost of implementation offsets a significant portion of the benefit. Some projects may benefit from a wider review and discussion on possible work zone strategies, such as:

- Value Engineering Study
- Constructability Study
- Industry plan reviews

- Work Zone Construction Peer Review
- Maintenance of Traffic Meetings
- Traffic Survey/Study
- Innovative contracting
- Governmental agency and special event coordination meeting

Constructability is a key element in a successful work zone strategy. Issues of material selection, production rates, and work operation efficiencies have a direct tie to the feasibility of the strategy. The following successful strategies have been implemented:

- Short duration closures (weekend, week, or a combination)
- Continuous weekday closure
- Weekend closure
- Nighttime and weekend lane closures
- Rolling 15-min short term freeway closures

These strategies use specific materials such as quick-curing concrete, accelerated work schedules, prefabricated structure components, on-site mix plants, etc., and are based on actual production rates. Work zone strategy development is a dynamic process that continues as project information and design features are developed. There may be many factors involved with strategy development.

FHWA provides additional guidance and a comprehensive table of work zone impact management strategies to consider in the development of a TMP.

FHWA document links:

- Developing and Implementing TMPs (TMPs) for Work Zones
  - FHWA Document Section 4.0
  - FHWA Document Appendix B

MDOT also provides a best practice folder which may be found on ProjectWise (TMP Best Practices). For access to this folder please contact the WZMU.

4.03 WORK ZONE CONSIDERATIONS

Work zones should be planned and designed to consider work operations and address safety impacts for workers, traffic regulators, motorists, and non-motorized users.

4.03.01 Work Zone Hazards

Each work zone should be assessed for hazards. The following provides a list of example conflicts for drivers, workers, and traffic regulators that designers should consider when developing the TTCP:

- Congestion related crashes
- Work zone crashes & crash patterns
- Roadway configuration, merging tapers and lane drops
- Unexpected queues
- Unstable traffic flow
- Lane widths
- Pavement markings
- Clear zone safety issues
- Drainage
- Lane departures
- Barrier wall and attenuation
- Roadway geometrics
- Vertical hazards, drop offs
- Emergency vehicle access
- Disabled vehicle refuges
- Night work visibility
- Confusing or conflicting signs, markings and features

Designers should also consider the following conditions for workers and traffic regulators when developing a work zone TTCP:

- Work zone protection
- Impaired or distracted drivers
- Errant vehicles
- Narrow work zones
- Equipment and materials storage

- Escape routes for workers
- Exposure to moving equipment
- Aggressive drivers
- Speeding drivers
- Vehicle crashes and crash patterns
- Work zone access (ingress / egress)
- Pedestrians/Non-motorized Traffic
- Shared use trails and paths

4.03.02 Workers (Updated 12/3/2020)

Drivers experiencing long delays become impatient and can act unpredictably increasing worker exposure. Other driver conditions to consider include:

- Impaired drivers
- Drowsy drivers
- Distracted drivers
- Aggressive drivers

Designers should also take into account the position of the workers behind barrier walls. Unless the wall is secured to the pavement or has limited deflection, consideration should be given to improving or creating a lateral buffer space.

Barrier protected work zones should be considered on a project-by-project basis and not just for long term stationary projects.

In addition to the location of the workers and their proximity to traffic, the type of work taking place should be factored into the design of the TTCP.

Active work should not take place with traffic on both sides of the workers, on the same roadbed, unless there is positive protection. Traffic can be on both sides of a lane closure for concrete curing when no workers are present.

A. Traffic Regulators and Spotters

Traffic regulators are typically used to stop and direct traffic for work activities such as:

- One lane alternating traffic control
- Intersection control

- Road closures (Parades, Special Events, etc.)
- Short durations
- Spot locations
- Ingress and egress Locations

A spotter may be used to watch traffic and alert workers of an approaching errant vehicle.

The following are some TTCP considerations:

- Evaluate the necessity of using traffic regulators at night. If determined that traffic regulating is the most effective option for the TTCP, the engineer should review and approve the lighting plan and layout prior to the start of construction. Balloon Lighting is required for traffic regulator stations.
- Traffic regulators must not be utilized on freeways at any time. Haul road crossing may require a traffic regulator and should be reviewed and approved by the project office.
- The traffic regulator's location, escape route, protection and other safety related issues should be incorporated into the traffic regulator station.
- Law enforcement may be used for some traffic regulator operations. See Section 4.05, Work Zone Law Enforcement, for information on how to include enforcement in projects.
- Spotters may be used to decrease worker exposure when applicable. Intended spotter locations should be shown on the TTCP.

Detailed information on traffic regulator procedures and conduct is available through the resources included in Appendix G (Resources).

4.03.03 Road Users (Updated 12/3/2020)

The message conveyed to the user through signing, pavement markings, and devices must be concise and consistent.

A. Drivers

Drivers and their passengers account for a large portion of work zone fatalities. It is important to provide a TTCP that effectively guides and protects drivers while traveling through the work zone. Effective planning and design of work zones should be considered from the driver's perspective.

To provide adequate time to react and make rational decisions to navigate safely, the work zone impact mitigation strategies should be easily understood by motorists.

Temporary channelization and alignment should be modified to the work zone conditions. MDOT work zone guidelines and typicals should be followed; however modifications that

improve the safety and operations of the work zone should be made according to field conditions. Changes should be documented in the *Inspector's Daily Report* (IDR).

The riding surface is important for the safety of motorcycle riders. Whenever possible, construction operations should be avoided that place motorcycles on grooved pavement, pavement lane edge drops from milled surfaces, rumble strips and unpaved surfaces. If these conditions cannot be avoided, the TTCP should include adequate warning signs for these conditions to alert the motorcycle riders. Consideration should also be made for ingress/egress points, where designs should include the capability of a motorcyclist accessing the roadway perpendicular to differentials in pavement elevations.

B. Non-motorized Users

Adequate facilities should be provided to allow non-motorized users to travel through or around the work zone. Requirements and guidance on maintaining non-motorized user traffic in work zones are found in Chapter 5: Non-Motorized Work Zone Safety and Mobility.

C. Oversized Vehicles

If the TTCP for the proposed work zone does not allow vehicles that exceed the legal width, height or weight limits, notify the region/TSC transport permit agent. Warning signs notifying vehicles of the restriction must be provided. On some projects, it may be necessary to designate a detour route for oversized vehicles.

4.03.04 Work Zone Crash Reduction Strategies and Mitigations (Updated 1/20/2020)

According to the *MDOT Trunkline Crashes in Work Zones Report (2012),* the five primary crash types in work zones are:

- Rear-end straight (RE-ST)
- Sideswipe-same direction (SS-SM)
- Fixed object (FXOBJ)
- Other object (O-OBJ)
- Angle-straight (AN-ST)

The five primary crash types have accounted for approximately 80% of trunkline work zone crashes from 2002 to 2014. Each type may be related to several work zone factors. Potential crash reduction strategies for the TTCP design and during construction are shown in the tables below. Please contact the WZDE for additional methods or option details.

TABLE 4-1: WORK ZONE CRASH REDUCTION STRATEGIES AND TOOLS: REAR END CRASHES

Work Zone Crash Factors	Crash Reduction Strategy	Crash Reduction Tools
Speed	Review Work Zone Speeds	• Single, Double, or Triple speed limit step downs
	Additional devices	• Temporary rumble strips • Flashing speed limit signs
	Uniformed Law Enforcement Presence	Use law enforcement to alert motorists of work zone queue
Geometry	Review Work Zone Lane Closure / Shift Tapers	• Work Zone Audit Report (Form 0397) • Drive thru work zone after initial setup and stage changes • Verify work zone taper lengths
Access	Review ingress and egress of work zone vehicles	• Internal Work Zone Traffic Control Plan • Add signing (Truck Entrance /Exit Ahead, Truck Crossing) • Add acceleration / deceleration area for trucks
	Signing for work zone ingress and egress locations	• Turn restrictions at driveways and access points
Capacity / Congestion	Additional warning for motorists	• Dynamic Message Signs • PCMS • Queue Detection Systems • Dynamic Lane Merge System • Rumble Strips (transverse prior to work zone) • Additional Global Signing • Travel time information signs
	Accelerated construction techniques; working / lane closure time restrictions	• Night work • Off-Peak work • Switch to full closure • Use lane / ramp rental or liquidated damages special provisions
	Minimize number of stops / delay improvement	• Temporary signal timing coordination • Adjust signal phasing and splits • Add turn lanes and/or passing flares • Close crossovers or alternate intersections • Close on / off Ramps

TABLE 4-1 CONT: WORK ZONE CRASH REDUCTION STRATEGIES AND TOOLS: REAR END CRASHES		
Capacity / Congestion (CONT)	Alternate Route	• Alternate Route Signing Plans • Traffic signal optimization along alternate route
	Review MOT staging, look at ways to add lanes (capacity)	• Moveable barrier • One-way detour • Temporary Widening • Split Merge
Geometry	Review sight distance and operation at intersections and driveways within the work zone	• Turn restrictions • Decrease device spacing • Gap for approaches • Worker Vehicle Equipment Location
Delineation and Signs	Additional warning signs for approaches and high traffic volume driveways	• Add temporary signing for approaches i.e., W2-1, W2-2, W2-3
	Review work zone devices at intersections and driveways within the work zone	• Decrease device spacing • Gap for approaches • Review barricade locations - do not interfere with intersection sight distance

TABLE 4-2: WORK ZONE CRASH REDUCTION STRATEGIES AND TOOLS: SIDESWIPE- SAME DIRECTION CRASHES

Work Zone Crash Factors	**Crash Reduction Strategy**	**Crash Reduction Tools**
Speed	Review work zone speeds	• Single, Double, or Triple speed limit step downs
	Intelligent Transportation System (ITS) speed warning signs	• Flashing speed limit signs • Increase law enforcement
Geometry	Increase lanes and/or shoulders widths, where possible	• Separate truck lane • Parking restrictions
	Review Traffic Shift and Lane Closure Taper Lengths	• Work Zone Audit Report (Form 0397) • Verify taper lengths • Verify proper sight distance to closure

TABLE 4-2 CONT: WORK ZONE CRASH REDUCTION STRATEGIES AND TOOLS: SIDESWIPE- SAME DIRECTION CRASHES		
Delineation and Signs	Review configurations for Yield, Merge, or Acceleration Lanes	• Temporary application of Geometric Design Guide, if possible • Remove when work is complete
	Review travel path delineations	• Temporary rumble strips
	Additional signs for traffic merge / shift locations	• Add warning signs (i.e., W11-24) • Dynamic Lane Merge System • Add R4-9 Signs (Stay In Lane)
	Add delineations	• Channelizing devices and/or temporary barriers • Temporary delineators
	Pavement markings	• Solid temporary pavement markings (no temporary skips) • Increase pavement marking reflectivity • Temporary raised pavement markings • Increase width of pavement markings • Use contrast markings

TABLE 4-3: WORK ZONE CRASH REDUCTION STRATEGIES AND TOOLS: FIXED – OBJECT CRASHES

Work Zone Crash Factors	Crash Reduction Strategy	Crash Reduction Tools
Work Zone Speed	Review work zone speeds	• Single, Double, or Triple speed limit step downs
	ITS speed warning signs	• Flashing speed limit signs
Delineation and Signs	Place object markers at fixed object locations near travel path	• Temporary reflector • Temporary attenuator
	Add delineation	• Channelizing devices • Temporary delineators • Safety Edge
Fixed Object Location	Remove, relocate, or protect fixed object	• Temporary guardrail • Temporary concrete barrier

TABLE 4-4: WORK ZONE CRASH REDUCTION STRATEGIES AND TOOLS: OTHER OBJECT CRASHES

Work Zone Crash Factors	Crash Reduction Strategy	Crash Reduction Tools
Delineation and Signs	Frequent inspection and review location and placement of temporary devices (signs, drums, barricades, channelizing devices, etc.)	• Work Zone Audit Report (Form 0397)
	Delineate travel path from objects and devices	• Ensure Lighting for Night Work requirements. See the section titled "Lighting for Night Work in section 812 in the specbook. • Review pavement marking • Temporary delineators
Speed	ITS speed warning signs	• Flashing speed limit signs
	Review work zone speeds	• Single, Double, or Triple speed limit step downs

TABLE 4-5: WORK ZONE CRASH REDUCTION STRATEGIES AND TOOLS: ANGLE CRASHES (ADDED 1/20/2020)

Work Zone Crash Factors	Crash Reduction Strategy	Crash Reduction Tools
Signal and ITS	Advance warning flashers	• Add advance temporary intersection or Signal Ahead warning signing with flasher
	Review signal head placement and timing	• Ensure correct signal head placement over lanes • Cover or bag any conflicting information • Check signal corridor timing
Geometry	Review turning movements	• Add left turn lanes or limit left turns • Create right turn pocket with devices
	Review intersection and stopping sight distance.	• Ensure construction materials and equipment are not blocking sight distance. • Verify intersection and stopping sight distance
Delineation and Signs	Additional advance intersection signing	• Add lane assignment signs (R3-8 series) (ground mount & overhead) • Add No Left/Right turn signing (R3-1, R3-2) • Add advance intersection (W-2 Series), signal ahead (W3-1), or stop ahead (W3-1), warning signs
	Review travel path	• Verify taper / shift lengths
	Pavement markings & advance warnings	• Temporary stop bars, and crosswalks • Lane assignment arrows on pavement • Temporary rumble strips • Solid temporary pavement markings leading up to stop bars

4.04 WORK ZONE TRAFFIC INCIDENT MANAGEMENT (TIM) CONCEPTS

Work zone TIM involves monitoring traffic conditions and making adjustments when traffic incidents (unplanned events) occur in the work zone. TIM involves deploying technology, establishing procedures and policies, and implementing systems for improving the detection, verification, response, and safe quick clearance of events when they occur in the work zone and on associated detour routes.

A work zone TIM program provides specialized techniques for detecting, verifying, responding to and clearing traffic incidents in work zones.

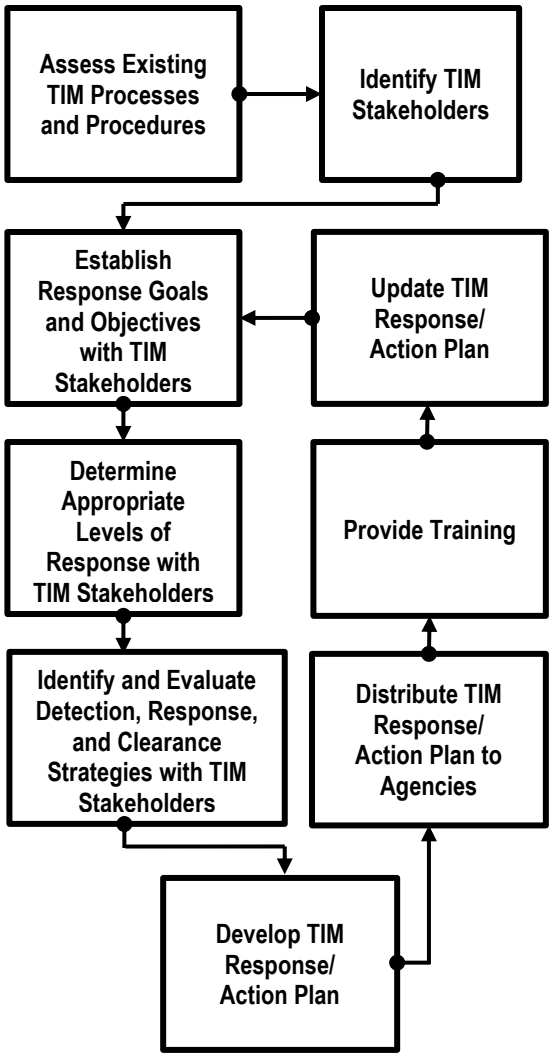
The congestion and delays in and around work zones can come from vehicle crashes and breakdowns. As congestion builds, work zone crash rates can increase. TIM can help reduce the time required to clear incidents in and around work zones. This results in a reduction of traffic congestion and delay, making the area safer for those working to clear the incident. The longer the incident is active, the higher the chance/rate of a secondary incident. A secondary incident is often more severe than the primary. The TTCP and TOP should include mitigation measures and strategies for TIM.

The steps involved in the development of a TIM plan for construction projects to mitigate the impact of traffic incidents are summarized in **Exhibit 4-1**.

4.04.01 Assess Existing Processes and Procedures

TIM programs and processes have been established in most regions. Using the existing TIM processes and procedures in the work zone is the first step to developing TIM for the construction project. Verify whether the construction project is within the jurisdiction of an existing incident management program and coordinate with MDOT region/TSC/TOC and first-response personnel.

EXHIBIT 4-1:
WORK ZONE TIM DEVELOPMENT PROCESS



4.04.02 Planning and Design

TIM strategies appropriate for the type of work zone should be developed, identified, implemented, and detailed in the TMP.

A. Identify Stakeholders

Incident management programs are successful when they are built on a foundation of cooperation and collaboration. It is essential that work zone TIM includes coordination with the incident responders within the area. This includes identifying and meeting with agencies to discuss current response policies, procedures, and practices.

The following is a list of potential agencies and organizations traditionally involved in the region TIM programs:

- MDOT and local transportation agencies
- State and local law enforcement
- Fire and rescue agencies
- Regional, county, and local 911 dispatch
- Towing and recovery providers
- Emergency medical service providers
- State and local hazardous material recovery personnel
- Medical Examiners or Medical Examiner Investigators
- Emergency Management
- Media
- Contractor
- Other response personnel in the project area
- Sovereign Nation

B. Establish Response Objectives and Procedure Guidelines

Objectives and procedures for incident responders in a work zone should be established when developing the TIM strategies for the construction project. Different stakeholders involved in the project may have different goals and objectives. The following list provides some objectives for developing work zone TIM and should be included in the TMP:

- Minimize detection, notification and verification times; number of closed lanes; length of exposure; motorist delay; response time of emergency services;
- Maximize the use of existing communication resources; safety of responders and travelers; information sharing and coordination among agencies;
- Provide timely, accurate information to the public enabling them to make informed decisions

Procedures may also be developed for how and when certain TIM functions should be performed in a work zone. Standard documentation for TIM response/action plans should be maintained by each TOC or TSC, and should be discussed with project staff and the TOC prior to the start of the project.

Procedure guidelines for traffic incidents in work zones may be needed for:

- Notifying other emergency responders

- Managing the scene
- Moving damaged or disabled vehicles and debris
- Closing and opening lanes
- Disseminating information to travelers and media
- Implementing alternate / emergency routes

C. Determine Appropriate Levels of Response

Each strategy and incident scenario should be evaluated by agencies to determine the appropriate level of response for each type of traffic incident. The MMUTCD Part 6 I *Control of Traffic Through Traffic Incident Management Areas*, divides incidents into three classes based on duration, each of which has unique traffic control characteristics and needs.

1. **Major** - typically includes traffic incidents involving hazardous materials, fatal crashes, and disasters. These traffic incidents involve closing all or part of a roadway facility in excess of two hours.

2. **Intermediate** - affects travel lanes for 30 minutes to two hours, usually requiring traffic control on scene to divert road users, full roadway closure may be needed for short periods**.**

3. Minor - Affects all or parts of the roadway for less than 30 minutes. Typically includes disabled vehicles and minor crashes. On scene responders are typically law enforcement and towing companies.

D. Identifying and Evaluating Detection, Response, and Clearance Strategies

Strategies for detecting, responding to, and clearing incidents from the roadway are summarized below. Additional information may be found in the FHWA document, Traffic Incident Management in Work Zones.

1. **Detection –** Several strategies commonly used to improve incident detection are**:**

   - Permanent Cameras and Detection
   - Temporary Portable Cameras
   - Stopped Traffic Advisory System
   - Portable Traffic Detector/Sensors

   More details can be found in Section 6.06 Work Zone Intelligent Transportation Systems (ITS) and Technology

2. **Response -** Strategies commonly used to improve work zone TIM response, are summarized below:

   - Dedicated Response Vehicles / Freeway Courtesy Patrol
   - Emergency Personnel Resource List
   - Equipment and Material Resource Lists

3. **Safe Quick Clearance -** Safe Quick clearance strategies for improving traffic incident clearance in work zones are summarized below:

   - Emergency Pull Off/Vehicle Refuge Areas
   - Crash Investigation Sites
   - Wrecker Service Special Provisions
   - Emergency Turnarounds/Access Gates
   - Dedicated Service Patrols
   - Alternative Emergency Response Access Routes
   - Predefined Staging Areas for TIM Personnel
   - Traffic Responsive Signal Control Plans

MDOT region/TSC personnel, construction staff, and emergency responders should *together* review the construction activities to ensure the response procedures and communication plans are appropriate.

E. Develop and Distribute Response/Action Plan

A response or action plan should be developed to depict what types of responses may be necessary for different levels of traffic incidents that may occur in the work zone. The response plan needs to be distributed to appropriate TIM stakeholders and project staff should ensure that it is disseminated to appropriate response and field personnel.

The emergency response procedures and practices in a work zone should remain valid and up-to-date for all phases of construction.

F. TIM Training

Training is an important aspect of developing and implementing a work zone TIM plan. Please visit the MI-TIME website to request training.

4.05 WORK ZONE LAW ENFORCEMENT (Updated 12/3/2020)

Work Zone Law Enforcement offers a valuable proactive strategy to reduce traffic speeds and crashes and to alter and improve motorist behavior. Examples of Work Zone Enforcement include:

- Visible presence - this application affects a large percentage of motorists as law enforcement is on-site and stationary or mobile within or just outside of the limits of a work zone.

- Active enforcement - is used in close proximity of workers, where speed compliance is an issue. This type of enforcement enhances work zone laws and regulations regarding motorist behavior by performing stops for violations within the work zone.

Work Zone Enforcement should be considered in the earliest phases of project scoping and is included in form 0268 Project Cost Estimating Checklist for this consideration. Operations, Traffic and Safety, Design and Construction should collaborate and consider utilizing Work Zone Enforcement on high risk and high worker exposure activities including:

- Night work
  Traffic Stops for beam setting or removal and utility crossings
- Rolling closures
- Traffic Switches and Stage Changes
- Other High Worker Exposure activities such as:

    - Frequent worker presence adjacent to high-speed traffic without positive protection devices.

    - Traffic control set-up or removal activities that present high risks to workers and road users.

    - Complex or short term changes in traffic control patterns with potential for road user confusion or high risk worker exposure to traffic.

    - Existing traffic conditions and crash histories that indicate a potential for substantial safety and congestion impacts related to the work zone, which may be mitigated by improved driver behavior and awareness of the work zone.

    - High-speed roadways when unexpected or sudden traffic queuing is anticipated, especially if the queue forms a considerable distance in advance of the work zone or immediately adjacent to the workspace.

Guidelines have been set up for Work Zone Enforcement cost estimation. These guidelines will be updated regularly to ensure that the approach to Work Zone Enforcement funding is iterative and considerate of where there is the most need. These guidelines do not take the place of engineering judgement, which must prevail specifically in instances where more than one higher exposure activity is occurring simultaneously or where projects are running adjacent to one another. Engineers are encouraged to use the

below hourly calculations at a rate of $100/hour for Michigan State Police enforcement and at a rate discussed for local agency enforcement:

- Assume 8 hours of enforcement for every traffic shift and stage change
- Assume 6 hours of enforcement for every squad car used on each shift containing Full Stops
- Assume 9 hours of enforcement for every squad car used on each shift that nightwork is performed (without positive protection)
- Assume 3 hours of enforcement for every other day that High Worker exposure activities are taking place

It is imperative that funding is made available for this phase, and that Phase Initiator (PI) is used to do so. Work Zone Enforcement Funds (formerly "Other Construction Phase") can be obligated by the Project Manager, Construction Engineer or other delegate. Upon submitting payment revisions and additions to PI, MDOT's Financial Operations Division will coordinate approval of funding with FHWA. MDOT Requirements for Work Zone Enforcement can be found in Guidance Document 10202.

Projects utilizing Michigan State Police Work Zone Enforcement will compensate officers on their overtime hours, with two (2) hour scheduling minimums as per their Union agreement. Overtime must be scheduled out of the post, and best practices include scheduling at least 48 hours in advance of a new pay period. Frequent communication with the post regarding project needs is imperative to success.

To add Work Zone Enforcement to Projects of Division Interest (PoDI) after letting, Form FHWA-1365 (Record of Authorization to Proceed with Major Contract Revision) must be created and submitted to FHWA. The form must include the executed agreement with the law enforcement agency and hours for coverage and equipment at true and defensible rates.

It is encouraged that all projects with Work Zone Enforcement incorporate local and state police representatives at Pre-Construction meetings, Progress meetings and Post-Construction Meetings. This is a critical time to collaborate with all stakeholders and gain feedback regarding project needs and officer staging. MSP should be invited to such meetings where Work Zone Enforcement is programmed and will be discussed by sending correspondence to Inspector Scott Marier with Michigan State Police (MarierS@michigan.gov).

In addition to Work Zone Enforcement on MDOT Projects, Region and TSC staff should engage the local and state law enforcement jurisdictions each season to enhance safety in all maintenance, and permitted activity work zones.

4.05.01 Agreements, Documentation & Strategies (Updated 12/3/2020)

Work Zone Enforcement Agreements should be filled out for every project where Work Zone Enforcement is occurring. Work Zone Enforcement Agreements for Local and State Law Enforcement can be found in the MDOT Forms Repository as forms 0565 (Local Law Enforcement) and 1449 (State Law Enforcement). These forms are also listed for reference in Appendix J.

MDOT will be billed by MSP at the responding officers hourly rate plus benefits. Due to the nature of this work being voluntary on an officers overtime, the same officer will not be available for the whole project. For this reason, it is imperative that a hourly rate is not specified in the Work Zone Enforcement Agreement. Work Zone Enforcement agreements should be stored in accordance with the Construction Manual Standard Naming System for Documents. Work Zone Agreements should be sent to MDOT Field Operations Engineer and MSP personnel as stated on form.

Each Region shall complete the Work Zone Annual Report spreadsheet by December 31 each year. This report can be found on Projectwise. The intention of this report is to better our understanding of how Work Zone Enforcement can be used, budgeted, and coordinated. Completion of these reports will aid the Department in applying the appropriate financing to the appropriate activities and will assist us in developing a policy that adds value and safety to our customers. An iterative approach will be taken, evaluating comments on effectiveness and necessity from the field in our calculation of cost and hours.

CHAPTER 5

NON-MOTORIZED WORK ZONE SAFETY AND MOBILITY

The MMUTCD Chapter 6D provides the requirements and guidance for non-motorized traffic accommodations in construction and maintenance work zones, as well as for work performed under permits. As stated in the MMUTCD:

> *"The needs and control of all road users (motorists, bicyclists, and pedestrians within the highway, or on private roads open to public travel), including persons with disabilities (in accordance with the Americans with Disabilities Act of 1990 (ADA), Title II, Paragraph 35.130) through a TTC zone shall be an essential part of highway construction, utility work, maintenance operations, and the management of traffic incidents."* (Michigan Manual of Uniform Traffic Control Devices, 2011, p. 547 Part 6)

The chapter provides additional information specific to the planning, scoping, design, and implementation of non-motorized traffic control.

5.01 DEFINITIONS

5.01.01 Pedestrian Facilities

Pedestrian facilities are improvements and provisions that accommodate or encourage pedestrian mobility. Such facilities may be temporary or permanent and include but not limited to:

- Sidewalks
- Crosswalks
- Curb ramps
- Traffic Control Devices
- Grade separations (overpasses, underpasses, and structures)
- Shared-use / side paths
- Design features intended to encourage pedestrian mobility, such as:
    - Traffic calming devices
    - Center refuge islands

5.01.02 Bicycle Facilities

Bicycle facilities are improvements and provisions that accommodate or encourage bicycling. Such facilities may be temporary or permanent and include but are not limited to:

- Exclusive bikeways (bicycle lane/cycle track)
- Shared-use / side paths
- Marked shared lane
- Protected bike lanes
- Paved shoulders (≥ 4')

5.01.03 Recreational Facilities (Future)

Intentionally Left Blank

5.02 DESIGN CONSIDERATIONS (UPDATED 12/3/2020)

Existing non-motorized activity should be evaluated during the scoping and planning phases to plan for pedestrian and bicyclist needs during construction. This information will be used in the development of the TMP. Additional information regarding the project development process is provided in Section 1.02 Process.

Non-motorized response to signing, pavement markings, and other traffic control devices is often different from vehicular responses. Pedestrians and bicycles are more likely to follow their desired path and ignore long alternate routes. The physical space available for mitigating pedestrian impacts is often limited.

Mitigation should occur within the proposed right-of-way (ROW). If that cannot be accomplished, early notification to obtain additional ROW or to assess alternatives is critical to the schedule and budget of the project. If the closure meets standards and no viable alternatives exist, closing a non-motorized route may be an acceptable alternative.

Per the MMUTCD section 6G.05 *"where pedestrian routes are closed, alternate pedestrian routes shall be provided."* The level of detail required for the alternate route should be based on guidance given in this section and can range from something as complex as providing a licensed transportation shuttle, to something as simple as providing advance warning as in the MMUTCD Typical Application - 28.

A. Site Review

The site review should include an assessment of the existing pedestrian facilities for impacts relative to the project. ROW impacts should be documented during the site review. Pedestrian and bicyclist volumes are frequently low and not readily obtained. Indications that these activities do occur within the work zone include:

- Existing sidewalk, trail, or pathway
- Observed pedestrian activity
- Evidence of pedestrian activity (i.e. worn paths along the roadway)
- Area traffic generators (i.e. commercial or institutional land uses near residential areas and transit stops).

- Dedicated bike lanes/bike route

The site review should assess the nature and scope of activities, potential safety, and capacity concerns along with alternative routes where appropriate.

In addition, non-motorized traffic generators should be documented and reviewed. Generators that may require additional attention are schools, shopping centers, and local street side businesses. ADA considerations must also be evaluated for every project. In certain locations, an engineering study of the non-motorized traffic may be required to determine the impact the project will have on the local population. It is important to note any ROW impacts found either during the scoping process or the preliminary review.

B. Data Collection

The required analysis to be conducted and the data collection necessary will vary depending on the type of project and location. In low volume areas, a site review may be sufficient to assess the relative number of pedestrians and the pattern of their movements. In urban, suburban, and rural areas with tourist activity, it may be necessary to collect more detailed pedestrian and bicycle count data including:

- Classification counts
- Speed survey
- Origin-destination information
- Intersection control &and signal timing
- Adjacent land uses

Pedestrian data may be available from a number of existing sources:

- MDOT's Transportation Data Management System (TDMS)
- Past Traffic Signal Optimization Projects
- Existing Traffic Impact Studies
- Regional and Local MPO

Past traffic signal optimization projects may provide the majority of information if the intersection is signalized. This data is typically limited to peak hours.

If existing data is not available, field counts are preferred. If trip generation rates are available, they may be used to estimate the pedestrian activity through the work zone. Typical pedestrian and bicycle traffic generators include:

- Residential housing
- Shopping centers
- Churches

- Shelters / rescue missions
- Schools
- Universities / Colleges
- Daycare centers
- Senior centers
- Retirement communities
- Community centers
- Stadiums / Arena
- Parks and beaches
- Dedicated bicycle routes
- Central business districts
- Transit/school bus routes
- Sporting, Special Event and concert venues

C. Feasibility Analysis

A formal mobility analysis is not required, a feasibility analysis should be conducted if there are more than 10 pedestrians per hour in the peak hours. The surrounding pedestrian traffic generators should be reviewed as pedestrian peak hours may not coincide with vehicular peak hours. In some areas, pedestrian peak volumes may occur on the weekends.

The feasibility analysis should consider pedestrian delay due to additional travel time along an alternate route. Review the additional distance pedestrians have to cover as a part of the detour or diversion. In rare cases, with extreme pedestrian volumes, congestion induced pedestrian delays should also be considered.

D. Non-motorized Design Guidance

Non-motorized work zone design strategies are summarized below.

TABLE 5-1: NON-MOTORIZED WORK ZONE GUIDANCE: FACILITIES

• Pedestrians should be physically separated from the work zone and vehicles through the use of barriers and longitudinal channelizing devices.
• Pedestrian routes should be maintained free of any obstructions and hazards such as holes, debris, mud, construction equipment, stored materials, etc.
• Temporary lighting is not required, but should be considered for temporary walkways if the existing route is lighted.
• Hazards (ditches, trenches, excavations, etc.) near or adjacent to walkways must be clearly delineated and protected with appropriate channelizing devices.
• A covered pedestrian walkway may be required under, or adjacent to, elevated work activities including bridges and retaining walls.
• The minimum dimensions of a covered walkway for use by both pedestrians and bicycles should be 7 feet high by 4 feet wide, with a 32-38-inch handrail and a slip resistant walk surface.
• Where construction activities involve sidewalks on both sides of the street efforts should be made to stage the work so that both sidewalks are not out of service at the same time.
• Audible devices should be considered in urban areas where an existing device is provided, or in areas known to be frequented by individuals with visual impairments.
• Existing devices should be re-programmed or de-activated at locations where a facility is closed or detoured.
• Audible devices should be proposed at temporary or detoured crosswalks if existing devices were provided at the closed crossing.
• Coordination between the owner agencies of the existing audible devices is important to determine who will make the required modifications.
• Temporary pedestrian accommodations must be as accessible as the existing pedestrian facilities.

TABLE 5-2: NON-MOTORIZED WORK ZONE GUIDANCE: DETOURS

• Advance notice of closures to allow pedestrians to avoid the construction site entirely
• Detour routes should provide the most direct and safest route to minimize travel time and distance.
• A detour route, alternate pathway, or travel assistance is required to maintain pedestrian traffic if sidewalks on both sides of the roadway are closed.
• Signing should provide clear indications for each route where detours overlap.
• Provide advance signing at intersections rather than mid-block locations.

5.03 DETOURS

5.03.01 Pedestrian

Pedestrian detour routing or temporary pathways should be considered based upon the level of impact. To be effective, pedestrian detours need to be clear and concise. Using existing pathways, ramps, and crosswalks is preferred; however, it may be necessary to construct temporary facilities.

With a temporary pedestrian facility consider the following to determine if the proposed plan is appropriate:

- Number and demographics of pedestrians
- Environmental Clearance Requirements (Section 5.02.A) are satisfied
- Roadway ADT
- Crosswalk configuration
- When possible, avoid the use of non-signalized crosswalks.

Temporary facilities should be a minimum of 4 feet wide, however, 5 feet is desirable. If the temporary facility sidewalk is bi-directional and 4 feet wide, a 5 x 5 foot passing space is required for every 200 feet of length.

The temporary facility must be designed such that ADA compliant accessibility is provided, at minimum, to the same level as the existing facility. To the extent practical, it is recommended to design temporary facilities to full ADA standards. If additional guidance is required for complex location contact the WZDE for guidance.

Alternate pedestrian routes should be smooth and level. The use of a smooth, firm, stable, slip resistant, and continuous hard surface (compacted soils, aggregate and sand are not to be used) is required to provide an acceptable temporary pedestrian route. For example special provisions, contact the WZDE.

Physical barriers need to be provided to prevent pedestrians from entering the work area. Pedestrian channelizing devices or pedestrian barrier with fence may be used for increased protection.

If a covered pathway is used to protect pedestrians from overhead work, 5 foot-candles (54 lux) of illumination are recommended.

In the event of a full bridge closure, when a practical or alternate pedestrian route option does not exist, other mitigation measures should be considered. Such measures include the use of temporary structures and licensed transportation shuttles to transport pedestrians around the closure.

Where there is evidence of pedestrians but no pedestrian facilities (aka: a goat path), the route may be closed without a detour.

Pedestrians should not be temporarily rerouted across railroad tracks unless there is an existing pedestrian crossing. If unavoidable, contact MDOT's WZMU.

Informational signs or other suitable devices should be used to provide reasonable notice to pedestrians, including the type and duration of construction activities. PCMS should only be used for pedestrian detours with substantial pedestrian traffic volumes. For example, the placement of a PCMS for pedestrians at a stadium should clearly indicate that the message is for non-motorized traffic.

5.03.02 Bicycle (Future)

Intentionally Blank

5.03.03 Recreational (Future)

Intentionally Blank

5.04 SIGNING

The MMUTCD provides non-motorized sign details to help maintain consistent messages in work zones. The signs should be sized and positioned to provide clear, visible, and appropriate information.

Supplemental street name plaques should be added to the pedestrian detour signs for further clarity, especially when signing for multiple detour routes.

A minimum bottom height of 7 feet is typically required. If the sign and supports are clear of the accessible route and have no impact on non-motorized traffic, a minimum bottom height of 5 feet should be used. The sign and the sign support should be clear of the accessible route to eliminate tripping, vertical, and other hazards. See MMUTCD section 6F.03 Sign Placement for additional details.

Additional work zone signing for drivers should be considered in locations where pedestrian signs may conflict with vehicles signs (i.e. locations such as crosswalks and side streets).

5.04.01 Pedestrian

Positioning of temporary pedestrian signing should generally be just prior to potential route decision points. If a detour route is extended multiple blocks, is a complicated route, or other extenuating factors, confirmation signing should be incorporated along the route at potential decision points. An "*End Detour"* sign should be placed at the end of the detour to complete the process of directing pedestrians back to the original route.

If a business or business district with pedestrian access is cut off by a pedestrian detour, consideration should be made to include pedestrian specific signed route indicating that the businesses are open. Generic signs stating, *Businesses Open,* may be used. Specific names or advertisements may not be placed on signs.

5.04.02 Bicycle (Future)

Intentionally Blank

5.04.03 Recreational Vehicle (Future)

Intentionally Blank

5.04.04 CHANNELIZING DEVICES

Pedestrian channelizing devices should be used to delineate an alternate route. When used properly, they should indicate a suitable route for pedestrian travel around or through the work zone. The bottom and top faces of the pedestrian channelizing device should have retroreflective material or delineation for improved nighttime visibility. For more information about the characteristics, review the following special provisions in Division 8 - 812:

- Temporary Pedestrian Type II Channelizer
- Temporary Pedestrian Type II Barricade

If a suitable alternate pedestrian route is not viable, it may be necessary to channelize pedestrians into the roadway. Utilizing continuous barriers is required for channelizing pedestrians into the roadway where motor vehicle traffic normally travels. If pedestrian traffic is placed on the existing shoulder or in a location where there was no existing motor vehicle traffic, channelizing devices at a reduced spacing may be an acceptable method to provide separation.
Guidelines for effective pedestrian channelization are shown in Table 5-4. Additional information is provided in the US Department of Justice ADA Accessibility Guidelines, *American Traffic Safety Services Association* (ATSSA) guidance documents, and PROWAG

TABLE 5-3: CHANNELIZING DEVICE GUIDELINES

• Joints between segments should be closed and flush
• Bottom of the detection plate should be no more than 2 inches above the ground and extend to a minimum of 8 inches above the walkway.
• Must provide retroreflective delineation on traffic side of barrier
• Must meet crash protection, NCHRP 350 and/or AASHTO Manual for Assessing Safety Hardware (MASH) standards appropriate to the speed of traffic
• Must provide detectability for visually impaired pedestrians using a cane
• Guide rails are required. Top surface should be at least 32 inches above the ground and have a smooth continuous surface.
• Railings should be sturdy and fixed in place
• Avoid guiding pedestrians into the roadway
• Where pedestrians must be guided into the roadway, provide channelization including a positive barrier to protect them from vehicles intruding on the pedestrian path.
• Tape, rope, chains or similar devices are not allowed per the MMUTCD
• Vehicular and pedestrian signs should not obstruct the pedestrian route
• No protruding objects that could pose a trip hazard, obstruct or injure a pedestrian
• Existing pedestrian pathways may only be closed using Type II Pedestrian Barricades.

5.04.05 Pedestrian Barriers

Temporary barriers are devices designed to prevent or reduce work zone intrusion by vehicles, minimizing injuries to vehicle occupants. They are designed to provide positive separation of pedestrians from motorists and the work area.

When pedestrian traffic is placed in a location that motorized traffic normally travels, positive protection, facilitated by temporary barriers, is required when separating pedestrian traffic from motorized traffic on a temporary or permanent facility.
Types of temporary barrier protection used in construction work zones include items that meet the NCHRP Report 350 and MASH crash testing requirements:

- Concrete barriers
- Movable barriers
- Prefabricated steel barriers
- Water filled barrier wall (avoid use if construction extends into winter)
- Barrier with attached fence

Barriers can be one of the most effective safety measures used in a work zone to separate pedestrians from the work area and traffic.

When there is concern that pedestrians may climb over a barrier, consider installing a temporary pedestrian barrier with fence, consisting of a typical barrier section (usually concrete, or water-filled) and a six-foot tall chain link fence attached to the top of the barrier wall.

This type of device greatly discourages pedestrians from proceeding into the construction area or into live traffic. Pedestrian barrier walls with fence are crashworthy and ADA compliant. For more information see the Special Provision for Temporary Pedestrian Barrier with Fence in Division 8, 812. The following elements should be considered for the use of barrier walls:

TABLE 5-4: BARRIER USE CONSIDERATIONS

Excavations
Drop offs
Unprotected features (walls, piers, sign structures, foundations, etc.)
Working and non-working equipment
Interim unprotected items (i.e. non-standard slopes, stockpiles, ditches within the roadway clear zone, etc.)
Number & nature of pedestrians
Proximity to and severity of hazards
Time of exposure
Barrier deflection distance
Vertical / horizontal roadway alignment
Hazard presented by barrier itself once in place
Hazard presented to pedestrians and traffic during barrier placement

5.05 PATHWAYS, CROSSWALKS AND RAMPS

It is preferable to use existing pathways, crosswalks, and ramps. Crosswalks and ramps should be located to allow pedestrians to cross during construction activities.

Crosswalks that are temporarily closed, should be removed or blocked. The use of temporary surfaces is acceptable for temporary pathways and should be ADA compliant or at a minimum provide an equivalent existing level of accessibility. Design, construction, and maintenance guidelines for pathways, crosswalks and ramps are provided in the following tables:

TABLE 5-5: PATHWAYS, CROSSWALKS AND RAMPS GUIDELINES: DESIGN

• Pathways should be clear and flat.
• Detectible warning surfaces should be used at the ends of crosswalks on ramps.
• The pathway grade should not exceed 5% without incorporation of level landings.
• Temporary level turning spaces should be provided at ramps (minimum 4x4 feet, preferred 5x5 feet.)
• Cross slope perpendicular to traffic should be no more than 2%.
• Pathways must be at least 4 feet wide with 5 feet width preferred.
• Passing spaces must be provided at 200 feet intervals if the pathway is less than 5 feet wide.
• Passing spaces must be at least 5x5 feet.
• The maximum allowable rate of change of grade is 12.5%. The rate of change is determined by measuring the grade difference and the distance over which it occurs.
• A level turning space is required at both ends of a temporary curb ramp.

TABLE 5-6: PATHWAYS, CROSSWALKS AND RAMPS GUIDELINES: CONSTRUCTION

• Joints should be closed and flush.
• Vertical discontinuities along pedestrian routes should be less than ¼ inch.
• All surfaces should be firm and slip resistant.

TABLE 5-7: PATHWAYS, CROSSWALKS AND RAMPS GUIDELINES: MAINTENANCE

• Clear pedestrian facility of debris, trash, mud, snow, ice, and standing water.
• It is preferable that drainage runs perpendicular to the pathway

5.06 TRAFFIC SIGNALS

In most cases, temporary traffic signals for pedestrians will not be required but may be warranted where high volumes of pedestrians are expected. A review of the pedestrian and/or school crossing warrants in the MMUTCD Part 4 is recommended.

The pedestrian signal heads should be reviewed and adjusted if the crosswalk is being modified to meet MMUTCD requirements for visibility. Pedestrian push button locations adjacent to level landing areas should be reviewed and updated to meet current standards. Locations of signalized temporary crosswalks with pushbuttons should be initially designed to work in all stages of construction. It may be necessary to move the pushbuttons with each stage if the initial crosswalk location is moved.

Adjustments for push button height should consider changes in the elevation of the level landing as temporary surfacing and final walkway surfacing is placed.

If the crosswalks or ramps are modified, the signal timing permits should be reviewed and updated. The pedestrian clearance intervals should be updated based on:

- Crosswalk length
- Level Landing location
- Pushbutton location
- Changes expected in pedestrian volumes

Temporary or permanent pedestrian traffic signals and pushbutton signs should be bagged when a crosswalk is closed. The corresponding pushbutton to the bagged pedestrian traffic signal should be deactivated and the locator tone turned off.

Temporary audible devices should be considered on a case-by- case basis for existing audible devices at crosswalks and where the proposed operation may be confusing to a person with a visual disability. The Pedestrian Signal Guidelines, found within the MDOT Electronic Traffic Control Device Guidelines should be reviewed to determine the need for audible pedestrian signals at existing signalized intersections within the work zone.

5.07 TRANSIT STOPS

Access to existing transit stops should be maintained to retain access and associated pathways should follow standards similar to other temporary pathways. Consult the local transit agency regarding the proposed work zone and impacts to pedestrians and transit operations.

Temporary stops should be provided when existing transit stops cannot be maintained. They should include a level landing for waiting passengers and a hard-surfaced path to connect to the adjacent pedestrian facilities. Signing should be updated to direct riders to the new stop.

Accommodations for transit passengers with disabilities are to be considered. Transit vehicles typically have ramps or other ADA compliant methods to allow wheelchair access to transit vehicles. The design of temporary transit stops should accommodate these riders and the transit system vehicles. For more information see Special Provision for Temporary Bus Stop.

When a transit stop cannot be maintained, closure may be considered with agreement from the transit agency.

5.08 GRADE SEPARATED CROSSINGS

In most cases, pedestrians will cross roadways via crosswalks. In rare cases, it may be unsafe or the pedestrian volumes are high that a grade separated crossing is necessary.

If a grade separated crossing is required, it should be constructed to meet the current level of accessibility of the existing pedestrian facilities. Contact the WZMU for additional details.

5.09 NON-TRADITIONAL FEATURES

Temporary islands, speed bumps and other non-traditional pedestrian traffic control devices are not typically necessary for temporary situations. If you are considering the use of one of these devices contact MDOT's WZMU.

5.10 LIGHTING

Adequate lighting is important to pedestrians as it provides a sense of personal security, safety, and enables signs and instructions to be seen clearly. Many visually impaired pedestrians testify to the importance of good lighting conditions. When planning a pedestrian pathway as part of a TCP, consideration should be given to avoiding trees and other objects that would cast a shadow and obstruct the light output.

Temporary lighting should be considered for temporary covered pathways or in areas where the lack of additional lighting may present a safety concern. Balloon Lighting or a form of diffused lighting should be utilized.

CHAPTER 6

TRAFFIC CONTROL DEVICES AND IMPLEMENTATION

6.01 TEMPORARY TRAFFIC CONTROL

Temporary traffic control devices used in work zones are required by FHWA to meet the requirements of Part 6 of the MMUTCD.

Federal regulations also require all roadside devices, such as portable sign stands, barricades, barrier terminals, crash cushions and other work zone hardware to be compliant with NCHRP 350 and / or MASH crash test requirements.

Devices used on MDOT facilities must also follow the requirements detailed in MDOT's Standard Specifications for Construction, and other policy related documents.

Sometimes it is necessary to decrease spacing in between channelizing devices to keep vehicular traffic out of the work zone. It is not acceptable to use caution tape to tie channelizing devices together in the roadway.

6.01.01 Cones

Cones used on freeways and other high-speed highways must be a minimum of 28 inches tall. The exception to this rule allows 18-inch cones to be permitted for the protection of uncured pavement markings where no static lane closures are used.

Cones smaller than 42 inches in height are prohibited for use at night on all MDOT roadways.

6.01.02 Plastic Drums

Drums must be provided as detailed in WZD-125 and meet the requirements detailed in section 812 and 922 of the MDOT Standard Specifications for Construction. The spacing between plastic drums on roadways must follow the guidelines outlined below in Table 6-1 Channelizing Device Maximum Spacing.

EXHIBIT 6-1:
FLUORESCENT DRUM

TABLE 6-1:
CHANNELIZING DEVICE MAXIMUM SPACING

Work Zone Speed Limit	Taper	Tangent
< 45 mph	S	2 x S
≥ 45 mph	50 feet	100 feet

S=Work Zone Speed Limit (mph)

6.01.03 42 Inch Channelizing Devices

42-inch channelizing devices (grabber cones) are recommended when a plastic drum restricts the proposed lane widths to less than 11 feet, including shy distance.

EXHIBIT 6-2:
42 INCH CHANNELIZING DEVICE

Grabber cones are recommended for Capital Preventive Maintenance (CPM) projects such as chip seal, micro-surface, concrete repairs, and crack seal applications, or any daytime closure lasting less than 12 hours.

They are also recommended for use when lane closures are required to install pavement markings on freeways.

If cones are specified in the contract, use of 42-inch channelizing devices may be permitted at the expense of the contractor. Lights on 42-inch channelizing devices are not allowed.

When 42-inch channelizing devices are used during nighttime work the devices spacing is a maximum distance of 50 feet apart in tangent sections, and a maximum of 25 feet apart in tapers. These spacing requirements apply for all speed limits.

Grabber cones weigh less than plastic drums and require ballast for different conditions. 30 lb. ballasts are recommended for freeways and 15 lb. ballasts are recommended for non-freeways.

6.01.04 Tubular Markers (Updated 1/20/2020)

Use of tubular markers should only be considered after other channelizing devices have been ruled out. Tubular markers are not a recommended channelizing device unless used to separate traffic or work operations. They may be used in work zones where more permanent delineation (attached to the pavement) may be required during winter shutdown.

EXHIBIT 6-3: TUBULAR MARKERS

Tubular markers are required to be a minimum of 28 inches in height. Markers less than 42 inches should have two three inch white reflectorized bands placed at the top, and markers 42 inches or greater should have four 4- to 6- inch wide alternating orange and white stripes with the top stipe being orange.

6.01.05 Delineators

Delineator panels are not allowed for channelizing but may be used for roadside safety delineation based on engineering judgment.

Flexible delineators, delineator panels, and flexible guardrail delineators are used along narrow shoulders, next to an open ditch section on 3R and 4R freeway projects as described in WZD-126-A. Flexible delineators and delineator panels should be located one foot off the edge of the paved shoulder and spaced at a maximum distance of 200 feet, unless otherwise directed by the Engineer.

Other types of delineation devices include; concrete barrier reflectors, guardrail reflectors, and lateral clearance markers and must be included in the TTCP.

EXHIBIT 6-4:
FLEXIBLE DELINEATOR

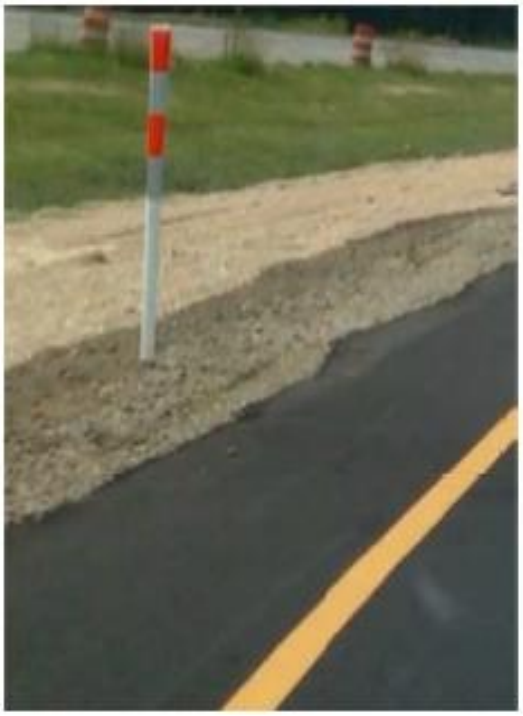


EXHIBIT 6-5:
DELINEATOR PANEL

EXHIBIT 6-6:
FLEXIBLE GUARDRAIL DELINEATORS

6.01.06 Barricades

Barricades are used to control traffic by closing, restricting or delineating all or a portion of a roadway.

EXHIBIT 6-7:
TYPE III BARRICADE

Only Type III barricades are allowed for use with motorized traffic on MDOT projects.

Barricades are equipped with reflective sheeting that is intended to be a directional indicator. Stripes angled down to the right indicate passing on the right, whereas angled down to the left indicates passing on the left. Stripes angled down to the middle of the barricade indicate a closure. Stripes angled upward to the center of the barricade indicate passing on both sides.

Type III barricades are required to have two working type C lights attached, as detailed in WZD-125 and MDOT's Standard Specification for Construction.

6.01.07 Temporary Barriers (Updated 1/20/2020)

Barriers are devices designed to prevent or reduce work zone penetration by vehicles while minimizing injuries to vehicle occupants. They are designed to provide positive separation of motorists from workers, bicyclists, and pedestrians. Types of barrier protection include concrete barriers, movable barriers, prefabricated steel barriers, and water filled barrier walls.

A temporary barrier wall should be installed on a compacted aggregate or paved surface. This surface must be flush with the surface adjacent to the barrier. If a limited deflection barrier is used it must be on a surface as detailed in Standard Plan R-53.

Barriers are required to meet quality standards contained in the current edition of the American Traffic Safety Services Association (ATSSA) Quality Guidelines for Temporary Traffic Control. Temporary traffic barriers are required to meet NCHRP 350 and / or MASH crash testing criteria, meeting a minimum of Test Level 3.

Barrier endings must be located outside of the clear zone or fitted with an impact attenuator, as detailed in Standard Plan R126. Additional information on temporary barriers is available in Section 7.01.67 and 7.01.68 of the Roadway Design Manual. See table 6-8 Edge Drop-off Treatments for detailed barrier wall use information.

Consideration should be given to extend the barrier wall past the work area, both upstream and/or downstream to encompassed materials, equipment and work operations. Worker access to the job site should also be protected when practical. The length of need should be shown or detailed in the internal traffic control plan. Each location should be evaluated to determine the length of need, as a best practice a range of 100 to 300 feet is recommended.

The following tables include elements to consider when deciding on the use of barriers and examples of typical barrier applications.

TABLE 6-2:
BARRIER USE CONSIDERATIONS

Excavations
Drop offs greater than or equal to 12 inches, that will not be backfilled overnight
Unprotected features (walls, piers, sign structures, foundations, etc.)
Working and non-working equipment
Interim unprotected items (i.e. non-standard slopes, stockpiles, ditches within the roadway clear zone, etc.)
Proximity to and severity of hazards
Duration of exposure
Size of work area available
Traffic exposure to opposing traffic
Contractor mobility and ingress / egress
Volume of traffic
Work zone speed
Barrier deflection distance
Vertical / horizontal roadway alignment
Hazard presented by barrier itself once it is in place
Hazard presented to pedestrians and traffic during barrier placement

TABLE 6-3: BARRIER USE TYPICAL APPLICATIONS

• To keep vehicular traffic from entering work areas, such as excavations or material storage sites.
• To separate workers, bicyclists, and pedestrians from motor vehicle traffic. See Chapter 5 for more information.
• To separate opposing directions of freeway traffic.
• Where drums or cones do not provide adequate guidance for the motorist or for the protection of the worker.
• Where workers are exposed to unusually hazardous traffic conditions.
• Where existing traffic barriers and bridge railings are removed during a construction stage.

• On all bridge work where a precipitous drop-off is within 4 feet of the toe of the barrier closest to the active traffic lane. Examples of precipitous drop-offs include but are not limited to:
  ○ Bridge deck work with open holes in the deck.
  ○ Bridge railing removed

• On projects where scaffolding or other structures or equipment with workers overhead are in place for three days or more.

The following alternatives to using temporary barriers should be considered due to risks to drivers and workers during placement and removal of the devices:

- Buffer lane closures
- Nightly backfill of excavations
- Tapers
- Temporary detours or crossovers
- Additional or closer spacing of channelizing devices and extra warning signs

Barriers must be used on freeway projects where opposing traffic lanes are shifted and are adjacent to each other.

A. Movable Barriers

Moveable barrier walls are designed to move laterally as a unit to close or open a traffic lane. Adequate storage sites at both ends of the barrier are required for the barrier transfer machine. Movable barrier walls meet NCHRP 350 and MASH Test Level 3.

EXHIBIT 6-8:
MOVEABLE BARRIER OPERATION

B. Mobile Barrier Walls (Added 12/3/2020)

Mobile barrier walls are devices that function similar to the traditional temporary barrier wall. Mobile barrier walls provide for positive protection of workers during mobile and short term work when temporary barrier is not practical and are transported and operated via a single semi-truck. Mobile barrier walls are required to meet NCHRP 350 or MASH Test Level 3. Check with the WZDE for any questions on using mobile barrier walls on projects.

EXHIBIT 6-9: MOBILE BARRIER WALL DEVICES

C. Water Filled Barrier

Consideration for using this barrier should be limited to low speed, low volume roadways where an improvement over the use of traffic cones or drums is needed. Water filled barrier walls should not be used as a replacement for concrete barrier walls due to their large deflection.

D. Barrier Endings (attenuation)

Within the clear zone, the approach ends of temporary barriers, are fitted with impact attenuators to reduce the potential for occupant injury during a vehicle collision with the barrier. Details for placement of impact attenuators on approach ends of the barriers may be found in the Standard Plan R-126. WZD-175 covers one layout of sand module impact attenuators.

If work extends into a time frame in which the weather could drop below freezing, the manufacturer's recommendation for anti-freeze treatments must be followed when using a water filled attenuator system.

E. Mobile Attenuators (Updated 12/3/2020)

Truck mounted attenuators (TMA) and trailer mounted attenuators are referred to as mobile attenuation as described in the Frequently Used Special Provision 12SP812(A). Mobile attenuators are recommended to protect personnel or equipment in certain cases.For more detailed information and guidelines on the placement of mobile attenuators, reference the Maintenance and Surveying Operations Chapter .

6.01.08 Temporary Signs (Updated 12/3/2020)

Work Zone signing can range from ground driven wood supports to portable temporary roll-up signs. The size of the sign and the duration and location of the work will determine which type of sign should be used. All temporary signs must be crash tested to meet the requirements of *National Cooperative Highway Research Program Report 350 (NCHRP 350)* or *Manual for Assessing Safety Hardware* (MASH). The size of sizes must follow table 6F-1 Temporary Traffic Control Zone Sign and Plaque Size of the MMUTCD.

While it is not required for all projects, it is recommended to show the specific temporary sign locations on the plans or location detailed in the special provision for maintaining traffic. This effort during design will assist in providing more accuracy in the field to ensure proper placement and reduce the number of obstructions and conflicts.

A supplemental plaque is recommended when signs are located on a side street leading into where the work is taking place. A route marker or the road name should be used and can be spelled out if space allows as shown in Exhibit 6-10.

Sign design for projects can be very elaborate with specific guidance found in section 6.01.11.

EXHIBIT 6-10: ROAD NAME PLAQUE

A. Ground-Driven Temporary Signing

Ground-driven temporary signing mounted on conventional driven sign supports should be used for projects that last more than fourteen days. Portable sign supports should be used when it is not possible to use ground-driven sign supports.

Cover or remove existing signs that can be misinterpreted or that may not apply during construction. Signing must be reviewed throughout the life of the project to ensure messages are current and meet the needs of the motorist.

B. Portable Temporary Signing

Portable temporary signing is generally used in short term and mobile work zone operations where frequent repositioning of the signing is necessary to keep pace with the work along the roadway. Portable temporary signs must be mounted on crashworthy sign supports at a 5 foot bottom height, including signs located in the closed section of a walkway. If erecting signs behind a curb, or within 6 feet of a pedestrian walkway, mount signs at a bottom height of at least 7 feet above ground.

Portable sign systems should not be left up unless active work is taking place. When signs are removed they must be stored in accordance with the section titled “Temporary Signs” in 812 of the Standard Specifications for Construction.

Portable sign supports should only be used with the recommended ballast for wind conditions approved by the manufacturer. If signs cannot withstand wind conditions in the field, they should be ground-driven or work postponed until conditions allow work to take place safely.

When a Leap Frog traffic control method is used, it requires additional sets of signs to increase productivity and mobility, project offices should pay for two additional sets of temporary signing. The operation places signs in the correct location and has them stored on the ground and then stands the signs up in the new location and lays the signs down as the operation progresses down the road. The additional sets of signing will keep the operation moving, thus lessening the number of days needed to complete the work.

C. Portable Temporary Signing – Roll-up

Signs made of roll up material must not be used at night or during hours of darkness. This includes early mornings before the sun rises.

D. Innovative Temporary Signing (Added 1/20/2020)

In areas with limited space or specific geometric features traditional temporary sign may not function ideally so the use of innovative signs should be evaluated.

1. Concrete Barrier-Mounted Temporary Sign System

In locations with concrete barrier wall and limited space the Barrier mounted sign should be considered. The condition of the existing barrier wall should be evaluated during the design phase to verify the condition. In areas with limited shoulder width the size of the

sings can be reduced as detailed in table 6F-1 Temporary Traffic Control Zone Sign and Plaque Size of the MMUTCD. For more details on this device see the section titled "Concrete Barrier-Mounted Sign System" in the MDOT Standard Specifications for Construction.

2. Temporary Water Filled Base Sign System

In locations that don't allow for temporary signs to be post driven an alternative to consider is a water filled base sign system. This sign system provides a sturdy base without the need to drive into the ground. Ideal locations are bridge decks or paved shoulders.

This sign system can also be utilized in lieu of type III barricades in locations where there is a high potential for devices to be moved by the motoring public. The next weight of the system is above 400 lbs when filled with water. For more detailed information see the recommended special provision Temporary Water Filled Base Sign System-12RC812-A445

6.01.09 Sign Covers (Updated 12/3/2020)

Temporary sign covers must cover the entire legend or symbol when the sign is less than 60 square feet. The material used needs to be opaque during all light and weather conditions. Lifting devices cannot remain attached to the sign covers. When sign covers are removed, they must be laid flat on the ground. See "Sign Covers" in Division 8 of the Standard Specifications for Construction for additional details.

When covering overhead signs or signs larger than 60 square feet, the contractor is not required to cover the entire sign but must ensure conflicting information is covered, using a Type 1 sign cover. Placing a closed sign across an exit sign as shown in exhibit 6-10 provides the motorist with the best information and allows them to understand which exit is closed.

EXHIBIT 6-11:
SIGN COVERS

For additional information See "Sign Covers" in Division 8 and 9 of the Standard Specifications for Construction.

Existing signs must be covered or removed and replaced with the appropriate temporary regulatory signing. Sign covers not in use must be stored in accordance with 6.01.10. Additional information is provided in the MMUTCD Part 6 (Section 6F.07).

A. Directional Guide Signs

< 24 hours
When a detour is to be placed for 24 hours or less, all existing conflicting permanent signs should be covered as determined by the Engineer.

> 24 hours
When a detour is to be placed for more than one day, all existing conflicting permanent signs must be covered.

B. Overhead Signs

The covering of overhead signs is always recommended but may not always be practical. For this reason, the requirements will be determined at the project level and detailed in the plans. The message and length of the project should be used when determining what signs will be covered or modified. Projects lasting longer than 14 days should have overhead signs covered. Also see page 812 of the Construction Manual for in depth guidance on overhead sign covers..

C. Regulatory Signs

Regulatory signs, such as speed limits, with contradictory information must be covered.

6.01.10 Signing Coordination

When projects have traffic control that overlaps with another project, a coordination clause should be developed for all projects that are affected. If multiple projects are going to be in the same location, a removable marking or tag may be considered for tracking and payment purposes. Requiring project numbers or permanent identifiers must not be used.

6.01.11 Project Specific Signing (Updated 12/3/2020)

Unique and special temporary signs must be detailed (i.e. SignCAD) and included in the contract documents. Special temporary sign locations should be specified in the TTCP and the special provision for maintaining traffic.

When designing project specific signing, motorist comprehension of the sign and the meaning needs to be considered. If the information on the sign cannot be quickly processed by a passing motorist who is not familiar with the area, multiple signs may need to be utilized. It is recommended to have a person not familiar with the project review the design to determine if the sign is easily understood. Follow the Temporary Sign Design Guidelines in Appendix K.

6.01.12 Temporary Pavement Markings

Temporary pavement markings are installed in work zones to provide road users with a clearly defined path for travel through the work zone.

The two types of temporary pavement markings designated in the pay items, include Removable “Type R" and Non-Removable “Type NR".

Temporary wet reflective pavement markings increase guidance through the work zone during dry and wet conditions. Temporary wet reflective pavement markings may be paint or preformed tape and must be selected based on the pavement surface and time of year they are placed. Temporary Type R Tape and Type NR Paint pavement markings must be wet retroreflective.

For additional details please see the section titled "Temporary Pavement Markings" in section 812 of the Standard Specifications for Construction and PAVE 904-A Temporary Longitudinal Line Types & Placement.

Temporary markings must be removable if applied to the pavement surface course, unless lines are painted in the final configuration and the final marking is not a durable marking. Type R tape should not be used on courses other than the surface course unless the marking is removed prior to paving.

Type NR Tape pavement markings may be used to mark the base and leveling courses of asphalt and need not be removed. Type NR Tape is not to be used on any final surface course.

Payment for removing pavement markings, when necessary, will only be made for Type NR markings.

Temporary pavement marking products approved for use are listed on MDOT's Qualified Product List.

A. Pavement Marking Removal

Non-applicable or inappropriate permanent pavement markings must be removed before making any changes in the traffic pattern that will last longer than three days. This may be done using grinding, air, or water blasting. Painting over existing markings is not allowed per section 812.03.F of the Standard Specifications for Construction.

Scarring caused by the removal of temporary markings can result in a permanent shadow of a line that may be followed by a motorist. Temporary markings must be designed and placed such that abrasive removal techniques that result in the scarring are not used. To prevent scarring that could confuse a road user out of their lane, temporary wet reflective removable tape should be used in shift / taper sections.

B. Shift Markings (Updated 12/3/2020)

All temporary traffic shifts (except merging tapers) on freeways should be striped with 6-inch solid Wet Reflective Type R, Tape. 6-inch solid edge and lane lines must be placed 300 feet prior to the traffic shift, through the shift, and 300 feet after the traffic shift. This is required for both entry and exit shifts.

To provide contrast on concrete surfaces, a 4-inch white line may be used next to a 4-inch black contrast line. A field review should be conducted prior to choosing this method to ensure the black contrast tape does not conflict with existing crack seal.

Non-freeway shifts (except merging tapers), must be striped with 4-inch solid Wet Reflective Type R, Tape edge lines and lane lines must be placed 150 feet prior to the

traffic shift, through the shift, and 150 feet after the traffic shift. This is required for both entry and exit shifts.

The leading and trailing markings described above are used to provide motorists with additional guidance and reassure the driver they are in the correct location, as the lane lines will have just been modified.

C. Pav Temporary Raised Pavement Markers (TRPM), Type 3

TRPM, Type 3, may also be used to supplement edge line markings in temporary crossovers and traffic shifts. Spacing of devices should be at a minimum of 25-foot intervals beginning 250 feet in advance of the cross over shift and ending 250 feet beyond the crossover point on the tangent section.

D. Pavement Marking Cover

Covering existing markings with black Type R tape is allowed when specified in contract documents or as directed by the Engineer. Covering existing markings is typically done on short term tapers or in areas with frequent lane closure changes and must be done with black tape.

E. Curing Compound Removal

On newly paved concrete surfaces, the cuing compound should be removed prior to placing temporary markings. Removal of curing compound prior to placing temporary markings on new concrete must be done by water blasting. This will minimize the scarring of the surface. If the final markings are going to be placed in the same location, water blasting is not required.

F. Edge Line Markings

Temporary edge lines should be placed on new pavements in place for longer than three days or drums placed at 200 foot spacing or 42 inch channelizing devices placed at 100 foot spacing may be used to delineate the shoulder. Edge line markings are recommended for placement after 14 days. If temporary edge line markings are not placed after 14 days, the reasons should be documented.

Broken line applications of temporary paint or tape are not acceptable for edge line delineation. If the project requires striping in stages, it should be striped with temporary wet reflective markings until landscaping is complete, excluding water and cultivating.

G. Capital Preventive Maintenance (CPM) Projects

For CPM Micro-Surfacing projects, temporary pavement markings application and guidelines should be as described in Frequently Used Special Provision 12SP-811(E)-03, located on the frequently used special provision page.

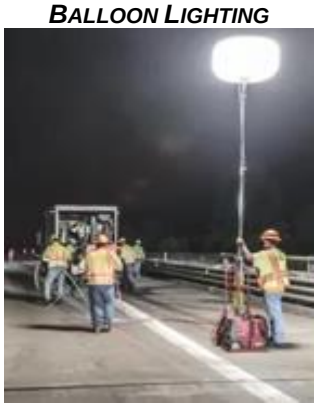
For cold mill one course HMA overlay and one course HMA overlay projects, the previously special provision, 12RC811-A475.pdf, can be used, which specifies that pavement markings should be placed at the end of the work day:.

For chip seal, micro surface, and crush and shape projects, place Temporary Raised Pavement Markers (TRPM) – Type 1, in accordance with the manufacturer's specifications to mark the centerline of the roadway. TRPM's should be removed prior to placing permanent markings. Space TRPMs at 25 feet (6F.79 of the MMUTCD).

6.01.13 Lighting (Updated 1/20/2020)

Lighting is required for night work in accordance with the Standard Specifications for Construction, Section 812, "Lighting for Nightwork." When traffic regulators are necessary for nighttime construction activities, supplemental lighting of the traffic regulators stations with balloon lighting is required.

EXHIBIT 6-11
BALLOON LIGHTING



Consideration should be given to placement of the lighting to ensure it does not shine into the drivers' eyes.

Provide a minimum illumination intensity of 10-foot candles (108 lux) on a jobsite where construction work is performed. Maintain a minimum of 5-foot candles (54 lux) throughout the entire area of operation where workers pass on foot or are present but are not performing construction work.

Lighting levels will be measured with an approved light meter (cell phone applications are unacceptable). Readings will be taken where the work is performed, in a horizontal plane, 3 feet above the pavement or ground surface. Vehicle or equipment headlights are not an approved light source.

6.01.14 Arrow Boards (Added 12/3/2020)

An arrow board is a sign with a matrix of elements capable of either flashing or sequential displays. The arrow board provides additional warning and directional information to assist in merging and controlling road users through the work zone. For stationary lane closures, the arrow board should be located on the shoulder at the beginning of the merging taper. Where the shoulder is narrow, the arrow board should be located in the

closed lane. Type A, B, and C arrow boards must have a solid rectangular appearance. See figure 6F-6 in the MMUTCD for more the requirements of each arrow board type. See MDOT Standard Specifications, section 812 for the requirements of arrow boards on MDOT projects.

EXHIBIT 6-12
ARROW BOARD

An arrow panel in the arrow mode must only be used for lane closures on multi-lane roadways. For shoulder work, blocking the shoulder, for roadside work near the shoulder, or for temporarily closing one lane on a two-lane, two-way roadway, the arrow panel must be used in the caution mode (bar mode).

For addition information on arrow board display options, see Figure 6F-6 in the MMUTCD.

The arrow board must be inspected to make sure it is working properly. Form 1013S may be used as a check list.

When arrow panels are used to close multiple lanes, a separate arrow panel must be used for each closed lane. If the first arrow board is placed on the shoulder, the second arrow board should be placed in the first closed lane at the upstream end of the second merging taper. When the first arrow board is placed in the first closed lane, the second arrow board should be placed in the second closed lane at the downstream end of the second merging taper.

6.01.15 Portable Changeable Message Sign (PCMS)

PCMS are an effective way to provide additional information to road users. Usage must be designed according to the needs of the project and follow the PCMS Guidelines in Appendix F.

PCMS may be programmed with specific messages which may be modified as needed and are supplemental to other warning signs. Only two message screens per PCMS are allowed. If additional information is necessary, an additional PCMS should be used at a separate location.

TABLE 6-4: PCMS TYPICAL APPLICATIONS

• Long queuing and delays are expected
• Adverse environmental conditions are present (i.e. ice, snow, wind)
• Major changes in alignment or surface conditions
• Where advance notice of ramp, lane or roadway closures is necessary, due to a desire to increase traffic diversion
• Advise of a crash or incident
• Changes in the road user pattern
• Work zone stage changes
• Road work scheduling advisories
• Real-time travel time messages

Designers should limit the usage of PCMS boards to specific areas and include specific language in the TTCP for each board at each stage. PCMS boards should not be used in the same location displaying the same message for more than 2 weeks. Static temporary signs should be considered for such locations. The National Transportation Communications for ITS Protocol (NTCIP) compliant PCMS aids in posting traffic incident response messages, current and accurate construction scheduling messages, or real-time traveler information.

The NTCIP system should be considered on all projects. It is recommended to use NTCIP compliant PCMS for projects that do not have a dynamic message sign in place, areas containing historically high crash rates, remote areas or high impact roadways. Use should be considered and documented during the development of the project. If a project warrants the use of travel time messages that require more than eight characters per line, or a message with formatting that does not fit on a standard PCMS, then the use of the Full-Matrix NTCIP-Compliant PCMS is needed. Region approval is required prior to the use of a full matrix PCMS.

6.01.16 Temporary Traffic Signals

Temporary signals are typically used in work zones to control traffic when one lane is closed and alternating traffic movements are necessary. For temporary traffic signal installations, provide a TTCP that includes the location in relation to the work operation, based on the geometrics, operation and delay of traffic.

When work operations are suspended and traffic lanes will be open for less than 72 hours, the temporary signal may remain in place in flash mode. If the temporary signal will be non-functional for longer than 72 hours, the signals should be removed from the roadway. When signals are removed, signs must be removed or covered.

A. Temporary Mounted Signal System

A fixed temporary signal system is recommended where there is adequate power available and the temporary signal will be in place for 30 days or more.

Temporary traffic signals should have actuation when one or more of the following conditions exist on the project site:

- Traffic volumes are low enough to create time periods when a vehicle would be held on a normally timed red signal with no opposing traffic present.

- Traffic volumes are unbalanced and heavy directional traffic may be stopped on multiple red indications before the entire queue can clear the signal.

The temporary signal configuration must be evaluated to determine the recommended timing for each stage of construction. The temporary signal timing must be determined using the approved mobility analysis tools summarized in Section 3.03.

Typical intersection evaluations use Synchro software or the procedures outlined in the HCM to determine the temporary signal timing. MDOT's Traffic Signals Unit should be contacted for the temporary mounted signal timing and for any further questions.
For more information on temporary signals see section 3.01.03.

B. Temporary Portable Signal System

A Temporary Portable Signal System is recommended for locations when it is not feasible to use a temporary mounted signal system or where the signal will be in operation for less than 30 days. Signal timing for temporary signals are based on speed and the length of the work zone. Contact the WZMU for timing assistance.

1. Temporary Portable Traffic Signal (PTS) System – Trailer Mounted

Each PTS system consists of two trailer-mounted, solar powered portable traffic signals with battery back-up.

A trailer mounted system is recommended when a temporary portable signal system is in place, without active work. This device carries a larger footprint than a pedestal mounted system but provides a more stabilized setup which is needed for longer durations.

Exhibit 6-13
Temporary Mounted Signal

2. Temporary Portable Pedestal-Mounted Traffic Signal System

A temporary portable pedestal mounted traffic signal system is defined as four connected pedestal-mounted traffic signal units designed to control two directions of traffic. This

device has a smaller footprint, is more portable than a trailer mounted system, and does not place a signal head over the active lane (has a signal on each side of the roadway).

A Temporary portable pedestal mounted traffic signal system may only be used when active work is taking place. It should be considered for projects that will frequently change locations. This system may also be used in lieu of a traffic regulator operation when the project location has limited access points and does not require intermediate traffic regulators.

EXHIBIT 6-14
TEMPORARY PORTABLE PEDESTAL-MOUNTED TRAFFIC SIGNAL

6.01.17 Automated Flagger Assistance Device (AFAD)

Automated Flagger Assistance Devices (AFADs) enable a traffic regulator(s) to be positioned out of the lane of traffic and can be used to control road users through temporary traffic control zones. These devices are designed to be remotely operated either by a single traffic regulator at a central location, or by separate traffic regulators at each device's location.

When a single traffic regulator is operating two AFAD's from a central location, the AFAD's must be a maximum of 750 feet apart with a line of sight to each AFAD. If the work operation will take longer than 4 hours, then it is recommended to have an additional standby regulator. When AFAD's are placed farther apart, a traffic regulator must be placed at each AFAD location to operate each AFAD. AFAD's are only to be used on low volume roadways with no side roads in between unless there are equipped intermediate traffic regulators at each crossroad or commercial driveway.

AFAD's must be equipped as defined in the MMUTCD under section 6E.04 and have met the below requirements:

- AFAD's must have a 8'-10' break away cross bar with a manual and automated intrusion alarm system and a locked cabinet.
- Camera's and tablets will not be allowed for use with AFAD's.
- The regulator should not have a personal or work vehicle placed within 500 feet of the AFAD station when two regulator stations are in use.
- Regulators must communicate with each other by using handheld radios and may use an approved stool as described in the Traffic Regulating manual.
- When not in use the AFAD's must be removed from the roadway.

EXHIBIT 6-15
AUTOMATED FLAGGER ASSISTANCE DEVICE

6.01.18 Glare Screening (Updated 1/20/2020)

Glare screening is used on temporary barriers separating opposing traffic to reduce headlight glare from oncoming traffic. This screening also reduces the potential for motorist confusion by shielding the headlights of other vehicles on adjacent roadways or construction equipment.

Glare screening should be used on all projects where opposing traffic is separated by temporary barrier in tangents, crossover locations, curved areas and elevation changes.

6.01.19 Transverse Temporary Rumble Strips (Updated 12/3/2020)

Transverse rumble strips are used to provide a tactile and audible alert to traffic, typically in advance of a closure/shift point. They alert motorists to changing roadway geometry, advance notification, or stop conditions. Noise consideration should be a factor when determining locations.

A. Fixed Temporary Transverse Rumble Strips – Freeway

Fixed transverse rumble strips may be placed on freeway projects that remain in place for three days or more as determined by the Engineer. They should be considered on freeway projects with sight distance concerns, where traffic volumes are such that queues extend well past the typical influence area or where changing conditions warrant additional driver attention.

Rumble strips may also be used to draw additional attention to temporary signing. Rumble strips should be located upstream of the sign (500 to 1,000 feet) to allow distracted drivers time to hear the sound, refocus on the roadway, and observe messaging that may be in

place. This method is extremely effective when using a stopped traffic advisory system, detailed in section 6.06.04.

On MDOT projects, where lane closures or crossover shifts will be in the same location for 14 consecutive days or longer, Temporary rumble strips (orange) shall be used in accordance with 812.03.D.13 of the 2020 Standard Specifications for Construction.
.

EXHIBIT 6-16
TEMPORARY RUMBLE STRIPS IN ADVANCE OF A WORK ZONE

B. Fixed Temporary Transverse Rumble Strips - Non- Freeway

When a project modifies or establishes a stop condition, the pay item Temporary Rumble Strips (Orange) shall be used in accordance with the section titled "Temporary Rumble Strips (Orange), in the Standard Specifications for Construction, section 812.

EXHIBIT 6-17: TEMPORARY RUMBLE STRIPS IN ADVANCE OF A STOP SIGN

C. Portable Temporary Transverse Rumble Strips - Non- Freeway

Temporary portable rumble strips are designed to alert motorists of changing traffic patterns and reduce rear end crashes in advance of work zones. They also protect traffic regulators and workers by alerting distracted drivers prior to entering the work zone. These rumble strips are ideal for work zones where daily installation and removal is required. The portable rumbles do not have adhesive or get nailed to the surface of the roadway. The portable rumble strips are not recommended to be placed on fresh crack seal or chip seal projects.

Temporary portable rumble strips may be used on roadways with a speed limit of 65 MPH or less and should be considered for projects with active work, traffic regulating, or limited sight distance to the work zone. Some applications where temporary portable rumble strips may be placed in advance of are:

- Emergency Traffic Control
- Traffic Regulating Operations

- Temporary Lane Closures
- Traffic Shifts

Temporary portable rumble strips should be placed in accordance with the special provision for Temporary Portable Rumble Strips, 12RC812-A480. Use on all regulating projects with existing speed limits of 45mph or higher where traffic regulating will be in place longer than 4 hours. Optional use for local agency and all other trunkline projects.

These devices are designed to be placed and removed with the lane closures. If the closure is to remain in place for an extended duration the rumble strips must be monitored and adjusted as detailed in the specification.

EXHIBIT 6-18
TEMPORARY PORTABLE RUMBLE STRIPS

6.01.20 Existing Longitudinal Rumble Strips

Existing longitudinal rumble strips may make drivers uncomfortable if traffic is shifted onto them. When traffic is shifted onto the shoulder and places the vehicle wheel track within 12 inches of the rumble strip, the rumble strips may be removed, filled, or left in place. This treatment will vary depending on project duration, location, surrounding land usage and work type, as determined by the Engineer. Contact Pavement Operations for best practice information.

In transition areas where traffic is only shifted across the rumble strip, additional signing may be placed advising the motorist of the crossing.

In tangent areas where rumble strips will not be removed or filled, signing must be installed to advise motorists

EXHIBIT 6-19
RUMBLE STRIPS WARNING SIGN

6.01.21 Pilot Vehicles

Pilot vehicles are used in traffic regulator applications for one lane operations on two lane, two-way roadways. Pilot vehicles should be considered for any project in which diverted traffic may have difficulty navigating the temporary route or to control the pace of traffic such as crush and shape projects.

When determining the use of pilot vehicles, site conditions should be reviewed to ensure speeds are established appropriately.

Temporary traffic control is required when using a pilot vehicle. For further requirements of pilot vehicles, refer to MMUTCD Part 6 (Section 6C.13).

6.01.22 Innovative Traffic Control Devices

Traffic control devices not presented in this manual should be considered for use in work zones to reduce crashes, risks, and consequences of motorized traffic intrusion into the work space or to improve mobility. Please contact the WZMU for information on recently developed/approved products, or to recommend a new product for a pilot project that may have a tangible benefit.

6.01.23 Rolling Roadblocks (Added 1/20/2020)

A rolling roadblock is a technique used to temporarily slow or stop vehicles in order to provide a gap in traffic in advance of construction activities. Temporarily removing or slowing traffic enables the completion of short-term work where a long-term closure using standard TTC devices is not needed.

A. Work Activities

Location and traffic volumes may require the contractor to perform a rolling roadblock to allow for access of construction vehicles and material delivery. This method should be used during off-peak hours and only when traffic volumes don't allow for ingress and egress into the work site and should be detailed as part of the internal traffic control plan.

B. Construction

Traffic should not be stopped for over fifteen minutes. Additional stoppages should not be conducted until the traffic queue has cleared completely. Traffic queue formations and dispersals should be monitored.

All efforts should be made to conduct all traffic stoppages utilizing law enforcement officials and vehicles. When not available, one construction vehicle per open lane of traffic with a permanently affixed rotating beacon or strobe light should be used. These vehicles should start in their appropriate lanes, beacons on, well in advance of the signing sequence flowing normally with traffic. As they progress through the signing sequence, they should slowly reduce their speed until a full stop is attained at the prescribed stopping point.

Appropriately marked construction vehicles with an amber rotating beacon and conspicuity tape should be used at a minimum. As a best practice a "Pilot Car, Follow Me" sign should be considered. Law enforcement should always be considered the first choice over contractor vehicles if this is to occur at a high frequency during the project.

C. Operations Plan

Before implementing a rolling roadblock for planned work, a meeting with all stakeholders to define responsibilities and ensure the activities for successfully executing a rolling roadblock should be completed. An emergency plan should be developed to handle traffic should unforeseen circumstances occur. Emergency response agencies should be notified of the dates and times of the rolling roadblock. All efforts should be made to inform the public at least 3 days in advance of the roadblock. Dynamic message signs (DMS) or portable changeable message signs (PCMS) should be used to alert the users of the operation and when it will be happening that day including the day and hours. A press release should be issued to radio/television stations, newspapers, the agency's website, and any applicable agency social media sites. A final meeting among stakeholders before executing the rolling roadblock should be held to ensure all comments have been addressed.

6.02 SPEED LIMITS IN WORK ZONES (Updated 12/3/2020)

Work zone speed management must follow current department policies, provided in *Guidelines to Establish Speed Limits in Work Zones*, located in Appendix E. Work zone speed limits should be monitored during construction.

Revisions or refinements should be considered if speed compliance by the road user is determined to be lower or higher than acceptable or if there are indications that the posted speed limits may be contributing to safety issues.

A temporary Traffic Control Order (TCO) is required when a speed reduction is posted when the work is 2 feet or greater from the edge of the traveled way and no lanes are closed. See the Traffic Regulations Guidelines and the Traffic Regulations Engineer Manual for more information about obtaining a traffic control order.

If the work is located within 2 feet of the traveled lane, a temporary TCO is required for speed reductions greater than 10 mph and reductions lowering the speed limit below 30 MPH, excluding the posting of 45 mph Where Workers Present (WWP).

For roadways with posted speeds of 75 mph, the speed should be reduced from, 75 mph to 60 mph and, when appropriate, 45 mph WWP, following current work zone guidelines. The 15 mph drop is allowed for 75 mph roadways to promote uniformity by posting a work zone speed limit of 60 mph, and to reduce worker exposure by eliminating an additional speed limit signs.

In areas where the workers are protected by barrier wall 45 mph WWP should not be posted.

When speed reductions are used, the factors used to determine the reduced speed must be included in TTCP and must be based on engineering judgment.

6.03 QUALITY GUIDELINES

The condition and maintenance of traffic control devices is critical as they serve as the first line of safety for the work zone and transportation customers.

The quality of temporary traffic control devices is referenced in the most current edition of the *Quality Guidelines for Work Zone Traffic Control Devices and Features published by ATSSA.* This document is available for MDOT staff through the WZMU or for purchase directly from ATSSA. Additional information may be found at http://www.atssa.com/ (on-line store).

Additional maintenance and cleaning requirements are shown in Sections 812 and 922 of the Standard Specifications for Construction. Inspection methods and acceptance criteria are detailed in*Temporary Traffic Control Certification and Acceptance Procedure* of the Materials Quality Assurance Procedures Manual.

6.03.01 Channelizing Device Quality Process (Added 12/3/2020)

This section serves to give guidance for the payment of drums and channelizing devices, as described in the section titled “Damage Compensation” in Section 812 of the Standard Specifications for Construction. This section also provides examples of drums and channelizing devices rated acceptable, marginal, and unacceptable.

Damaged devices are defined as those devices that have fallen into the unacceptable range per the *American Traffic Safety Services Association Quality Guidelines for Temporary Traffic Control Devices and Features* (ATSSA QG) after initial inspection.

A flat rate for replacement for drums and 42” channelizing devices has been agreed upon by MDOT and MITA. These rates, detailed in the specifications, will be used for damage compensation.

A. Process

Until initial inspection of the traffic control devices has been made, no damaged compensation claims have to be paid, unless otherwise determined by the engineer. No damage compensation or initial payment will be made for devices failing initial inspection. Devices must also be placed appropriately to be eligible for damage compensation. Devices will be assumed to be placed appropriately unless it is otherwise documented.

If Project Staff witness a contractor, or any individual working for the contractor, damage a traffic control device, no damage compensation will be paid. This must be documented in order to refuse payment.

During the course of the project, after initial inspection, MDOT will flag marginal devices with a blue ribbon for replacement at stage changes, or when more than 25% of the total quantity on the project are in marginal condition. At these times, as stated in the ATSSA Quality Guidelines, all devices within the work zone must be brought up to 100% acceptable condition.

If at any time, any Contractor is witnessed tampering with the marginal marking method, the Engineer may require all marginal devices on the project to be upgraded to acceptable outside the timeframes detailed in the ATSSA Quality Guidelines.

The Contractor may clean the drums or 42” channelizing devices to bring them back up to the acceptable condition, but will need permission from Project Staff to remove the ribbon, if the devices are to be placed back on the same project.

Prior to payment, Project Staff need to meet with the Contractor to determine which devices are damaged to the unacceptable range. Once a device has been deemed unacceptable and has not been documented as misplaced or damaged by the Contractor, MDOT will spray paint an X on the device so it is taken out of inventory. These devices will then be removed from the project and disposed of by the Contractor. If any device is removed from the project before inspection, no damage compensation payments will be made.

If traffic control remains on the roadway after project completion (excluding water and cultivating) and is waiting to be picked up, no damage compensation will be paid.

The goal of this process is to increase the quality of the traffic control devices on projects. Documenting and removing the marginal & unacceptable devices will lead to a safer work zone for the workers and the motoring public.

For questions or concerns about this process please contact the WZDE.

EXHIBIT 6-20:
ACCEPTABLE DRUMS

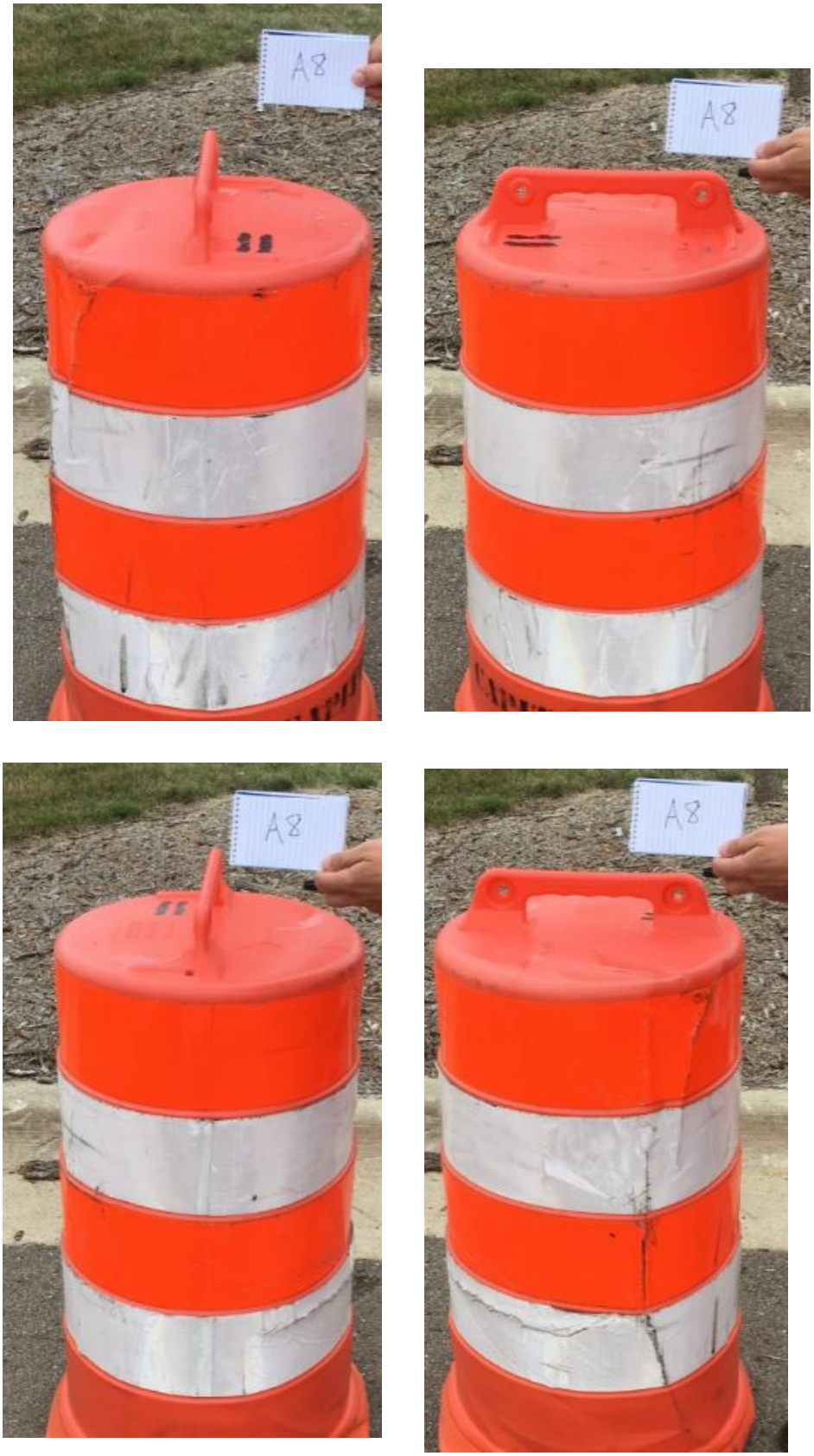


EXHIBIT 6-21:
ACCEPTABLE DRUMS

EXHIBIT 6-22:
MARGINAL DRUMS

EXHIBIT 6-23:
MARGINAL DRUMS WITH BLUE RIBBON

EXHIBIT 6-24:
UNACCEPTABLE DRUMS

EXHIBIT 6-25:
UNACCEPTABLE DRUMS

EXHIBIT 6-26:
ACCEPTABLE 42" CHANNELIZING DEVICES

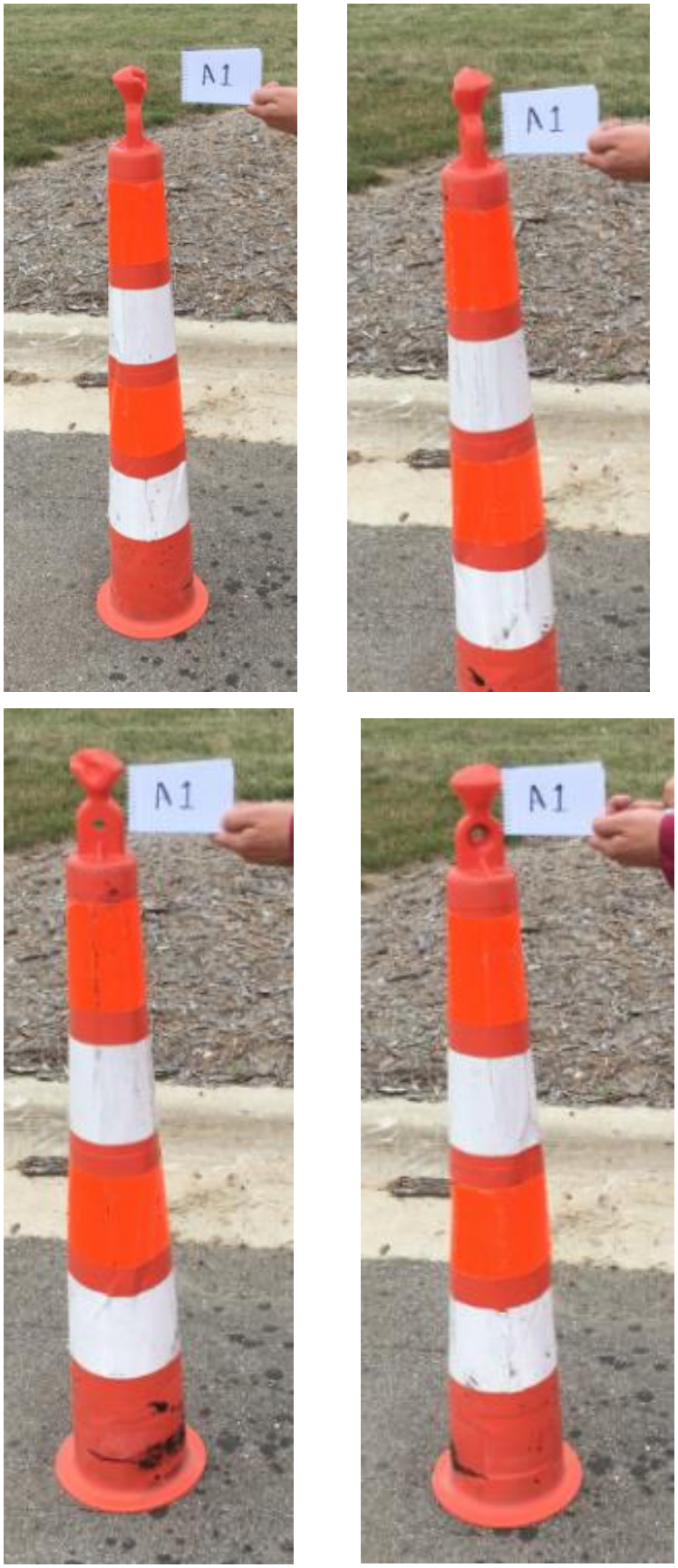


EXHIBIT 6-27:
MARGINAL 42" CHANNELIZING DEVICES

EXHIBIT 6-28:
UNACCEPTABLE 42" CHANNELIZING DEVICES

6.04 DETOURS & ALTERNATE ROUTES

The project designer should ensure that sign placement will fit the locations shown along the detour or alternate route and that signing will not conflict with existing signs, bridges, driveways, trees, landscaping, or pedestrian movements. Detours and alternate routes should be reviewed for upgrades to existing signing, pavement marking and traffic signals. Considerations must be given to the adequacy of shoulders, lane widths, turning radius for commercial vehicles (Auto-turn or turning template(s)), and structural condition of pavement. Timing may need to be adjusted on signals along the detour route.

Project designers must coordinate and document approval of detours and alternate routes with local transportation agencies and affected parties to avoid conflicts with local projects and transportation needs (email may serve as official documentation). In addition, a field review of the detour should take place to assess route conditions. Traffic volumes should also be observed. Anticipated modifications to existing traffic patterns should be noted during the field review.

All existing restrictions (horizontal, vertical, weight) must be evaluated on the proposed detour or alternate routes to ensure that traffic is not further impeded or restricted. Emergency services should be provided access to the worksite at all times for any emergency related event within or adjacent to the work zone. Project engineers should evaluate and discuss detour and alternate routes with emergency service providers (fire, police, ambulances, etc.) so that response times may be reviewed and taken into account. Contractors are required to include emergency access plans as part of the WZTCP and coordinate with the emergency service providers.

Consideration must be given to detour routes that cross railroad crossings at grade. An increase in traffic volumes on the detour route may require the use of gates at the crossing. The WZMU should be contacted when a detour route includes an at-grade crossing to determine the necessary traffic control.

6.04.01 Full Road Closures

Full road closures are the most positive separation of road users and workers. They must be evaluated and considered for projects with underground utility work, bridge demo, deck replacements, and complete reconstruction activities. Consider expedited work schedules to complete the work and return the road to the user as quickly as possible. Road closures also impact travel time as there may not be reasonable detour routes around the project site.

Detour routes for a full closure must also be reviewed for capacity, existing crash patterns, and signal timing that could contribute to additional crashes and delay.

In advance of a closure, lighted Type III barricades must be placed on the shoulder or behind curb at the nearest cross road in advance of the closure. R11-3 signing must be placed above and behind the Type III barricades.

At a road closure point, lighted Type III barricades must be placed across the entire closed area. R11-2 or other R11 series signs must be placed on or above and behind the Type

III barricade in the center of the closure. Refer to MMUTCD Part 6 (Sections 6F.08- 09 and Figure 6F-3).

Areas that warrant additional protection from a hazard, or if traffic is found to be moving signs, the special provision for Temporary Water Filled Base Sign System - 12RC812-A445 may be utilized.

6.04.02 Directional Detours

Directional detours provide additional work space for part width construction. It is recommended that these types of closures are evaluated in the same manner as complete roadway closures where a specific direction of travel may need to be detoured. Projects must be reviewed carefully to determine which direction of travel should be detoured. Impacts on road user travel and their ability to change their travel path must be Included in the review.

For non-freeway projects, it is recommended to detour traffic the same direction for the duration of the project. This provides motorists with consistent routes and travel paths as changing back and forth could lead to head-on traffic crashes. Consistency is critical for areas that have residential or business driveway access.

In business or residential areas, public feedback may be helpful in determining which direction to detour. Public input should be taken into consideration but engineering judgment should be utilized when making the final MOT selection.

Turning movements and existing capacity of the detour route, along with public input, should be a factor in the design. A detour route that has all right hand turns and free flow movements would be desirable over left hand turns.

Freeway projects have controlled access points so the need to maintain the same direction of traffic for the duration is not as critical for non-freeways. The traffic volumes and viable detour routes should be considered when determining which direction to maintain during the course of the project.

6.04.03 Ramp Closures

Ramp closures can provide separation of road users and workers and also reduce the amount of interaction between mainline traffic and entering traffic. Ramp closures should be evaluated when construction is occurring at or near the merge point and when merging locations will require a stop condition or visibility is impacted. These locations are known to contribute to congestion, backups, and rear end and side swipe crashes. Closing ramps may improve the safety and travel time of mainline traffic.

Design considerations should include requirements to prevent the closure of adjacent interchanges simultaneously. Consideration should be given to expedited work schedules to complete the work and return the ramp to the user as quickly as possible.

6.04.04 Detour Signing

The type and location of detour signing depends on the following factors:

- ADT

- Area traffic generators (i.e. commercial or institutional land uses nearby residential areas and transit stops).

- Time of year

- Project duration

- Other consideration: emergency operations, incidents, planned special events, etc.

Detour signing must be placed as described in the MMUTCD Part 6 (Sections 6F.19, 6F.20, 6F.28, and 6F.59). Guidance for freeway, ramps, non-freeway and local roads are summarized in Tables 6-8 and 6-9.

Cardinal directional signs (North, South, East, West) are required if both directions of the roadway are closed and detoured. If the detour route combines both directions, the cardinal direction sign may be eliminated. Detour signs posted on non-freeway routes at left turns should be posted at the near right and far left of the intersection. On freeways, one-way, and/or divided roadways, detour signs should be placed on both sides of the roadway in the same direction.

When signing for a detour ahead or road closure ahead, adding a supplemental plaque is required when the sign is not on the roadway to be closed or detoured. A route marker should be used or the road name can be spelled out if space allows as shown in Exhibits 6-29 and 6-30.

Exhibit 6-29:
DETOUR WITH ROAD NAME

Exhibit 6-30:
DETOUR WITH ROUTE MARKER

A. Sign Color and Sizes

Detour sign color is based on the parent route marker sign. The local road name must not extend past the edges of the M4-9 sign by more than 3 inches on either side. The letter size of the sign may need to be reduced to fit within these dimensions. If the road name consists of two words, they may be placed on two separate lines. For detour signs designed with route marker signs, use the standard sizes and colors as described in the Work Zone SHS Manual (SHS 13-Work Zone) found on the MDOT Traffic Signing page.

The M4-8 "DETOUR" plaque must be used on top of all state route detours with the route marker designation. The M4-8 sign is always on an orange background with black letters. Additional information regarding route markers can be found in MMUTCD Part 2 .

EXHIBIT 6-31: DETOUR CLUSTERS

The addition of special sign designs may be appropriate for some projects to enhance the standard detour signing. These signs have an orange background with a black border and should include the route marker signs and arrows. The word "DETOUR" is not required for these signs as they are recognized as a construction detour sign.

EXHIBIT 6-32: SAMPLE DETOUR SIGNS

B. End Detour

END DETOUR (M4-8a) signs are recommended to end a detour route. If the detour is for a local route, the road name plaque must be placed above the M4-8a sign. If the detour route is a numbered route, the cardinal direction and the route plaque (if appropriate) is required below the M4-8a sign as detailed in exibhit 6-20.

C. Portable Changeable Message Signs (PCMS)

PCMS may be used for detours less than 72 hours in lieu of detour signing as determined by the Engineer.

Example:

Closing a low volume ramp overnight; place PCMS board in advance of ramp closure with the following messages:

Phase 1: EXIT XXX CLOSED AHEAD

Phase 2: USE EXIT XXX

OR

Phase 1: EXIT XXX CLOSED AHEAD

Phase 2: FRIDAY 9 PM -10 AM SATURDAY

Additional information regarding PCMS placement and messaging is provided in Appendix F and in the MMUTCD Part 6 (Section 6F.60).

TABLE 6-5: NON-TRUNK LINE DETOUR SIGNING DESIGN GUIDELINES

Detour Duration	Non-Trunk Line Detour	
	Signing	**Example** (*all road name signs to be paid for as Sign Type B Special)
< 24 hours	• M4-9 (R) (L) - Detour Sign with appropriate directional arrow at each decision point. • Or portable changeable message boards (6.04.04 Section C)	
24-72 hours	• M4-9 (R) (L) - Detour Sign with Road Name Plaque and appropriate directional arrow at each decision point. • Or portable changeable message board (6.04.04 Section C)	
> 72 hours	• M4-9 (R) (L) (U) - Detour Sign with Road Name Plaque and appropriate directional arrow at each decision point near right and far left corners of the intersection. • M4-9 (UL) (UR) - to be placed in advance of each turn. • An “up” pull through arrow should be required after each major intersection, and should be considered after each turn decision point.	

TABLE 6-6: TRUNK LINE DETOUR DESIGN SIGNING GUIDELINES

Detour Duration	Trunk Line Detours	
	Signing	**Example**
< 72 hours	• M4-8 Detour Plaque • M3-1, M3-2, M3-3, M3-4 Cardinal Directional Sign • M1-1, M1-2, M1-3, M1-4, M1-6 Route Marker Sign • M6-1(R)(L), M6-2(R)(L) Directional arrow at each turn or exit. • A PCMS may be used for simple detours (6.04.04 Section C)	
> 72 hours	M4-8 Detour Plaque • M3-1, M3-2, M3-3, M3-4 Cardinal Directional Sign • M1-1, M1-2, M1-3, M1-4, M1-6 Route Marker Sign with directional plaque must be placed in advance and at each turn. • M5-1, M5-2, M5-3, M6-1, M6-2, M6-3 Directional Arrow at each turn or exit • An "up" pull through arrow is recommended after each major interchange and after each turn or exit.	

TABLE 6-7 DETOUR SIGNING PLACEMENT GUIDELINES

Detour Signing Placement Guidelines			
Roadway	**Turning Detour Signing**	**Advance Turn Detour Signing**	**Pull Thru Detour Arrow Signing**
Non-Freeway	50 feet (min) before intersection spring point	500 feet (min) before intersection spring point.	500 feet (max) after intersection
Freeway	100 feet (min) before exit lane taper	1/2 Mile (min) before exit lane taper	500 feet (max) after lane merge taper
Ramps	50 feet (min) before spring point	500 feet (min) before spring point	N/A

6.05 GEOMETRIC DESIGN & SAFETY

Design engineers must design safety into all MDOT work zones and address safety considerations in all MOT's. Considerations include items such as vertical differentials, vertical / horizontal clearance, lane widths, etc. and must be evaluated when scoping and designing projects.

6.05.01 Lane Transitions and Widths

Existing lane widths should be maintained during construction when feasible. Consider the following factors when narrowing lanes or shifting traffic:

- Overall roadway width available
- Posted speed limit
- Traffic volumes through the project
- Number of lanes
- Length of project
- Duration of the lane width reduction
- Roadway geometry
- Percentage of commercial traffic
- Special vehicles such as campers and boats

Lane transitions, reduced lane width, and traffic control changes in conjunction with the proximity of temporary traffic control devices must be designed in a manner that does not result in an unexpected condition for the motorists.

Projects should have a minimum 11-foot lane, and any shoulder next to an open ditch should be at least 3 feet from the hinge point (2 feet paved with 1 foot aggregate preferred). If the required lane widths and shoulders cannot be maintained during the staging of a 3R / 4R freeway project and the project is next to an open ditch or roadway section, a work zone shoulder width variance request must be completed using Form 5632 Open Ditch 3R/4R Freeway Work Zone Width Variance Request.

Submit variance request to WZMU for review by the Traffic and Safety Statewide Alignment Team (TSSAT). The TSSAT will provide one of the following recommendations.

- The MOT design is acceptable based on the documentation provided and the project can proceed.
- The MOT design is acceptable, but additional mitigation methods, as noted by the review team, should be incorporated into the project, and the project can proceed.

- The MOT design is unacceptable and requires the project office to adjust the MOT design.

Shoulder delineation devices must be used as detailed in WZD-126. Flexible delineators, delineator panels, or flexible guardrail delineators must be used on narrow shoulders. Contact the WZMU to discuss additional mitigation measures.

6.05.02 Shy Distance and Buffer Zones

Shy distance is defined as the distance from the edge of the travel lane to the nearest roadside object or traffic control device.

Lateral buffer zones provide additional space between the motorist and temporary traffic control devices, work zone operations, and equipment and materials. Lateral buffer spaces should be included anytime there is additional space. A 2-foot shy distance is optimal, however, a 1 foot shy distance is acceptable. The TTCP must provide the lateral buffer zone or clearance dimension to be used during construction operations.

Longitudinal buffer zones are provided at the beginning of the work zone between the end of the temporary traffic control transition and the beginning of the active work area. The length of this buffer zone, defined in the maintaining Traffic Typicals.

In locations with intersecting side streets or business driveways, it may be safer to reduce the amount of buffer space below the typical layout to allow for a more defined work zone. If this occurs on a project, documentation explaining the reasons the typical length was reduced should be provided.

6.05.03 Work Zone Clear Zone

The contractor's operations may be exposed to errant vehicles that enter areas adjacent to the traveled way. A Work Zone Clear Zone (WZCZ) must be maintained by the contractor as part of the WZTCP to address storage of equipment, employee private vehicle parking, storage/stockpiling of materials, etc.

The WZCZ applies during working and non-working hours and will only apply to roadside objects introduced by the contractor's operations. If the equipment or materials cannot be relocated outside the WZCZ then the items must be delineated or attenuated with appropriate traffic control devices.

The WZCZ and buffer zone dimensions should be evaluated and increased where appropriate for horizontal curves, long downgrades, steep inclines and locations of high traffic volume.

See section 7.01.10 Clear Zone History of the MDOT Road Design Manual for detailed information on the WZCZ.

6.05.04 Vertical Under Clearance

It is critical to maximize the vertical under clearance on all construction projects. Any reductions to the existing vertical under clearance below the required minimum structure height must be posted on the Active Permit Restriction Bulletin System and signed on the

construction project. For more information, see Design Criteria – New and Reconstruction Projects – Vertical Underclearance in Bridge Design Manual.

An orange on black W12-2 sign should be used. The TSC Permit Engineer or Agent can assist with the posting of any reductions to existing under clearance.

6.05.05 Lane Edges

Vertical differentials should be minimized, mitigated, or eliminated. Anticipated vertical differentials should be included in the project plans along with the requirements for warning the motorist. The section titled "Chip Seal Surface Treatment and HMA Construction, Staggered Lane Endings with Vertical Longitudinal Joints," in section 812 of the MDOT Standard Specifications for Construction provides additional requirements for shoulders and vertical longitudinal joints while maintaining traffic.

Vertical differential treatments are shown in *Table 6-8: Lane and Edge Drop Treatments*. Uneven lane (W8-11) warning signs should be repeated after each intersection or interchange, and at additional locations as determined by the Engineer.

TABLE 6-8: LANE AND EDGE DROP TREATMENTS

Differential	Distance from the Active Traffic Lane	
	0 to 3 feet for shoulders or between directional traffic lanes*	3 to 8 feet
0 to < 2 inches without taper	Install shoulder drop-off signing or uneven lane signing	Install striped edge line Install Low Shoulder signing (optional)
2 to < 4 inches with 1:3 taper	Install shoulder drop-off signing or uneven lane signing	Install striped edge line Install Low Shoulder signing (optional)
2 to < 4 inches without taper	Install shoulder closed signing or uneven lane signing, and Install channelizing devices	Install Shoulder Closed signing Install channelizing devices
4 to < 12 inches with 1:4 taper	Install shoulder drop-off signing or uneven lane signing	Install striped edge line Install Low Shoulder signing (optional)
4 to < 12 inches with 1:3 taper	Install shoulder closed signing or uneven lane signing, and Install channelizing devices	Install shoulder Closed signing Install channelizing devices
4 to < 12 inches without taper	Install shoulder closed signing or uneven lane signing, and Install channelizing devices Install Type III barricades, at 20xS spacing	Install Shoulder Closed signing Install channelizing devices Install Type III barricades at 20xS spacing
12 inches or greater	Install barrier wall or reduce Channelizing device spacing**	Install Barrier wall or reduce channelizing device spacing*

* Standard Plan R-53 must be followed for barrier that is 0-26 inches from the drop-off, outside 26 inches follow Standard Plan R-126

** Use channelizing devices at a reduced spacing if mobility requirements on the project prohibit the use of barrier wall.

6.05.06 Freeway Ramps

When construction activities require ramp traffic to be maintained off existing alignment, design the temporary ramp alignment to meet a minimum design speed of 10 mph below posted speed prior to construction (Standard Plan R-113). Once the proposed ramp work is complete and can be opened to traffic, remove temporary traffic control devices that modified the freeway ramp traffic.

Placing a stop or yield condition for freeway entrance ramps should be avoided by supplying a merge area that is similar to the pre-work zone distance, during the project life. Consider temporarily closing the ramp to complete the necessary work.

If there must be a shortened gap requiring a stop or yield condition in the ramp area, minimize the amount of time the gap is shortened; expedite the work, try to avoid peak traffic times, and restore the ramp to a merge condition as soon as possible.

6.05.07 Relocating Traffic

Project scoping and design staff should verify the existing conditions and thicknesses to ensure the pavement will be able to handle the expected traffic volume (passenger & commercial). Pavement core samples should be taken to verify the condition of the pavement.

A. Road Way

When shifting traffic, review the roadway to ensure the integrity of existing features (i.e. drainage structures, culverts, handholes etc.) can support the expected traffic. The review should take place just before shifting traffic to verify the current pavement condition has not deteriorated or the design has not been modified.

Existing rumble strips should be evaluated for proximity to wheel paths and temporarily filled where appropriate. Determination and guidance is detailed in section 6.01.21.

B. Vertical and Horizontal Clearance

Vertical and horizontal clearances should be evaluated on shoulders in the same manner as the mainline as detailed in 6.05.04 Vertical under Clearance.

C. Objects within the clear zone

Objects within the clear zone should be identified using object markers. If feasible, object should be removed, otherwise they will need to be protected. Existing guardrail runs should be evaluated with the temporary edge of travel lane and adjustments should be included in the TTCP.

D. Shoulder Conditions

Existing lateral conditions and construction operations may result in a narrow shoulder while maintaining traffic. The project designer should evaluate the cost to pave additional shoulder width in these areas to improve safety and mobility.

All permanent shoulders or shoulder widening that will be used as temporary lanes, with construction speeds of 45 mph or greater, when traffic is shifted onto a shoulder that has been

temporarily widened for maintaining traffic must incorporate the Safety Edge per the section titled "Safety Edge" in section 501 of the Standard Specifications for Construction.

When temporarily widening a shoulder for maintaining traffic, the material used must be specified per *Frequently Used Special Provision, 12SP307A*

EXHIBIT 6-33: SAFETY EDGE

6.05.08 Value Engineering Change Proposals (VECP)

A VECP is a change, proposed by the contractor, to a project's specifications, plans, or other contract requirements. VECP's should consider the requirements of the Work Zone Safety and Mobility Policy in the analysis process, see FUSP 104C. Safety and mobility mitigation costs should be included in the analysis. When reviewing a VECP for approval all factors need to be looked at, including work site safety, which can be difficult to quantify but should be factored into the final discussion process. Simply reducing the lane widths to reduce the project cost should not be considered unless other tangible factors are gained by the width reduction.

It is common for offices to detail a timeframe for review and submittal of VECP's in the MOT SP. During the VECP process the TMP should be reviewed to determine if the proposed change has already been evaluated during the TMP development.

6.05.09 Transport Permits for Oversize (Weight, Width, Height, Length) Vehicles

Route availability is important for oversize vehicles. TSC staff must coordinate alternate route availability with the Transport Permit Unit in the Bureau of Development, Development Services Section, when placing restrictions on width, height or weight for oversized vehicles in construction

work zones. Special attention “should be given to” routes “to/from” border crossings. Global signing may be utilized depending on the scope scale and complexity of the project. Contact information for Transport Permits may be found on the MiTRIP website.

6.05.10 Temporary Median Crossovers

The use of temporary median crossovers moves traffic away from work areas. Temporary median crossovers should be considered for freeway reconstruction projects and bridge partial/complete replacement projects. The following should also be considered:

- Cost of building and removing crossover
- Construction scheduling compared with the cost of part width construction
- Capacity and delay evaluations.
- On and off ramp locations
- Expedited work schedules
- Roadway geometry
- Drainage

Temporary median crossovers should be designed with the same requirements as the roadway. If permitted, the project manager may complete this design work and build the temporary crossovers as a separate advanced contract.

6.05.11 Traffic Control - Setup, Removal, and Stage Changes (Updated 12/3/2020)

All Traffic control, including pavement markings, for project set-up and removal must be considered during the development of the TTCP.

A. Traffic Switch

A traffic switch is defined as a change in the present traffic configuration which requires multiple lane lines and/or edge lines to be relocated to a new location and the old lines to be abandoned or removed between construction stages or maintenance of traffic stages. There are times when conflicting pavement markings and sign information is unavoidable, but such occurrences must be minimized by accelerated work. The following factors should be analyzed when considering the time frames for night traffic switch operations:

- Local Crash Histories (with and without the work zone in the area)
- Traffic Speeds
- Traffic Volumes
- CO3 Mobility and Delay Analysis or Synchro Analysis

- Type of Work and Needed Traffic Control
- Duration of Work
- Residential and commercial concerns stated at outreach meetings during planning and design phases.

B. Advance Warning of Traffic Switch Operations

When performing traffic switch operations, it is important to notify the motoring public of changing conditions. When PCMSs are specified in the contract, it is recommended that they are moved in advance of the anticipated queue location. The message on the PCMS should state, *Traffic Switch Ahead*, and if anticipating traffic backups, a second message added, stating, *Be Prepared to Stop***,** should be placed on PCMS leading into the work zone. If the contract does not have PCMS specified in the contract, rigid static signs stating, *New Traffic Pattern Ahead,* should be utilized. Whether a traffic switch is performed during the day or night, special consideration needs to be given for motorists in the area of the queue.

C. Law Enforcement During Traffic Switch Operations

See Section 4.05, Work Zone Law Enforcement, for detailed information regarding inclusion of Work Zone Enforcement on MDOT jobs.

Traffic switches performed at night should include the use of Work Zone Enforcement. Frequent coordination with law enforcement posts on this activity is required in order to guarantee police presence at time of traffic switch. Extensions of time will not be approved for delays caused by lack of law enforcement.

6.05.12 Nighttime Traffic Switches

It is recommended that traffic switches are performed during daytime, off-peak hours if feasible when considering the overall project safety and mobility factors. If it is determined that traffic switches must be performed at night, based on the previous factors listed, a Temporary Traffic Plan (TTP) peer review should be conducted and approved by a team consisting of Region, TSC Traffic & Safety, and TSC Construction staff.

While a traffic switch operation is not specifically detailed in the project plans, Designers and Construction Engineers should carefully consider the time frames required for these operations. It is understood that due to mobility requirements, many of these operations should take place within the restrictions noted in the Special Provision for Maintaining Traffic.

Traffic switch operations, however, can be significant, and should be accounted for in the Progress Clause or the Special Provision for Maintaining Traffic. Lane closure restrictions for staged construction could be different than the requirements during traffic switch operations. Therefore, a separate section for traffic switch lane closure restrictions must be clearly defined with what applies during the traffic switch operations.

Construction staff is required to coordinate traffic switch operations with the contractor. It is not uncommon for the traffic switch operations to impact additional roadways or ramps, or take a substantial amount of time during non-peak traffic time frames. Flexibility is encouraged when reviewing and approving the traffic switch time frames, along with other operational logistics.

A. Nighttime Lighting for Traffic Switch Operations

Worker and motorist safety is a shared responsibility between MDOT and the contractor. When working at night, the lighting requirements as detailed in the section titled "Lighting for Night Work" in Section 812 of the Standard Specifications for Construction. must be established and deployed for the entire work zone. The appropriate lighting pay items must be included on projects requiring nighttime switches, or other night time work.

B. Lane Rental or Liquated Damage Assessments during Traffic Switch Operations

For the traffic switches to have the least impact on safety and mobility, language to address traffic switch operations and how assessments will apply for specific stages should be addressed in the *Maintenance of Traffic Special Provision and Progress Clause*. Allowable time frames should correspond with off-peak hours, and the contractor should be exempted from lane rental charges or liquidated damages when traffic is switched during the allowable time frames.

Include the following language as part of Progress Clause or Maintenance of Traffic Special Provision: "Traffic switch operations are exempt from rental or liquidated damage assessments for 8 hours for each traffic switch. Traffic switch operations are to take place within the allowable "Work Area Time Restrictions" as shown in the Maintenance of Traffic Special Provision.

6.06 WORK ZONES, INTELLIGENT TRANSPORTATION SYSTEMS (ITS) AND TECHNOLOGY

Safety and mobility within work zones and alternate routes can be greatly enhanced through the application of existing and emerging technologies and are referred to as ITS.

ITS systems can be used to display road user information in advance of the work zone to alter motorist behavior. This improves mobility, worker and public safety. ITS solutions can reduce the delay through and around a work zone by:

A. Monitoring and managing traffic

B. Collecting traffic data for near-real-time distribution to partner agencies and the media

C. Collecting traffic data for historical analysis to provide an evaluation of the effectiveness of a project's TOP and to forecast traffic conditions for similar future projects.

D. Providing traveler information to allow motorists to modify their route.

E. Providing advanced notice of work zone and traffic conditions.

When designing or deploying a work zone related ITS system, region/TSC development and construction personnel should work with their region's ITS representative and the Traffic Operations Center (TOC) covering the area. It is recommended that systems are reviewed and incorporated in areas where typical solutions (signing, rumble, strips, etc.) have not been successful or work zone impacts are non-typical.

When planning for the deployment of an ITS solution, sufficient time should be provided for the design, set-up, calibration, testing, and evaluation of the system. The proper selection of an ITS

solution should be accomplished and budgeted for during the scoping phases of the project. Bid items for the selected ITS solution(s) must be included in the project documents.

The FHWA document Work Zone Intelligent Transportation Systems Implementation Guide should be used to develop ITS strategies according to the following steps:

1. Assessment of Needs
2. Concept Development and Feasibility
3. Detailed System Planning and Design
4. Procurement
5. System Deployment
6. System Operation, Maintenance, and Evaluation

Before completing the proposed plan and strategies, contact the WZMU for information on current specifications and new best practices or lessons learned to incorporate into the project.

6.06.01 Permanent Systems (cameras, detectors, signs)

A typical ITS traffic management system in Michigan includes the use of permanent dynamic message signs, closed-circuit TV cameras, permanent vehicle detector stations, road weather information systems and traffic operation centers are monitored 24 hours per day. Each system's components should be leveraged by construction staff to assist in work zone traffic management.

Region ITS staff should be contacted to determine the most up-to-date location of devices on the roadway.

TOC contact information is detailed below:

- STOC
- SEMTOC
- WMTOC
- BWBTOC

6.06.02 Temporary Portable Cameras

Temporary portable cameras can be placed at key areas within the work zone to provide a visual representation of current traffic conditions in and around the construction site. Construction staff may evaluate current traffic conditions and consider options for changes or additional traffic control measures based on the real-time traffic conditions.

Images from the temporary portable cameras can typically be viewed using a web-based application. In areas with a permanent traffic management system, the camera images may be included and monitored with images from the permanent camera stations.

Images from the temporary portable cameras can also assist with TIM and the quick clearance of incidents in work zones by providing accurate, real-time images to dispatch centers and emergency first responders.

6.06.03 Variable Speed Limits

Static speed limits may not reflect current conditions and could lead to decreased speed limit compliance and a high variance in the distribution of vehicle speeds. Variable speed limit systems use sensors to monitor prevailing traffic and weather conditions, posting appropriate advisory or regulatory speed limits on dynamic message signs. The use of variable speed limits can improve speed limit compliance and the safety of traffic flow by promoting and facilitating uniform traffic flow. State law currently prohibits the use of these devices in Michigan for regulatory variable speeds limits.

6.06.04 Stopped Traffic Advisory System (Updated 12/3/2020)

A queue detection system determines where queues begin upstream of a work zone, using a series of traffic detectors. PCMS and DMS (if available) can be used to communicate information to drivers in advance of the work zone. This provides real-time messages and can reduce rear-end crashes significantly.

This system should be considered for back-ups or traffic delays outside of the work zone signing sequence, or in areas where the conditions are continuous or unexpected and cannot be avoided utilizing mitigation measures. The system can be modified to work for both short term and long-term work zones. Use of Stopped Traffic Advisory (STA) Systems is encouraged for use on all appropriate significant projects, predominantly on corridors with a history of rear of queue crashes.

6.06.05 Dynamic Lane Merge Systems (Early/Late Merge)

These systems actively monitor and direct traffic streams, commonly in a two lane roadway, to merge traffic into a single lane to promote uniform traffic flow and speed. Uniform traffic flow and speed may reduce turbulence and aggressive driving that have adverse impacts on crash rates and mobility.

Dynamic lane merge systems use roadside detectors to monitor traffic flow and PCMS to relay real-time information. As queue increases are detected near the approach to a lane closure, the system regulates merging traffic by providing information and direction to motorists, requiring either an early or late merge. Dynamic lane merge systems:

- Reduce confusion when merging
- Reduce aggressive driver behavior
- Reduce queue lengths
- Increase work zone capacity
- Reduce crashes

6.06.06 Highway Advisory Radio (HAR)

HAR systems use a combination of radio equipment and signs that broadcast real-time traffic information and construction updates and messages using a radio frequency.

The system may be a permanently located transmitter or a portable trailer mounted system that can be moved from location to location. When properly deployed, monitored, and maintained, HAR systems provide motorists with useful, timely information.
To be effective, messages provided on a HAR system must be accurate and timely. If a HAR system is not available in your location, local media outlets may provide the same benefits.

6.06.07 Portable Traffic Detectors/Sensors

Portable traffic detectors measure traffic volumes, speeds, and vehicle classifications. This information can be used as part of a larger system including real time information systems, dynamic lane merge systems, queue detection systems, and permanent ITS systems.

Portable detectors and sensors may be used for standalone applications such as project websites, collecting real-time traffic data for distribution, and historical traffic data for work zone performance analysis.

6.06.08 Ramp Metering

A ramp metering system includes traffic signals on freeway entrance ramps that help regulate traffic flow and promote uniform flow of traffic onto a freeway. Traffic flow regulation can minimize disruptions and traffic turbulence by regulating the gaps between vehicles that enter a freeway.
An effective ramp metering program would likely include more than one ramp or interchange location. Benefits are maximized by taking a systems approach. Proper geometry is critical and must be provided to ensure the signal system functions properly. This could be cost prohibitive for temporary use in construction projects. In addition, law enforcement support is needed with ramp metering systems to maximize effectiveness.

6.06.09 Information Response Systems (Updated 12/3/2020)

A. Trucks Entering, Crossing, and Exiting

Designed to advise the motorist of potential contractor interaction with intended travel paths that may cause a motorist to slow or stop at specific locations within the work area. Locations should be identified through the use of additional warning signs.

B. Temporary Speed Radar Trailers (Updated 12/3/2020)

A speed display trailer is used to enhance safety of the traveling public and workers in work zones by alerting drivers of their current speed, thus deterring them from driving above the posted work zone speed limit. Temporary speed radar trailers provide real time speed data to motorists.

Radar speed trailers should only post the work zone speed limit. 45 mph Where Workers Present should never be posted as a speed limit on speed trailers.

Temporary Speed Radar Trailers are required to in all freeway projects where the existing speed limit is 55 mph or higher and a speed reduction is required during construction for longer than 3 days. Optional use for local agency and all other trunkline projects. See Frequently Used Special

Provision 12SP-812HH-01, located on the MDOT frequently used special provision page, for details

A minimum of one radar speed trailer is to be placed in each direction of a qualifying project as shown on the plans, but more maybe added for problem areas as defined by the Engineer. The speed trailers are meant to be moved around inside the project approximately every two weeks so that motorists do not become used to seeing the message in the same location. If it is a short project in length such as bridge work, consideration should be given to removing the radar speed trailer for a week or two and then place it back. When applicable, having work zone enforcement at or near the radar speed trailers is recommended.

Radar speed signs may also be used in mobile operations attached to mobile truck mounted attenuators. The signs are intended to get the motoring public to see their speed and to slow down while driving by the mobile operation.

EXHIBIT 6-34:
RADAR SPEED TRAILER

C. Work Space Intrusion

Designed to advise workers of traffic intruding into the work zone, providing advance warning for workers to evade an intruding vehicle. Positive protection techniques should be considered before attempting to use intrusion warning systems. Although these systems are designed to warn of an errant vehicle, many motorists intentionally intrude the work zone to avoid delays, access driveways, intersections, ramps, etc. This may cause the alarm to sound unnecessarily, causing workers to ignore future alarms. Designers should consider other applications of positive separation before considering the use of intrusion alarms.

D. Oversize Vehicle

Oversize vehicle warnings should be considered for use when the roadway cross section places motorists, especially commercial traffic, into close proximity to fixed objects due to lane width restrictions, overhead restrictions, or in corridors that have previous history of over dimension crashes.

6.06.10 Additional ITS Resources

For more information on ITS systems, visit smarter work zone at workzonesafety.org and the FHWA document Work Zone Intelligent Transportation Systems Implementation Guide.

CHAPTER 7

WORK ZONE SAFETY AND MOBILITY ON FEDERALLY FUNDED LOCAL AGENCY PROJECTS

7.01 INTRODUCTION AND PURPOSE

This policy is intended to be used by Local Agencies (LA's) within the State of Michigan as a guide as they plan and design their individual construction projects.

This policy is intended to be followed by LA's for construction of all projects which are funded in part or in whole with Federal funds, and for all projects that propose construction work on MDOT-owned facilities or are located within MDOT owned right-of-way. In accordance with Federal regulations, this policy will be periodically reviewed for effectiveness and applicability, and revised or updated as necessary.

The primary goal of the WZS&M Rule and the WZS&M Policy is to reduce crashes and manage traffic congestion due to construction work zones. To accomplish these goals, the Local Agency (LA) prepares a Transportation Management Plan (TMP), which provides for consistent consideration of the safety and mobility impacts of work zones, as well as developing strategies and plans to reduce work zone impacts on all projects.

A TMP is required for all Federal Aid Highway projects which are funded in part or in whole with Federal funds and proposed construction on MDOT owned facilities or are located within MDOT owned right of way.

Local Agency Program compliance was mandated on all Federal aid projects by January 1, 2009.

7.02 LOCAL AGENCY POLICY BACKGROUND INFORMATION

For purposes of the WZS&M Policy, a Significant Project is defined as a project or work zone which, without proper traffic control and mitigation efforts, would cause "unreasonable delay, inconvenience, or risks" to road users, and road workers, residents, businesses, or the community.

In 2009, a subcommittee consisting of representatives of the County Road Association of Michigan (CRAM), now known as the County Road Association (CRA), the Michigan Municipal League (MML), Federal Highway Administration – Michigan (FHWA), and MDOT determined that all local agency projects that are constructed using Federal or State transportation funds are Significant, for purposes of the Work Zone Safety and Mobility (WZS&M) policy.

The subcommittee determined that LA's currently comply with the intent of the WZS&M requirements as part of the project planning and design process, including:

- Conducting public information dissemination, informing interested or affected stakeholders of the upcoming project, and conducting public information meetings.

- Notifying representatives of public utilities, emergency service providers, and public safety agencies of the construction project that will take place.
- Determining how the project will affect day-to-day public services and activities, and any special considerations that must be included in the construction project to accommodate these services and activities.

- Considering how each project will affect or be affected by local civic events.

- Determining the effect of the project on school activities including school bus routes.

- Meetings with MDOT representatives if any proposed work on the project will be completed in the MDOT trunkline right of way.

Also, construction documents prepared for LA's projects typically include the following items:

- Construction plan sheets representing the maintaining traffic plan, which consist of at least locations and descriptions of temporary signing and traffic control devices.

- If required for the project, construction plan sheets showing locations of detour routes.

- Special provisions for maintaining traffic during construction.

- Pay items and quantities for use during construction.

The subcommittee prepared the Local Agency Program WZS&M guidance, which was approved by CRAM, MML, and MDOT, and concurred with by FHWA. This guidance document includes several checklists that local agencies use to document its planning, public information, design, monitoring, and revision efforts during the entire course of its construction project. The guidance is posted on the MDOT LAP website at:

http://www.michigan.gov/documents/mdot/mdot_WZSM_policy_FINAL_AS_APPROVED_BY_CR AM120808_259537_7.pdf

7.03 IMPLEMENTING THE LOCAL AGENCY WZS&M POLICY

To meet the requirements of this segment of the policy, LA's document how the policy requirements were addressed, using Pages APP I-1 through APP I-5 of the checklist included in the guidance document on the LAP website, at the above link.

The programming application (MDOT Form 0258, 0259, or 0260) and the WZS&M checklists are reviewed at the Grade Inspection meeting, which is conducted for the project by the MDOT Local Agency Program (LAP) Staff Engineer. Copies of the checklists are kept in the local agency's permanent project file.

The Local Agency WZS&M policy requires LA's to monitor and control traffic in and around the work zone during construction, and that LA's revise or improve the traffic control elements during construction. Examples include:

- Actively monitoring traffic patterns on detour routes, alternate routes, and other side streets during construction, including any change in the number of incidents and accidents, and determining whether these events were caused by or affected by the construction project.

- Meetings with the construction team, including contractors, subcontractors, construction engineers, and inspectors.

- Providing updates on the construction progress at public meetings and on web sites.
- Receiving communications and other input from affected users during the construction period, either through predetermined public progress meetings, or indirect communications such as email, letters, and phone calls.

- Using the contract modification process to adjust or modify the Maintaining Traffic plan and construction pay items as necessary for such items as revising the number and types of signs, providing additional flaggers, modifying signal timing, or creating or modifying the alternate or detour route.

To meet the requirements of this segment of the policy, LA's document how the policy requirements were addressed, using Pages APP I-6 and APP I-7 of the checklist included in the guidance document on the LAP website, at the above link.

Additional information and reference material is available on the following websites:

- MDOT Local Agency Program

- FHWA

7.04 RECORDS RETENTION

The Local Agency WZS&M policy requires LA's to update the checklists as necessary during construction and keep these documents in its construction files. Information and documentation relating to detour and alternate routes should be recorded on the Inspector's Daily Report. The records are not intended to be submitted to MDOT, but are subject to MDOT and FHWA auditing.

CHAPTER 8

MAINTENANCE AND SURVEYING OPERATIONS

(Added 12/3/2020)

8.01 INTRODUCTION

This chapter focuses on maintenance and surveying operations. When considering the set up for a maintenance or surveying work zone, it is important to create a traffic control plan that considers signing, channelizing devices, arrow boards, truck mounted attenuators, and mobile operations. All of this maintenance and surveying information is covered in this chapter. Terms such as short and long duration are defined within the MMUTCD, 6G.02.

8.02 TYPICAL TRAFFIC CONTROL PLANS

Traffic control plans typical to most maintenance operations and surveying operations can be found here: MDOT Traffic and Safety Typicals. These typical plans should be used as guidelines for the layout of traffic control devices within maintenance work zones. Project and/or traffic conditions may warrant modifications of these plans, or the use of traffic control measures not shown within these guidelines. If there is a need to modify one of these guides, please contact your local TSC or Region Traffic or Operations representative for assistance.

8.03 WORK ZONE DEFINITION

When performing maintenance and surveying operations, it is critical that the areas that workers occupy meet the definition of a work zone. The following is an excerpt from the Michigan Vehicle Code, Act 300 of 1949, which defines a work zone:

257.79d "Work zone" defined. Sec. 79d.

"Work zone" means a portion of a street or highway that meets any of the following:

(a) Is between a "work zone begins" sign and an "end road work" sign.

(b) For construction, maintenance, or utility work activities conducted by a work crew and more than 1 moving vehicle, is between a "begin work convoy" sign and an "end work convoy" sign.

(c) For construction, maintenance, surveying, or utility work activities conducted by a work crew and 1 moving or stationary vehicle exhibiting a rotating beacon or strobe light, is between the following points:

(i) A point that is 150 feet behind the rear of the vehicle or that is the point from which the beacon or strobe light is first visible on the street or highway behind the vehicle, whichever is closer to the vehicle.

(ii) A point that is 150 feet in front of the front of the vehicle or that is the point from which the beacon or strobe light is first visible on the street or highway in front of the vehicle, whichever is closer to the vehicle.

8.04 WORK ZONE DURATIONS

Maintaining safe work and road user conditions is a paramount goal in all work zones.

Work duration is a major factor in determining the number and types of devices needed for TTC. The duration of an activity is defined by the length of time an activity occupies a location.

The five categories of work type and their duration at a location are defined in MMUTCD section 6G.02, and are summarized as follows in Table 8-1:

TABLE 8-1: WORK DURATIONS

Category	**Work Duration**
Long-term Stationary	Less than 3 days of daytime only work, or 1 hour of night work
Intermediate-term Stationary	Less than 3 days of daytime only work, or 1 hour of night work
Short-term Stationary	More than 1 hour, all daytime work
Short Duration	Up to one hour
Mobile	Moves intermittently or continuously

8.04.01 Long-Term Stationary Work

There is adequate time to install a full range of TTC procedures and devices. These may include channelizing devices, temporary roadways, and temporary traffic barriers.

Since this work will extend into nighttime, retroreflective and/or illuminated devices must be used.

8.04.02 Intermediate-Term Stationary Work

In intermediate-term stationary work zones, it may not be practical to use procedures or devices that would be desirable for long-term stationary TTC zones, such as altered pavement markings, temporary traffic barriers, and temporary roadways. The increased time to place and remove these devices in some cases could significantly lengthen the project, thus increasing exposure time and risk to employees. Elaborate temporary traffic control measures may not be justifiable based on duration of work.

If this work will extend into nighttime hours retroreflective and/or illuminated devices must be used.

8.04.03 Short-Term Stationary Work

Most maintenance and utility operations are short-term stationary work. Work zone traffic control measures should be provided in a manner that considers the amount of time that work will be performed.

The roadway speed, volume, and work type should be used to determine what level of TTCD are needed to safely complete the work. If additional information is needed to determine what should be used contact the local TSC representative.

8.04.04 Short-Duration Work

Compared to stationary operations, mobile and short-duration operations are activities that might involve different treatments. Devices having greater mobility might be necessary such as signs mounted on trucks. Devices that are larger, more imposing, or more visible can be used effectively and economically. The mobility of the TTCDs is important.

During short-duration work, it often takes longer to set up and remove the TTC than to perform the work. Workers also face hazards in setting up and taking down the TTC. Since the work time is short, delays affecting road users are significantly increased when additional devices are installed and removed.

8.04.05 Mobile Work

Mobile operations often involve frequent short stops for activities such as litter cleanup, pothole patching, or utility operations, and are similar to short-duration operations.

Mobile operations also include work activities where workers and equipment move along the road without stopping, usually at slow speeds. The advance warning area moves with the work area.

Channelizing devices to delineate open and closed lanes must be used at 50' spacing when workers are outside of their vehicles in a existing lane while in a mobile operation is occurring during the night time hours. An example of such an operation is the layout of concrete patches.

Mobile operations must have appropriate warning devices on the equipment (high-intensity rotating, flashing, oscillating, or strobe lights, signs, or special lighting), or must use a separate vehicle with appropriate warning devices.

When mobile operations are being performed, a shadow vehicle equipped with an arrow board or a sign should follow the work vehicle, especially when vehicular traffic speeds or volumes are high. Where feasible, warning signs should be placed along the roadway and moved periodically as work progresses.

Under high-volume conditions, consideration should be given to scheduling mobile operations work during off-peak hours.

8.05 MOBILITY AND SAFETY

All shoulder closures, encroachments, and lane closures are required to meet MDOT's Work Zone Safety and Mobility Policy for work hour restrictions. The specific hourly and daily mobility restrictions are provided on the MDOT Mobility Restrictions Map.

Prior to work, staff should contact the local TSC traffic representative to ensure the work being performed is within the current policy.

8.06 GENERAL TRAFFIC CONTROL GUIDELINES

Temporary Traffic Control (TTC) is a very important part of any maintenance or surveying operation. The purpose of this section is to provide guidance on the placement of TTC devices in maintenance and surveying work zones.

All traffic control devices used on projects must be crashworthy and meet MDOT requirements. See the Materials Quality Assurance Procedures Manual for the current crashworthiness requirements and standards for Work Zone Devices.

It is required that the MMUTCD, Part 6 be followed at a minimum to ensure that all traffic control devices used in work zones meet current standards.

Care must be taken to ensure that traffic control devices do not obstruct or intrude on the usable width of sidewalks, temporary paths, or other pedestrian facilities. For more information on how to facilitate pedestrian facilities see Chapter 5.

For more detailed information on traffic control devices see Chapter 6.

8.06.01 Regular Work Zone Inspections

The work zone should be driven on a regular basis to ensure the adequacy and condition of all traffic control devices on the project. During work zone inspections, traffic control should be compared to the applicable maintaining traffic typical(s) for the project.

During poor weather conditions such as rain or high winds, the frequency of inspection should be increased to make sure all devices are performing properly. If TTCD start to fail due to weather conditions crews should pick-up and postpone work.

8.06.02 Partial Lane Closures

Partial lane closures should be avoided where traffic is not being shifted. If any part of a lane is to be occupied, the entire lane must be closed to traffic. Shifting a lane is permitted as long as there is appropriate space for it.

8.06.03 Temporary Signs

Portable temporary signing is generally used for short term maintenance and mobile operations. Temporary warning signs are used to alert traffic of an upcoming maintenance or surveying operation. Diamond shaped orange warning signs should be 48" x 48" in size. Reflectorized signing is required.

For closures in non-pedestrian areas a five (5) foot minimum bottom height is required and driven posts are required for closures over 14 days. In pedestrian areas a seven (7) foot minimum bottom height is required.

For visibility, signs should be placed within six (6) to twelve (12) feet of the edge of the traveled lane or no closer than two (2) feet to the back of curb. Engineering judgement of lateral spacing should be appliedin situations where the sidewalk butts up to the curb or there is no area for the sign between the curb and buildings in downtown areas.

If the work within stationary closure moves more than two (2) miles from the original signing sequence, a new signing sequence should be set-up and the original sequence removed.

Temporary signing must be covered, stored, or removed when work ceases in accordance with the section titled “Temporary Signs” in Section 812 of the Standard Specifications for Construction. If roll-up signs are used they must be completely folded up and stored properly, or removed from the shoulder.

If it is determined that a lower speed limit must remain in place to maintain work zone safety/integrity, reduced speed signs may remain posted.

See Chapter 6 for more information about warning signs. See the MDOT Traffic and Safety Typicals for sign spacing requirements.

8.06.04 Existing Permanent Signs

Existing permanent signing in the work zone which conflicts with temporary signs must be covered in accordance with the section titled “Sign Covers” in Section 812 of the Michigan Department of Transportation’s Standard Specifications for Construction. Sign Covers should be removed when work ceases. Signs must be covered so that the reflective material is not damaged by scratching or crushing cells or by moisture.

Additional information on covering signs can be found in 6.01.9, Sign Covers

8.06.05 Channelizing Devices

Channelizing devices are used to warn road users of conditions created by work activities and to guide road users through the work zone. Channelizing devices include cones, grabber cones, plastic drums, and in some cases tubular markers where spacing is not adequate for other devices. Channelizing devices must be used to separate the work zone from traffic. More information about these devices, including the required spacing, can be found in Chapter 6 of this manual. Information about the taper and buffer lengths for channelizing devices can be found in the MDOT Traffic and Safety Typicals.

8.06.06 Traffic Regulators

Maintenance operations, particularly on two-lane, two-way roadways, often necessitate the use of Traffic Regulators. Prior to performing work, all Traffic Regulators must review the training requirements described in section 1.06.03 Traffic Regulator Training. .

EXHIBIT 8-1
TRAFFIC REGULATOR

8.06.07 Arrow Boards

Type A, B, and C arrow boards must have a solid rectangular appearance. A Type D arrow board must conform to the shape of the arrow. See figure 6F-6 in the MMUTCD for the requirements of each arrow board type.

- **Type A** arrow displays are appropriate for use on low-speed urban streets.
- **Type B** are appropriate for intermediate-speed facilities and for maintenance or mobile operations on high-speed roadways.
- **Type C** arrow displays are intended to be used on high-speed, high-volume motor vehicle traffic control projects.
- **Type D** arrow panels are intended for use on authorized vehicles. Type D arrow panels may not be used without prior approval from the TSC traffic representative.

The minimum mounting height of an arrow panel should be 7 feet from the roadway to the bottom of the panel, except on vehicle-mounted panels, which should be as high as practical.

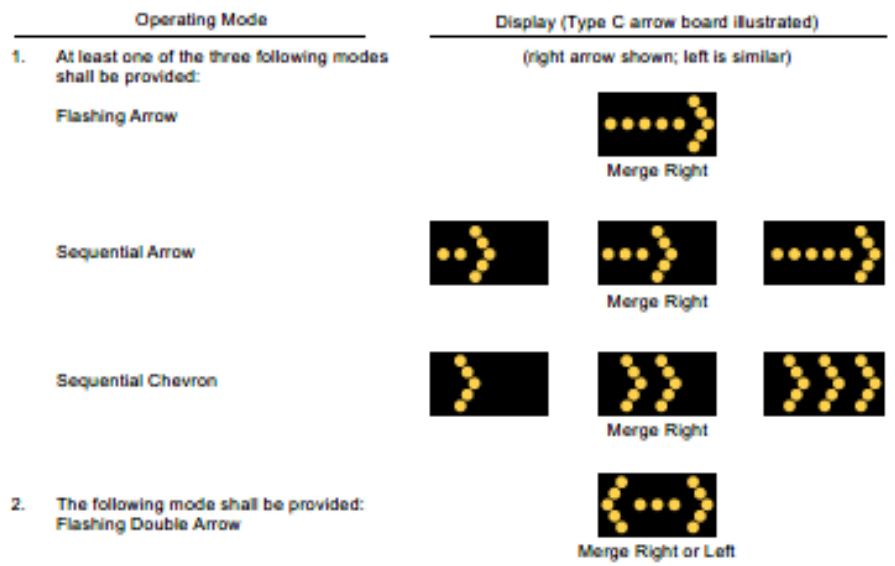
For Mobile operations where a lane is closed, the arrow board should be located to provide adequate separation form the work operation to allow appropriate reaction by approaching drivers.

A lighted arrow board is required on a TMA when the TMA is parked on the shoulder or within a lane. A lighted arrow board is not required on a TMA if it is located outside of the shoulder and is delineated by plastic drums.

All arrow boards shall be finished in non-reflective black. The arrow board shall be mounted on a vehicle, a trailer, or other suitable support. Arrow boards mounted on vehicles cannot be used for traffic regulating operations.

See 6.01.15 for more information about arrow boards.

EXHIBIT 8-2 : EXCERPT OF ADVANCE WARNING ARROW BOARD DISPLAY SPECIFICATIONS FROM FIGURE 6F-6 FROM THE MMUTCD



Arrow Board Type	Minimum Size	Minimum Legibility Distance	Minimum Number of Elements
A	48 x 24 inches	1/2 mile	12
B	60 x 30 inches	3/4 mile	13
C	96 x 48 inches	1 mile	15
D	None*	1/2 mile	12

*Length of arrow equals 48 inches, width of arrowhead equals 24 inches

8.07 MOBILE OPERATIONS

Maintenance operations which involve non-vehicular encroachment on lanes other than those immediately adjacent to the median or outside shoulder are not considered mobile operations, and should be reviewed by the appropriate traffic and safety representative, to determine what traffic control typical should be utilized to perform the work.

The following in table 8-2, are examples of Mobile Operations:

TABLE 8-2. MOBILE MAINTENANCE ACTIVITIES

Activity	Work location
Approach Sweeping	Intersections
Expressway Patrol	Shoulder, and minor non-vehicular encroachment in traveled way
Freeway Lighting	Shoulder and/or occupy a lane
Curb Sweeping	Occupy lane, continuously mobile ≈ 5 mph
Catch Basin Clean-out	Occupy lane
Litter Pickup	Shoulder and outside shoulder
Vegetation Control	Shoulder
Routine Blading	Shoulder and minor non-vehicular encroachment in traveled way
Gravel Shoulder Maintenance	Shoulder and minor non-vehicular encroachment in traveled way
Shoulder Spot Seal Patching (kettle)	Shoulder, edge of metal
Shoulder Bituminous Patching	Shoulder, edge of metal
Patrol Patching	Drive on shoulder and minor non-vehicular encroachment in traveled way
Pavement Marking	Occupy lane, continuously mobile

8.07.01 Adequate Sight Distance

For maintenance operations, adequate sight distance is the length of roadway that the driver can see and is greater than or equal to the stopping sight distance. See Table 8-3 for the stopping sight distances.

TABLE 8-3. STOPPING SIGHT DISTANCE AS A FUNCTION OF POSTED SPEED LIMIT

Speed	Distance
25	155
30	200
35	250
40	305
45	360
50	425
55	495
60	570
65	645
70	730
75	820

8.07.02 Shadow Vehicles

A shadow vehicle should be used for lane closures on all roadways which have a 45 mph or greater posted speed, and two or more lanes in each direction.

A shadow vehicle may be used in other work zones as deemed necessary. Factors to be considered in determining need include the following:

- Time of day of the closure
- Seasonal variations in traffic volume
- Length of lane closure and anticipated duration
- Traffic speeds
- Frequency of traffic stopping/turning movements

The shadow vehicle should be parked with the brakes set, and the front wheels turned away from traffic and work area if possible, or as specified by the engineer.

The roll-ahead space is the distance between the front of the shadow vehicle and the work area. Whenever a shadow vehicle is used, this additional space is required and is determined based on the weight of the shadow vehicle.

8.07.03 Mobile Attenuators

Mobile Attenuators (MA) refer to truck mounted attenuators (TMA) and trailer mounted attenuators. These devices should be considered for use when maintenance operations are conducted where the posted speeds are 45 mph or greater; where personnel and/or equipment occupy a lane customarily used by traffic.

Refer to the temporary traffic control typicals for proper placement of the mobile attenuator, typicals numbered in the 4400s and 5400s. In a traffic control operation the mobile attenuator vehicle should be the first vehicle encountered by the motorist. Please note that some operations require more than one mobile attenuator. The number of mobile attenuators required is based on the number of lanes closed. An additional mobile attenuator may be used on the shoulder of urban freeways. Additional guidance on the proper placement of mobile attenuator may also be found in the manufacturer's documentation and/or as directed by the maintenance supervisor or local TSC traffic representative.

The use of a mobile attenuator does not eliminate or reduce the requirement for the correct application of traffic control devices and measures outlined in this manual.

8.07.04 Truck Mounted Attenuator Applications

The following are examples of mobile attenuators used in projects to protect personnel or equipment:

- The vehicle is designated as a protective vehicle (shadow vehicle or barrier vehicle) as part of the maintenance of traffic typicals, maintenance of traffic plans, or other contract documents.

- Mobile attenuators are not intended to be used for the removal, installation or maintenance of traffic signals due to the uniqueness of the area that needs to be protected at an intersection.
- Mobile/short duration operations such as pavement marking convoys, grinding in rumble strips, permanent sign installation, luminescent installation, etc.
- Aerial work is being performed on scaffolding, lifts, hoists, bucket trucks, etc., where workers using this equipment are on the shoulder not protected by temporary barrier for longer than 15 minutes in duration.

Mobile attenuators must not be mounted on the vehicle or equipment used by personnel to complete aerial work. The use of a mobile attenuator should be considered for other operations depending upon the level of worker exposure. Engineering judgment should be used to determine the appropriate form of TTCD to complete the work on every project.

Mobile attenuators may not be used as a barrier ending except during the replacement of a damaged barrier ending. When a mobile attenuator is used as a temporary safety measure for a damaged barrier ending; it may only be used for a maximum of 48 hours or as approved by the Engineer.

8.07.05 Equipment Requirements for Truck Mounted Attenuator

All TMAs used must meet or exceed the requirements of NCHRP 350 test level 2 (TL-2) or test level 3 (TL-3), or MASH TL-2 or TL-3 as described below for work zone traffic control devices.

- TL 2 may be used on non-freeway roadways with a normal posted speed of 40 mph or less. Test Level 2 TMAs are prohibited for use on all roadways with posted speed limits of 45 mph or greater.
- All TMA rated for NCHRP 350 – Test Level 3 may be utilized on all roadways regardless of the posted speed limit.

The face of the TMA that is visible to approaching traffic must have reflectorized alternating yellow and black chevron stripes sloping downwards in both directions from the center of the attenuator.

When operating a MA, ensure the following is performed, as per the manufacture's recommendations:

- Ensure the height from the bottom of the mobile attenuator to the roadway surface is 12 inches (+/- 2.5 inches) and within manufactures specifications.
- Ensure the mobile attenuator is parallel (level) with the roadway surface.
- Provide a shoulder harness and headrest for the operator of the MA vehicle.
- Ensure material loaded on vehicle to obtain the gross weight is securely attached. Materials that will be off loaded and incorporated into the construction activities will not be considered part of the vehicle gross weight.

For stationary operations, ensure the attenuator vehicle is in second gear if it has a standard transmission and park if it has an automatic transmission. With the parking brake set, turn the front wheels away from traffic and work area if possible, or as specified by the engineer. Keep any and all blades on the vehicle raised. Ensure there is enough roll ahead distance between the vehicle and the work area.

EXHIBIT 8-3: MOBILE ATTENUATOR

The required gross vehicle weight must be as shown in the **Tables 8-4 and 8-5.** The attenuator device must not be mounted on a lift vehicle that is used in an aerial maintenance operation.

Table 8-4. Guidelines for Roll-Ahead Distance For Mobile Attenuator Vehicle Test Level 2

Weight of Mobile Attenuator Vehicle (Minimum)	Post Speed (mph) (Posted Speed Prior to Work Zone)	Roll Ahead Distance(a) (Distance from the Mobile Attenuator Vehicle to Work Area)
5.5 Tons (Stationary Operation)	40 or less	25 feet
a. Roll ahead distances are calculated using a 4,410 pound impact vehicle weight.		

Table 8-5. Guidelines for Roll-Ahead Distance For Mobile Attenuator Vehicle Test Level 3

Weight of Mobile Attenuator Vehicle (Minimum)	Post Speed (mph) (Posted Speed Prior to Work Zone)	Roll Ahead Distance(a) (Distance from the Mobile Attenuator Vehicle to Work Area)
5 tons (Mobile Operation)	60-70 50-55 45	175 feet 150 feet 100 feet
12 tons (Stationary Operation)	60-70 50-55 45	50 feet 25 feet 25 feet
a. Roll ahead distances are calculated using a 10,000 pound impact vehicle weight.		

8.08 SURVEY OPERATIONS

Due to the nature of survey activities being in close proximity of traffic, a Safety Plan should be in place prior to beginning a surveying operation. Exercising proper precautions when working near traffic is vital. The following guidance should be followed when performing surveying operations around and near traffic:

- Use a minimum of two survey personnel to perform any surveying operation within the right of way.
- Avoid working during peak traffic times and during periods of sun glare.

- Refrain from working on opposing sides of the road at the same time in one location.
- Perform work during reasonable weather conditions.
- Stay within 150 ft of the vehicle with a flashing beacon when there is no additional work zone signing or one is outside the work zone.
- Use proper advance signing depending upon work being performed.
- When working in a curved section of roadway, make sure the lead-in signs are pushed back prior to the beginning of the curve.
- Consult the TSC Traffic & Safety Engineer for guidance/notification two weeks prior to survey operations in the roadway.
- Have a site-specific emergency plan.
- Always wear the appropriate personal protective equipment, especially high visibility clothing.

8.08.01 Working without TTCD

Working without TTCD is only allowed when all of the following requirements are met:

- Traffic volume is light. This means that survey personnel can walk from the shoulder to the site on the traveled way, perform their duties, and walk back to the shoulder without interfering with traffic.
- Sight distance in each direction is at least 550 ft. When 550 ft. is not available a lookout may be used to extend coverage
- Vehicles can be parked completely off the traveled way.

When surveying without traffic control, all the following methods should be used:

- All survey personnel should be off the traveled way, on the same side of the roadway, when traffic passes.
- Survey personnel should face traffic whenever possible
- Survey personnel should have a planned escape route.

Anytime you feel unsafe doing surveying without traffic control, stop and consider adding additional traffic control devices, and even closing a lane.

8.08.02 Setting Up Traffic Control.

For setting up traffic control devices, install them with the flow of traffic: Signs, Arrow Boards, and then channelizing devices.When removing devices, take them down in the reverse order of the flow of traffic: Channelizing devices, arrow board, and then signs.

8.08.03 Temporary Traffic Control Considerations

Items to consider when going onto the roadway include the time of day, weather conditions, and escape paths. For the time of day, the factors to be aware of include sunlight glare, traffic volumes, lighting levels, and being well rested. For weather conditions, considering rain and wind, as well as if the temporary signs will stay upright. Pre-planning is also essential for a project. Do you know what the site looks like? Do you have the right traffic control to complete the work? Do you need to close a lane? Are there potential escape paths?

There are four basic situations when surveying:

- 1: Working within the paved surface of the roadway, within 150’ of an amber rotating beacon
- 2: Working within the paved surface of the roadway, NOT within 150’ of an amber rotating beacon
- 3: Working outside the paved surface of the roadway within 150’ of an amber rotating beacon
- 4: Working outside the paved surface of the roadway NOT within 150’ of an amber rotating beacon

Situation 1 - On the paved surface of the roadway, within 150’ of an amber beacon

- The survey personnel are covered by law and are not required to place any signs, but additional signs can be added.
- Additional signing may be considered depending on the location and duration of the work taking place.

Situation 2 Working within the paved surface of the roadway, NOT within 150’ of an amber rotating beacon

- Additional signs are required. The following signs are required:
  - Survey Crew or Survey Work Ahead (Can be substituted with Road Work Ahead)
  - Work Zone Begins
  - End Road Work

Situation 3, Outside the paved surface of the roadway, within 150’ of an amber beacon

- The survey personnel are covered by law and are not required to place any signs, but additional signs can be added.
- Additional signing may be considered depending on the location and duration of the work taking place.

Situation 4, Working outside the paved surface of the roadway, NOT within 150’ of an amber rotating beacon

- If the work takes place in less than 1 hour, no signing is required
- If the work takes 1 hour or more, the following signs are required:
  - Survey Crew
- Additional signing may be considered depending on the location and duration of the work taking place.

8.08.04 Surveying Operations, Locations, and Durations

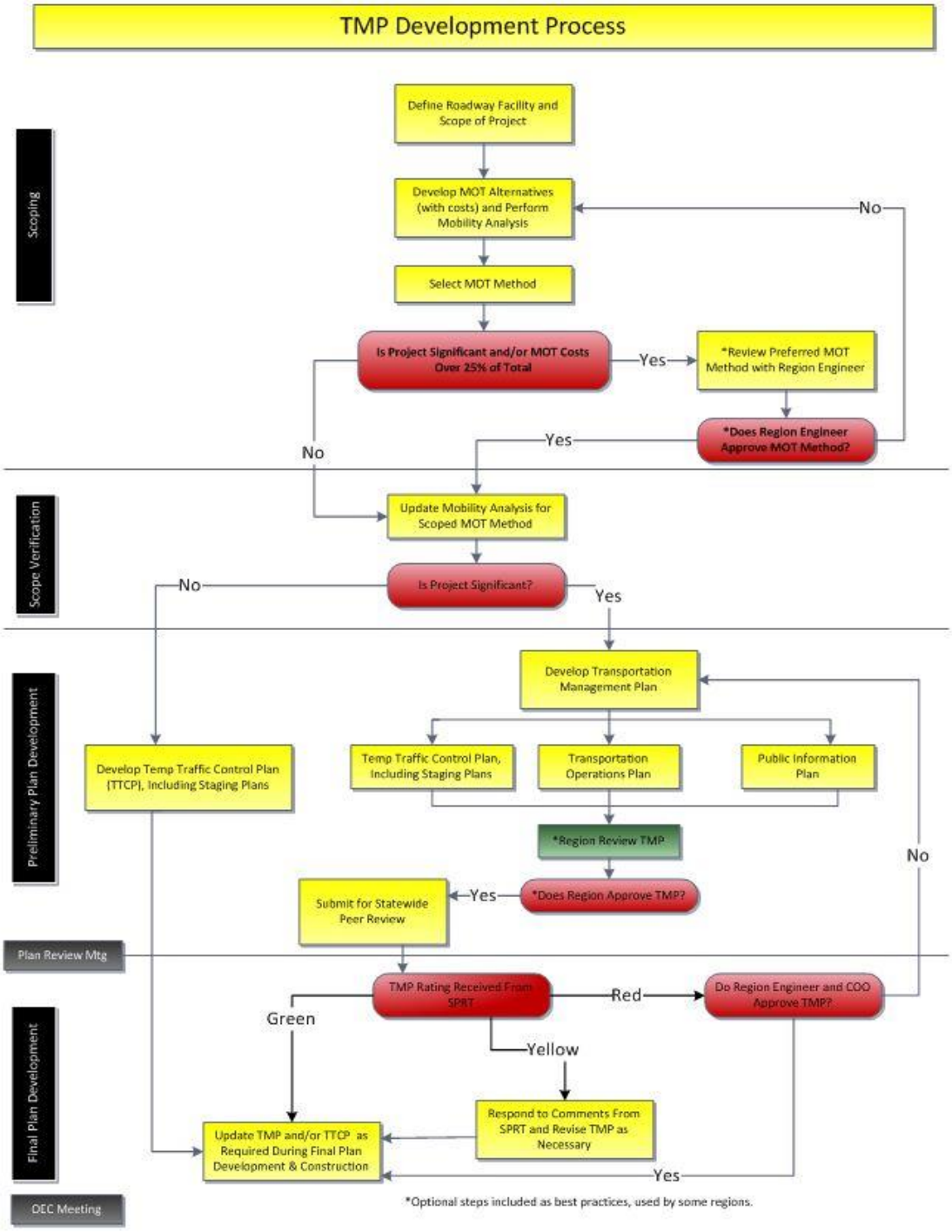
See table 8-6, below, for common survey operations, locations, and durations.

TABLE 8-6. SURVEY OPERATIONS

Survey Operation/Task	Daily Work Location	Duration
Mobile LiDAR Collection Vehicle	Along Roadway and Shoulders - minimal	Mobile (Survey)
	Two-Lane, Two-Way	
	Multi-Lane	
	Freeway	
Target Layout Along Paved Shoulders and Side Roads	Along Shoulders and Outside of the Shoulder minor non-vehicle encroachment in travel way	Mobile
	Two-Lane, Two-Way	
	Multi-Lane	
	Freeway	
Leveling Along Paved Shoulders	Along Shoulders and Outside of the Shoulder minor non-vehicle encroachment in travel way	Mobile
	Two-Lane, Two-Way	
	Multi-Lane	
	Freeway	
Access PLSS or Alignment Corner in travel way	In Roadway - Vehicles and personnel short mobile operation	Mobile or Short Duration
	Two-Lane, Two-Way	
	Multi-Lane	
	Freeway	
Place Monument/Monument Box	Occupy lane and/or intersection	Short-Term Stationary
	Two-Lane, Two-Way	
	Multi-Lane	
	Freeway	
Topographic Mapping Outside of the Shoulder	In ROW but outside of the travel way - Minor to no non-vehicular encroachment on the travel way	Non-Impact
	Two-Lane, Two-Way	
	Multi-Lane	
	Freeway	
Location of Drainage Structures and Inverts	In roadways and along paved shoulders	Short Duration
	Two-Lane, Two-Way	
	Multi-Lane	
	Freeway	
Survey Operation/Task	Daily Work Location	Duration
Topographic Mapping Crossing Traveled Way	Across roadways and shoulders	Mobile, Short Duration and Short-
	Two-Lane, Two-Way	
	Multi-Lane	
	Freeway	
Survey/Measurements of Bridge Structures	Occupy lanes and shoulders	Short Duration to Short-Term Stationary
	Two-Lane, Two-Way	
	Multi-Lane	
	Freeway	
Hydraulic Survey of Rivers, Streams and Drain Crossings	Along Shoulders and Outside of the Shoulder minor to no non-vehicular encroachment in travel way	Short Duration to Short-Term Stationary
	Encroachment on travel way	
	Two-Lane, Two-Way	
	Multi-Lane	
	Freeway	

APPENDIX A

PROJECT DEVELOPMENT PROCESS



TMP Development Items

Task	Planning	Scoping	Development		Construction	
			Non-Significant	Significant	Non-Significant	Significant
Temporary Traffic Control Plan (TTCP)	❖	❖	❖	❖	❖	❖
MOT Typicals			•	•	•	•
Detours Routes	•	•	•	•	•	•
Multi-Modal Considerations	•	•	•	•	•	•
Preliminary Construction Costs	•	•	•	•	•	•
WZTCP					•	•
Traffic Operations Plan (TOP)	❖	❖	❖	❖	❖	❖
Work Zone Mobility Analysis	✓	✓	✓	✓	✓	✓
Traffic Data Information	•	•				
Travel Time Analysis	•	•	•	•	•	•
Queue Lengths			•	•	•	•
User Delay Costs	•	•	•	•	•	•
Existing Operations Analysis		✓	✓	✓	✓	✓
Travel Time Analysis		•	•	•	•	•
Existing Crash Analysis		•	•	•	•	•
Work Zone Crash Analysis				•		•
Operational Factors Analysis		•	•	•	•	•
Non-Motorized Facilities		•	•	•	•	•
Alternatives Analysis		✓	✓	✓	✓	✓
Travel Time Analysis		•	•	•	•	•
Queue Lengths			•	•	•	•
User Delay Costs		•	•	•	•	•
MOT Cost Estimate		•	•	•	•	•
Preliminary Construction Costs		•	•	•	•	•
Determine Project Significance	✓	✓	✓	✓	✓	✓
Project Mitigation Measures				•		•
Work Zone Schedule and Incentives			•	•	•	•
Agency Coordination	✓	✓	✓	✓	✓	✓
Public Information Plan (PIP)			❖	❖	❖	❖
Agency Coordination			•	•	•	•
Public/Stakeholder Information			•	•	•	•
Methods of Delivery			•	•	•	•
Performance Assessment Plan (PAP)					❖	❖
Work Zone Monitoring					•	•
Work Zone Audit Report					•	•
Construction Zone Check List					•	•
Traffic Delay					•	•
Crashes					•	•
Non-Motorized Facilities					•	•

Project Checklists

- ☐ **Planning**
- ☐ **Scoping**
- ☐ **Development**
- ☐ **Construction**

Yes	No	N/A	**Transportation Management Plan** *All LAP projects are required to complete a TMP. Non-significant projects require only the completion of a TTCP; however a TOP and PIP are recommended where appropriate.*
☐	☐	☐	Temporary Traffic Control Plan (TTCP)
☐	☐	☐	Traffic Operations Plan (TOP)
☐	☐	☐	Public Information Plan (PIP)

Yes	No	N/A	**1. Project Significance** *The threshold criteria to determine project significance is travel time as outlined in the Work Zone Safety and Mobility Manual.*
☐	☐	☐	Significant
☐	☐	☐	Non-Significant

Yes	No	N/A	**2 .Project Information**
☐	☐	☐	Project Overview
☐	☐	☐	Summary of Project Scope
☐	☐	☐	Route and local Name
☐	☐	☐	Location (City, Township, Village, etc.)
☐	☐	☐	Control Section and Job Number
☐	☐	☐	Point of beginning (POB) and point of ending (POE), station and description
☐	☐	☐	Vicinity Map
☐	☐	☐	Letting Date
☐	☐	☐	Construction Dates/Duration
☐	☐	☐	Construction Cost

Yes	No	N/A	**3. Facility Description**
☐	☐	☐	Functional Classification
☐	☐	☐	National Truck Network Route
☐	☐	☐	Speed Limit
☐	☐	☐	Number of Lanes
☐	☐	☐	Lane Widths
☐	☐	☐	Shoulder Width (paved)
☐	☐	☐	Shoulder Width (unpaved)
☐	☐	☐	Adjacent area classification (commercial, residential, historic, etc.)
☐	☐	☐	Roadway geometry (median, boulevard, undivided, etc.)
☐	☐	☐	On-street Parking
☐	☐	☐	Sidewalks/Shared Use Path
☐	☐	☐	Bike Lane/Cycle Track
☐	☐	☐	School Bus/Transit Operations
☐	☐	☐	AADT (vpd)
☐	☐	☐	ADT (vpd) –During Construction i.e. summer
☐	☐	☐	Background Growth Rate
☐	☐	☐	Directional Distribution (%)
☐	☐	☐	% Commercial
☐	☐	☐	Peak Hour
☐	☐	☐	Peak Hour Volume (vph)
☐	☐	☐	Traffic generators
☐	☐	☐	Traffic signals

Yes	No	N/A	4. Existing Operations
☐	☐	☐	Roadway Capacity (vphpl)
☐	☐	☐	Volume/Capacity
☐	☐	☐	Peak Hour Level of Service (LOS)
☐	☐	☐	Existing Peak Travel Time
☐	☐	☐	Peak Hour LOS

Yes	No	N/A	5. Temporary Traffic Control Plan
☐	☐	☐	Construction Staging
☐	☐	☐	Special Provision for Maintaining Traffic
☐	☐	☐	MDOT Maintaining Traffic Typicals
☐	☐	☐	Staging Typical Cross-Sections
☐	☐	☐	Detour Routes (identify routes)
☐	☐	☐	Traffic Signals (Signal timing modifications, temporary signals)
☐	☐	☐	Multi-modal considerations (mitigation strategies for all transit, pedestrian and bicycle impacts)
☐	☐	☐	Preliminary Maintaining Traffic Costs
☐	☐	☐	WZTCP

Yes	No	N/A	6. Traffic Operations Plan
			A. Work Zone Operations
☐	☐	☐	Work Zone Speed Limit
☐	☐	☐	Number of Lanes
☐	☐	☐	Lane Widths
☐	☐	☐	Shoulder Width (paved)
☐	☐	☐	Shoulder Width (unpaved)
☐	☐	☐	Buffer Space
☐	☐	☐	Peak Hour Volume (vph) during construction i.e. summer
☐	☐	☐	ADT (vpd) –During Construction i.e. summer
☐	☐	☐	Travel Time Analysis
☐	☐	☐	Intersection Analysis
☐	☐	☐	Crash Analysis
☐	☐	☐	Diversion Rates (explanation of anticipated diversions or reductions in traffic volumes)
☐	☐	☐	Detour Routes (travel time delay, route capacity, intersection operations, intersection delay and queue lengths)
☐	☐	☐	Commercial/private access impacts
☐	☐	☐	Emergency services access
☐	☐	☐	Environmental issues
☐	☐	☐	Noise and/or work ordinance restrictions (local laws)
☐	☐	☐	Over height clearance conflicts
☐	☐	☐	Over wide clearance conflicts
☐	☐	☐	Railroad crossing
☐	☐	☐	Roadside conflicts or hazards
☐	☐	☐	School bus/transit access
☐	☐	☐	Utility conflicts
☐	☐	☐	Special events
☐	☐	☐	Commercial/private access impacts
☐	☐	☐	Emergency services access
☐	☐	☐	Environmental issues

Yes	No	N/A	**B. Work Zone Alternatives Analysis** *The alternatives analysis should provide advantages, disadvantages and a conclusion regarding the alternative why it was/not chosen.*
☐	☐	☐	Travel Time Analysis
☐	☐	☐	Intersection Analysis
☐	☐	☐	Detour Routes
☐	☐	☐	User Delay Costs
☐	☐	☐	Temporary Traffic Control Cost

Yes	No	N/A	**C. TOP Mitigation Strategies**
☐	☐	☐	Demand Management: Exhibit 2-6
☐	☐	☐	Work Zone Safety: Exhibit 2-7
☐	☐	☐	Corridor/Network: Exhibit 2-8
☐	☐	☐	Incident Management: Exhibit 2-9

Yes	No	N/A	**7. Public Information Plan**
☐	☐	☐	Agency Coordination
☐	☐	☐	Public/Stakeholder Information
☐	☐	☐	PIP Strategies-Public Awareness: Exhibit 2-10
☐	☐	☐	PIP Strategies -Motorist: Exhibit 2-11

APPENDIX B

MOBILITY ANALYSIS TOOL

Traffic Tab

PROJECT INFORMATION			REPORT INFORMATION	
PROJECT TITLE	I-69 From Irish Rd to M-15		REPORT TITLE	DETAILED USER COST REPORT SUMMARY SHEET
Paste Values	C.S.	25084	DIVISION	C&T
	JOB #	56984	REPORT BY	BK
	START DATE		REPORT DATE	3/11/2005
NOTES:	Stage 1: Maintain 1 EB lane and 2 WB lanes Stage 2: Maintain 2 lanes in each direction			

Input general project level information.

Briefly describe the MOT schemes to be modeled.

Copy This Sheet	period length (min)	60
	annual traffic growth (%)	2.50%
Update	years of growth	
VEHICLE INPUT	cars	trucks
design demand (%)	84.5%	15.5%
user cost per hour ($/V hr)	$14.83	$26.17
user cost per mile, ($/V mi)	$0.445	$1.54
user cost per cancellation, ($/V)		

Modeling duration = 24 periods
60 minute periods = 1 day
Can also use 30, 15 and 10

Number of years between the traffic count and the time we want to model.

Passenger car/commercial truck distribution.

Determined/updated based on FHWA Publication FHWA-SA-98-079, titled "Life-Cycle Cost Analysis in Pavement Design."

Cars: standard mileage rate
Trucks: Motor Carrier Annual Report (with wages & benefits removed)

Approximately 2/3 diversion costs (if utilized).

METHOD INPUT		METHOD 1	
	method title	EB Stage 1	
DISTANCE AND SPEED	(mi) (mph)	distance	speed
work zone	method travel	3.4	see delay
	normal travel	3.4	70.0
diversion	method travel	39.2	51.7
	normal travel	12.0	70.0
SPEED DELAY		threshold	range
capacity for speed delay (V/period)		1260	
speed (when D~0) (mph)		60	
speed (when D=C) (mph)		37	

Four runs can be performed on the same sheet.

Descriptive title for each scenario.

See table below

The capacity at and below which a speed delay occurs. Generally, the capacity of the work zone. (See work zone capacity table)

Speed when demand is low.

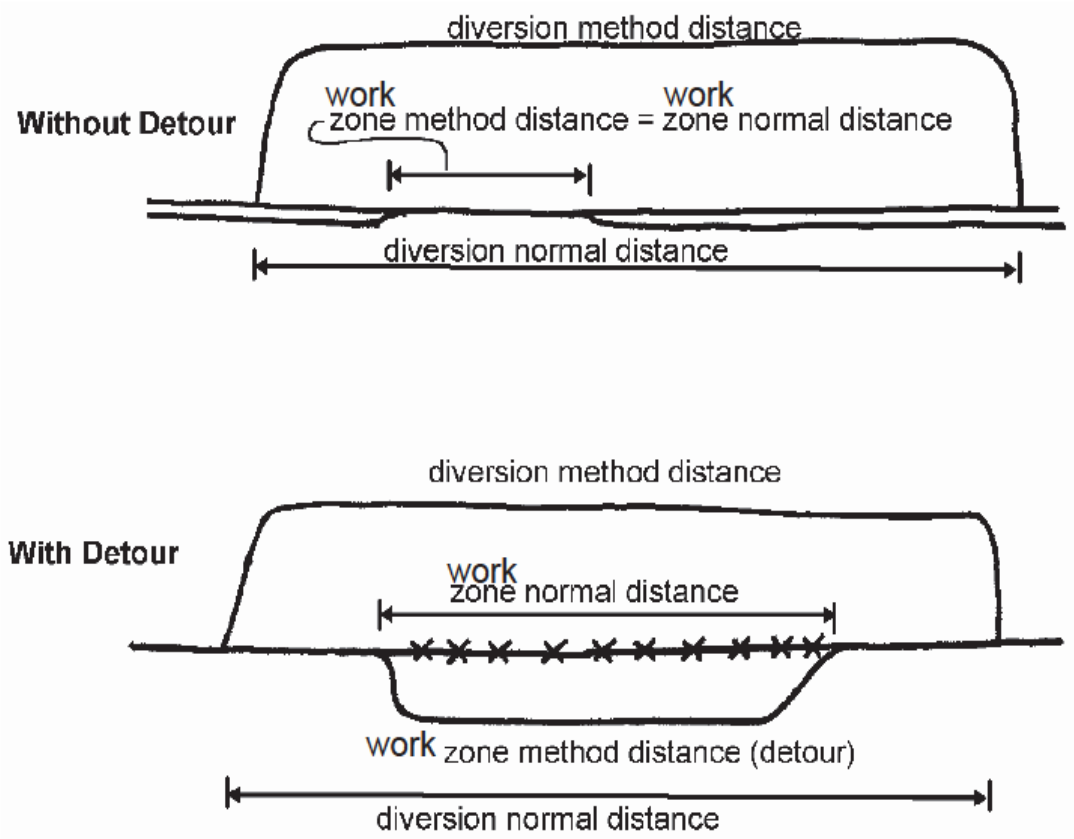
Speed when demand is at capacity. (See chart)

"Range" values: a secondary set of speed delay values for a different work zone capacity (use is optional). For example, if the capacity is at or below 750 VPH, D~0=45 mph, and D=C=34 mph.

Work zone method travel distance & speed	Distance each vehicle will travel through the work zone during construction, or a required detour around the work zone, if present. The speed vehicles travel through the work zone during construction is based on conditions that vary with demand and capacity in the work zone. This is calculated by CO^3 based on SPEED DELAY input above.
Work zone normal travel distance & speed	Distance and average speed each vehicle will travel if there is no construction, no work zone.
Diversion method travel distance & speed	Length and average speed of the most common alternate route vehicles will select to avoid going through the work zone or a required detour around the work zone. If there are several alternate routes, it is the average of the comparable lengths and average speeds, weighted by the number of vehicles expected to take each of them.
Diversion normal travel distance & speed	The distance each vehicle would travel if there were no work zone and the vehicle did not divert to an alternate route, and the average speed vehicles travel over the diversion normal travel distance, when there is no work zone.

See next page for a visual representation of the above table.

The average distance and speed can be calculated by using the "routes" tab in CO^3. See instructions later in this document.


diversion method distance
Without Detour
work
zone method distance = work zone normal distance
diversion normal distance
diversion method distance
With Detour
work
zone normal distance
work zone method distance (detour)
diversion normal distance

DECREASE TO DEMAND	threshold	range
capacity for decreases to design demand (V/period)	2100	
canceled cars (with no delay) (%)		
canceled trucks (with no delay) (%)		
canceled cars (with delay) (%/min)		
canceled trucks (with delay) (%/min)		
diverted cars (with no delay) (%)	42.2%	
diverted trucks (with no delay) (%)	5.0%	
diverted cars (with delay) (%/min)		
diverted trucks (with delay) (%/min)		

Capacity at or below when the detour or the diversion route will be in effect.

Percent of cars & trucks that will cancel their trip because of the work zone.

Percent of cars & trucks that will be detoured or will divert around the work zone.

With delay? or with no delay?

"with no delay" – regardless of how long users believe they will be delayed, this percent of drivers will cancel, divert or be detoured around the work zone.

"with delay" – drivers tolerate delay time differently. Generally, the longer the delay, the more drivers who will find their own way around a work zone. Thus, for every minute of work zone delay, this percent of drivers will cancel, divert or be detoured around the work zone. For example, your diverted cars (with delay) value is 5% per minute. If work zone delay is 4 minutes, 20% of cars will divert.

"Range" values: a secondary set of diverted/canceled percentages for a different work zone capacity (use is optional). For example, if the capacity is at or below 1400 VPH, more vehicles are likely to divert around the work zone or cancel their trips.

OTHER USER COST INPUT Update	cars	trucks
other user cost per actual demand ($/V)	$0.00	$0.00
user cost per diversion ($/V)	$20.76	$57.12

Any additional user cost per vehicle. (optional)

Calculated from the additional detour/diversion time & distance experienced per vehicle, and based on the costs at the top of the worksheet.

This can be changed to examine NB & SB or EB & WB.

To examine directional weekday & weekend traffic, copy the traffic sheet to model the other bound.

The number of vehicles backed up at the start of the first period being modeled. (optional) (12A in this example)

PERIOD INPUT			backup at start (V)		0	0
	weekday	weekend	weekday	weekend	weekday	weekend
period	historical demand		design demand		capacity	
(hr)	(V/period)	(V/period)	(V/period)	(V/period)	(V/period)	(V/period)
12 A	260	622	260	622	1260	1260
1 A	208	379	208	379	1260	1260
2 A	182	352	182	352	1260	1260
3 A	208	244	208	244	1260	1260
4 A	208	208	208	208	1260	1260
5 A	416	416	416	416	1260	1260
6 A	909	909	909	909	1260	1260
7 A	1351	1351	1351	1351	1260	1260
8 A	1247	1247	1247	1247	1260	1260
9 A	1117	1117	1117	1117	1260	1260
10 A	1091	1407	1091	1407	1260	1260
11 A	1221	1597	1221	1597	1260	1260
12 P	1221	1921	1221	1921	1260	1260
1 P	1377	1840	1377	1840	1260	1260
2 P	1844	2030	1844	2030	1260	1260
3 P	2312	2312	2312	2312	1260	1260
4 P	2519	2519	2519	2519	1260	1260
5 P	2493	2493	2493	2493	1260	1260
6 P	1662	1840	1662	1840	1260	1260
7 P	1117	1488	1117	1488	1260	1260
8 P	935	1218	935	1218	1260	1260
9 P	857	920	857	920	1260	1260
10 P	701	785	701	785	1260	1260
11 P	519	731	519	731	1260	1260
Total	25973.63	29944.4	25974	29944	30240	30240

24 time periods can be modeled. (24 hours shown)

Optionally you can use 10 min, 15 min or 30 min time periods, if you have traffic counts with that breakdown.

Hourly work zone capacity.

Can be varied for every time period, depending on the number of lanes open during that period.

Actual hourly traffic counts.

Aged hourly traffic counts, based on the growth rate and years of growth. (optional)

ROUTE DISTANCE, SPEED, AND TIME

Route Title: Detour around the I-69 work zone, using only State Trunkline

Normal Travel							Method Travel						
Input				Calculated Values			Input				Calculated Values		
Route Name	% that Take Route	Distance (mi)	Speed (mph)	Travel Time (min)	Weighted Distance (mi)	Weighted Time (min)	Route Name	% that Take Route	Distance (mi)	Speed (mph)	Travel Time (min)	Weighted Distance (mi)	Weighted Time (min)
I-69	1	12.02	70	10.30	12.02	10.30	I-75 NB	1	11.225	70	12.19	11.225	12.19
							M-57 EB	1	12.522	45	16.70	12.522	16.70
							M-15 SB	1	12.409	45	16.55	12.409	16.55
Totals	1.00				12.02	10.30	Totals	3.00				36.16	45.43
Averages		12.02	70.00	10.30			Averages		39.156	51.71	45.43		
							Differences		27.14	-18.29	35.13		

The route each vehicle would travel if there were no work zone and the vehicle did not divert to an alternate route. Input the distance and average speed vehicles travel for each leg of the route.

Input the distance and average speed vehicles travel for each leg of the detour route(s) or the most probable diversion route(s). If more than one route, enter the percentage of vehicles that would take each route.

Input the average distances and speeds into the appropriate areas of the Traffic Tab. The user delay cost per vehicle diverted will be calculated automatically.

Press the "Compute" button for each column, located between the 'other user cost input' and the 'period input' sections of the worksheet.

SUMMARY OUTPUT	traffic method	EB Stage 1	
	direction	weekday	weekend
	total user cost	$254,016	$299,866
	user cost of delays	$50,226	$64,921
	user cost of decreases	$203,790	$234,945
	maximum backup (V)	876	906
	maximum backup length (lane mi)	5.0	5.1
	maximum delay (min.)	44.3	45.8
	average delay, except diversions (min)	10.5	11.7
	total delay, except diversions (V hr)	2877	3719
	total vehicles canceled(V)	0	0
	total vehicles diverted (V)	9463	10910
	total decrease in demand (V)	9463	10910
	% decrease in demand	36.4%	36.4%
	delay per diverted vehicle (min)	35.1	35.1
	total diversion delay (V hr)	5542	6389
	average delay, including diversions (min)	19.4	20.3
	total delay, including diversions (V hr)	8419	10108
	user cost / design demand	$9.78	$10.01
	delay cost / actual demand	$3.04	$3.41
Aut ON Prin ON Nov OK	validity of output	VALID	VALID

You can copy these values into Impact Sheet

From the speed delay of going through the work zone.

From the vehicles that diverted or canceled.

This length is per lane mile. If the capacity reflects more than one lane, divide this length accordingly.

A check on whether the summary output shown was computed from the input shown. VALID indicates summary output shown was computed using the input shown. NOT VALID indicates one or more input values have been changed since the current summary output was computed.

APPENDIX C

TMP EXAMPLES AND BEST PRACTICES

For ProjectWise access please visit the

MDOT ProjectWise Website

This page provides links to ProjectWise

Significant Project Examples

Non-Significant Project Examples

TMP Best Practices

APPENDIX D

TRAVEL TIME DELAY SHEET

REGION:	IN: TSC AREA	TSC INSPECTING:
PROJECT #:	HIGHWAY:	ORIGINAL DELAY ESTIMATE: MIN.

SKETCH:

DATE	TIME	DIRECTION	APPROX. MILE POINT	MILES OF SLOWDOWN*	MIN. SPENT IN SLOWDOWN**	PRE-CONSTRUCTION ZONE TRAVEL TIME AT POSTED SPEED LIMIT IN MINUTES ***	DELAY= DIFF. OF TIMES	MEASURED BY

NOTES RE: SPECIFIC CIRCUMSTANCE IN ABOVE OBSERVATIONS:

* FROM ODOMETER OR D.M.I. FROM INITIAL DECELERATION UNTIL POSTED SPEED RESUMED
** FROM STOPWATCH FOR ABOVE DISTANCE

$$\frac{\textit{60 Minutes Per Hour}}{\textit{Posted Speed Limit MPH}} \times \textit{Miles of Slowdown} = \textit{Minutes}$$ ***

APPENDIX E

2006 GUIDELINES TO ESTABLISH SPEED LIMITS IN WORK ZONES (UPDATED 12/3/2020)

Work Zone Speed Limit Procedure

Condition 1 – Roadside Activity

Work activities, workers, materials, and equipment that are **more than 15 ft** from the edge of the traveled way.

Typical Applications

Construction	Utility work
Cleaning drainage	Reworking ditches
Landscaping work	Fencing work
Structural work	

Speed Limit

No reduction

There should not be a reduction to the regulatory speed limit, unless unusual situations create hazardous conditions for motorists, pedestrians, or workers. A temporary Traffic Control Order (TCO) is required **prior** to the start of work when speed reductions are required.

Work Zone Speed Limit Procedure

Condition 2 – Roadside Activity

Work activities, workers, materials, and equipment that encroach on the area closer than 15 ft, but not closer than 2 ft to the edge of the traveled way.

Typical Applications

Construction	Utility work
Culvert extensions	Side slope work
Guardrail installation	Landscape work
Cleaning drainage	Structural work
Reworking ditches	Sign installation
Shoulder work	

Speed Limits (Where Existing Speed Limits are 50 mph or Higher)

- Where workers are present with channelizing devices = 45 mph.
- Where workers are present with concrete barriers = a maximum 10 mph reduction or as geometric and physical conditions dictate.
- No workers present = a maximum 10 mph reduction or as geometric and physical conditions mandate.

Speed Limits (Where Existing Speed Limits are 45 mph or Lower)

- All conditions = a maximum of 10 mph reduction or as geometric and physical conditions mandate.
- No speed reductions where existing speed limits are 30 mph or less.

A temporary traffic control order is required **prior** to starting work if speed reductions are required.

If speed reductions are used, the factors used to determine the reduced speed shall be noted in the plans.

Example Factors for Speed Reductions During Non-Work Periods or When Barrier Wall is Present

- Horizontal curvature that might increase vehicle encroachment rate (could include mainline curves, ramps, and turning roadways).

Work Zone Speed Limit Procedure

Condition 3 – Lane Encroachment

Work activities, workers, materials, and equipment that encroach the area from within 2 ft of the edge of the traveled way to 2 ft into the lane from the edge of the traveled way. Lane closures shall be required if the remaining lane is less than 10 ft in width, excluding the channelizing devices.

Typical Applications

Roadway construction
Guardrail installation
Utility work

Shoulder work

Joint work

Speed Limits (Where Existing Speed Limits are 50 mph or Higher)

- Where workers are present with channelizing devices = 45 mph.
- Where workers are present with concrete barriers = a maximum 10 mph reduction or as geometric and physical conditions dictate.
- No workers present = a maximum 10 mph reduction or as geometric and physical conditions mandate.

Speed Limits (Where Existing Speed Limits are 45 mph or Lower)

- All conditions = a maximum of 10 mph reduction or as geometric and physical conditions mandate.
- No speed reductions where existing speed limits are 30 mph or less.

No traffic control order is required.

If speed reductions are used, the factors used to determine the reduced speed shall be noted in the plans.

Factors for Speed Reductions During Non-Work Periods or When Barrier Wall is Present

- Horizontal curvature that might increase vehicle encroachment rate (could include mainline curves, ramps, or turning roadways).
- Barrier or pavement edge drop-off within 2 ft of traveled way.
- Reduction in sight distance.
- Unique or special conditions.

Work Zone Speed Limit Procedure

Condition 4 – Short Duration and Mobile Activity on Shoulder

Work activities, workers, materials, and equipment that require a short duration or mobile activity on the shoulder.

Typical Applications

Utility work Delineator installation Shoulder and slope work Landscape work

Temporary and permanent signing

Speed Limit

No reduction

Example Factors of Speed Reductions During Non-Work Periods or when Barrier Wall is Present

None

Work Zone Speed Limit Procedure

Condition 5 – Lane Activity

Work activities, workers, materials, and equipment that occur in traffic lanes.

Typical Applications

Roadway construction	Pavement resurfacing
Pavement repair	Temporary pavement marking
Utility work	Bridge repair
Widening	

Speed Limits (Where Existing Speed Limits are 50 mph or Higher)

- x Where workers are present with channelizing devices = 45 mph.
- x Where workers are present with concrete barriers = a maximum 10 mph reduction or as geometric and physical conditions dictate.
- x No workers present = a maximum 10 mph reduction or as geometric and physical conditions mandate.

Speed Limits (Where Existing Speed Limits are 45 mph or Lower)

- x All conditions = a maximum of 10 mph reduction or as geometric and physical conditions mandate.
- x No speed reductions where existing speed limits are 30 mph or less

No traffic control order is required.

If speed reductions are used, the factors used to determine the reduced speed shall be noted in the plans.

Example Factors of Speed Reductions During Non-Work Periods or when Barrier Wall is Present

- x Lane width reduction of 1 ft or more with a resulting lane width less than 10 ft.
- x Traffic control devices encroaching on a lane open to traffic or within a closed lane, but within 2 ft of the edge of the open lane.
- x Reduced posted speed for taper length or speed change lane length.
- x Barrier or pavement edge drop-off within 2 ft of traveled way.
- x Reduced posted speed of horizontal curve.
- x Reduced posted speed for stopping sight distance.
- x Traffic congestion created by lane closure.
- x Unique or special conditions.

Work Zone Speed Limit Procedure

Condition 6 – Temporary Detour

Some activities require a temporary detour to be constructed. Existing routes used for detours should use established speed limits in place.

Typical Applications

Roadway construction
Sub-grade restoration
Bridge construction
Culvert repair

Speed Limits

No reduction

Example Factors of Speed Reductions During Non-Work Periods or When Barrier Wall is Present

None

Work Zone Speed Limit Procedure

Design Guideline Exceptions or Adjustments

1. For projects involving temporary traffic signals, no speed limit reductions shall be signed in advance of the temporary traffic signal. If the open traffic lane is restricted in width, signing for a reduced lane width with a speed advisory panel shall be used.

2. On longer projects, refer to the note sheets on the maintaining traffic typicals for additional speed limit sign placements.

3. Additional exceptions will be dealt with on an as needed basis through MDOT and within contract documents.

APPENDIX F

PORTABLE CHANGEABLE MESSAGE SIGN GUIDELINES

Portable Changeable Message Signs (PCMS) are used to provide motorists real-time traffic safety and advance guidance information that allows motorists to make an informed decision when approaching a work zone. This includes scheduled and unscheduled events that significantly impact traffic on the roadways.

APPLICATION GUIDELINES FOR PCMS

PCMS provide a variety of functions including:

- Ramp, lane, and road closures
- Traffic pattern changes (i.e. temporary crossovers & width restrictions)
- Moving Work Crews
- Roadwork Scheduling Advisories
- Traffic Management and alternate routing
- Warning of Adverse Road Conditions
- Traffic Operations Control
- Real-time Travel Time Messages
- Incident Management
- Safety Messages

PCMS Applications (ranked in order importance):

ADVANCE TIME NOTIFICATION

- Roadway Closures: Advance notice message, displayed 7-14 days prior to closure, addresses the temporary closure (short duration) of roadways for planned work i.e. truss or bridge beam installations.
- Ramp Closures: Displaying the message 3-7 days prior to the closure is

recommended. For freeway to freeway or weekend closures on freeways with high recreational/tourist travel, the message should be displayed longer (up to 14 days), and should include two Thursdays prior to closures. The message should include the start date/time as well as opening of the closure.

- Lane Closures: S ame as Ramp Closures.

- Planned Maintenance Work: it is recommended that the message is displayed 7-14 days prior to the planned work and include the start date/time and estimated completion date.

The message(s) displayed during the closure/work will differ from those displayed prior to the event.

EXISTING EVENTS

- Detour/Alternate Routes: The message should recommend detours/alternate routes during ramp/lane/roadway closures.

- Notice of Operations: Within unusual roadway geometrics, PCMS devices may be used as an advanced warning device in conjunction with static signing for stationary or moving operations. Hills, curves, and other unusual geometrics obstruct the view of motorists; a PCMS provides an additional notice/warning. Cancelation and completion of roadwork should also be messaged when applicable.

- Work Zone Traffic Backups: Involves monitoring congestion and backups (real- time). This is an ideal use for PCMS and requires a stopped traffic advisory system to be added to the project. Generic traffic backup messages should be avoided as this decreases the effectiveness of the stopped traffic advisory system. Programing a message during peak traffic time frames is allowed, but this message should not remain in place during off peak hours.

- Special Event Traffic Conditions: Unusual vehicle and/or non-motorized traffic patterns generated by sporting or charity events are examples for PCMS use. PCMS boards shall not be used under ANY circumstances to advertise special events. Messages for special events should be designed such that advertising is not embedded in the message. The message shall identify traffic conditions and a suggested remedy for those attending the special event and those using the same roadway to pass by the special event location.

- Real-Time, Travel Time Messages: Real-time, travel time messages are recommended to be displayed when other, higher priority messages are not available/needed. This provides useful information on current roadway conditions, providing the motorist with real-time information for informed decision making.

- Incident Management: Post roadway or lane closures due to crashes or incidents which cannot be addressed with static signing only.

- Safety Messages: If used, messages must be pre-approved by the Work Zone Business Team or a common National Work Zone approved message. Safety message should rarely be used on PCMS boards for work zones.

- Traffic Calming: LIMITED USE of messages to inform motorists of closures are permitted. Traffic calming messages indicate the reason a lane is closed (if not obvious) or when a lane will be re-opened. For example, messages notifying of an estimated opening may be displayed during the life of the closure.

PROHIBITED USE of PCMS

- Replacement of Michigan Manual of Uniform Traffic Control Devices (MMUTCD) required static signing or pavement markings.

- Advertising of any kind.

- No animation or rapid flashing symbols, pictures, or text.

- Lighted arrow replacement. (Exception: May allow static chevrons or a static arrow to provide additional direction on a detour route).

MESSAGE OBJECTIVE

PCMS boards should clearly identify what is happening within the work zone area. It should provide useful, actionable information to the motorist. Vague or generic messaging should not be used.

PCMS boards should clearly state the objective of the message by considering the following:

QUESTION	EXAMPLE MESSAGE
What is ahead?	(LEFT/RIGHT LANE CLOSED AHEAD)
How far away?	(XX MILES AHEAD)
Where?	(WOODWARD TO MOUND)
When?	(STARTS FRIDAY 8AM-9PM)
Directions advised?	(FOLLOW DETOUR)

The message should be designed to display the most important information, in as condensed a manner as possible, to meet the requirements of message timing.

PCMS MESSAGING GUIDANCE

Drivers must be able to see, read, and comprehend the message on a PCMS. It is essential that messages are clear, concise, and easily comprehended by the general public.

It is also important to properly describe the roadwork or incident location based on the expected audience. The public should believe that PCMS boards contain important, useful, and accurate information, so they read every message, every time. Providing inaccurate, confusing, non-priority messages reduces motorist interest, increasing risk factors, and ultimately leading to a loss of credibility.

PCMS must provide an 18-inch character height, with a maximum eight characters per line and three lines of text. Commuters are typically familiar with street names; however, tourists are not. Route Numbers should be used whenever possible. (Ex. M-24, US-23, I-696). When providing dates, use words for numbers whenever possible, because they are easier to read and comprehend. For example, use the format "NOV 24" instead of "11/24/11". Also, when possible, use days instead of dates for upcoming construction. "SAT-SUN" is easier to understand than "4/13 – 4/14."

FULL MATRIX LED PCMS BOARDS

NTCIP-Compliant, Full-Matrix Portable Changeable Message Boards may be used on projects as approved by each Region. Projects that may warrant the use of these pay items include locations where messages may require more than eight characters per line (with a 10-character maximum), on projects utilizing real-time travel time messages and unique messaging situations as determined appropriate.

PROHIBITED MESSAGING

The below messages do not provide the public with any guidance as it relates to an upcoming work zone and should not be used unless they meet the exceptions.

PROHIBITED MESSAGING	EXCEPTIONS
ONGOING ROAD WORK	None
DRIVE WITH CAUTION	Crash, Incident or Emergency
WATCH FOR BACKUPS	Stop Traffic Advisory and Temporary Portable Rumble Strip Projects
WORKZONE SPEED LIMIT STRICTLY ENFORCED	Project is patrolled 24/7

PCMS NOT IN USE & STORAGE

When PCMS is not needed for a message as contained in these guidelines, it must be turned off and removed from the road side, as indicated in the Standard Specifications for Construction. PCMS boards must never be turned sideways and stored on the shoulder or edge of roadway.

If during construction the message board is in an area that has limited access or may be used at a later date in the same location, 4 stars (*) may be placed in a flashing mode, with the first screen having the upper right and lower left stars (*) and the second screen having the lower right upper left stars (*). This notifies the public that the board is working, but no message is being conveyed to them.

PCMS LOCATION

PCMS should be visible from at least 1/2 mile under both daytime and nighttime conditions. Placement in advance of the work zone or incident should take into account the following factors:

- Where used for route diversion, PCMS should be placed far enough in advance to allow traffic ample opportunity to exit the affected roadway.
- PCMS are normally placed on a level shoulder of the roadway, perpendicular to traffic. If practical, placement further from the traveled lane is suggested.
- PCMS boards are typically located in remote locations, not easily accessed and far from a contractor's office. NTCIP PCMS boards are highly recommended for these areas.
- Delineate PCMS as described in the standard specifications.
- PCMS Boards must be locked at all times.
- PCMS Boards should not be located within 1000 ft. of an existing Digital Message Sign Board (DMS).
- PCMS Board locations should be detailed in construction plan sheets. When no plan sheets exist, the boards should be located by TSC staff prior to project startup.
- PCMS boards must be maintained at all times. This includes areas of dirt and dust and during the winter months, ensuring the dimming lens is free of debris, snow, and salt spray.

TEMPORARY RUMBLE STRIP PCMS PLACEMENT

PCMS boards may be used in conjunction with temporary rumble strips on a project. The boards should be placed a minimum of 500 ft. after a set of rumble strips to allow the driver time to read and comprehend the message.

STOP TRAFFIC ADVISORY PCMS PLACEMENT

PCMS boards should be placed on both sides of the roadway. Boards should be staggered approximately 1000 ft. apart to ensure the flash rate is not distracting to motorists. Depending upon the determined length of backup and the amount of PCMS boards placed on the project,

boards should be placed every 0.5-1.0 mile apart in advance of the lane closure taper.

MESSAGE TIMING

Sequencing messages are typically used when situations dictate the need for more messages than what can be displayed at one time on a PCMS. The cycle time and duration of the message is related to the operating speed of the highway. All message sequences should consist of a maximum of two messages and with a two-second minimum display time for each message. If additional sequences are needed, a second PCMS should be placed on the same side of the roadway, separated by at least 1000 ft.

INCIDENT MANAGEMENT

Incident management messaging should reference the MDOT Dynamic Message Sign Guidelines. Questions / examples of incident messaging provided below.

QUESTIONS	EXAMPLE MESSAGE
What Happened?	(CRASH)
Where?	(AT LIVERNOIS)
What is the effect?	(LEFT LANE BLOCKED)
Who is affected?	(THRU TRAFFIC)
What is advised?	(EXPECT DELAYS)

ABBREVIATIONS

Due to limitations of PCMS size or the message length, it is sometimes necessary to abbreviate words. The use of abbreviations however, should be minimized. The following are nationally recognized abbreviations for frequently used words:

STANDARD ABBREVIATIONS

WORD MESSAGE	STANDARD ABBREVIATION
Afternoon/Evening	PM
Alternate	ALT
Avenue	AVE, AV
Bicycle	BIKE
Boulevard	BLVD
Cannot	CANT
Center	CNTR
Circle	CIR
Civil Defense	CD
Court	CT
Crossing (other than highway-rail)	XING
Do Not	DON'T
Drive	DR
Emergency	EMER
Entrance, Enter	ENT
Expressway	EXPWY
Feet	FT
FM Radio	FM
Freeway	FWY
Friday	FRI
Hazardous Material	HAZMAT
Highway	HWY
Highway-Rail Grade Crossing Pavement Marking	RXR
Hospital	H
Hour(s)	HR
Information	INFO
It Is	ITS
Junction/Intersection	JCT
Lane	LN
Left	LFT
Maintenance	MAINT
Mile(s)	MI
Miles Per Hour	MPH

WORD MESSAGE	STANDARD ABBREVIATION
Minute(s)	MIN
Monday	MON
Morning/Late Night	AM
Normal	NORM
Parking	PKING
Parkway	PKWY
Pedestrian	PED
Place	PL
Pounds	LBS
Right	RHT
Road	RD
Saturday	SAT
Service	SERV
Shoulder	SHLDR
Slippery	SLIP
Speed	SPD
Street	ST
Sunday	SUN
Telephone	PHONE
Temporary	TEMP
Terrace	TER
Thursday	THURS
Traffic	TRAF
Trail	TR
Travelers	TRAVLRS
Tuesday	TUES
Two-Way Intersection	2-WAY
Two-Wheeled Vehicles	CYCLES
US Numbered Route	US
Vehicle(s)	VEH
Warning	WARN
Wednesday	WED
Will Not	WONT

ABBREVIATIONS USED WITH PROMPTS

Other abbreviations are easily understood when they appear with a prompt word commonly associated with it. The prompt word must be spelled out when used with the abbreviated word.

WORD	ABBREVIATION	PROMPT WORD
Access	ACCS	Road
Ahead	AHD	Fog*
Blocked	BLKD	Lane*
Bridge	BRDG	(Name)*
Chemical	CHEM	Spill
Condition	COND	Traffic*
Congested	CONG	Traffic*
Construction	CONST	Ahead
Downtown	DWNTN	Traffic
Exit	EXT	Next*
Express	EXP	Lane
Frontage	FRNTG	Road
Hazardous	HAZ	Driving
Interstate	I	[Number]
Local	LOC	Traffic
Major	MAJ	Accident
Minor	MNR	Accident
Minute(s)	MIN	(Number)*
Oversized	OVRSZ	Load
Pavement	PVMT	Wet*
Prepare	PREP	To Stop
Quality	QLTY	Air*
Roadwork	RDWK	Ahead [Distance]
Route	RT, RTE	Best*
Township	TWNSHP	Limits
Turnpike	TRNPK	(Name)*
Cardinal Directions	NB, EB, SB, WB	(Number)
Upper, Lower	UPR, LWR	Level
Work	WRK	Road*

* = Prompt word given first

Abbreviations should be used cautiously with prompt words as they can cause confusion when used in the wrong context. For example, drivers interpret BLKD as BLOCKED when it appears with LANE in the form LANE BLKD. CHEM is interpreted by drivers as CHEMICAL when used in the message as CHEM SPILL. The table below provides a list of abbreviations that are easily misinterpreted.

UNACCEPTABLE ABBREVIATIONS

ABBREVIATION	INTENDED WORD	COMMON MISINTERPRETATIONS
ACC	Accident	Access (Road)
CLRS	Clears	Colors
DLY	Delay	Daily
FDR	Feeder	Federal
L	Left	Lane (Merge)
LT	Light (Traffic)	Left
PARK	Parking	Park
POLL	Pollution (Index)	Poll
RED	Reduce	Red
STAD	Stadium	Standard
WRNG	Warning	Wrong

SAMPLE MESSAGING

STANDARD MESSAGES

RIGHT(LEFT) LANE CLOSED	XX MILES AHEAD
TRAFFIC SHIFT RIGHT(LEFT)	XX MILES AHEAD
RD WORK US-24 TO M-39	RIGHT(LEFT) LN CLOSED AHEAD
NEW TRAFFIC PATTERN	XX MILES AHEAD
ROAD WORK AHEAD	8 MILE TO 9 MILE
RD WORK US-24 TO ECORSE	TRUCKS USE LEFT(RIGHT) LANE
NARROW LANES AHEAD	REDUCE SPEED
NARROW LANES AHEAD	OVERSIZE LOADS EXIT XXX
RD WORK AT LAPEER	STARTING APRIL 5TH
RD WORK M-24 TO M-15	BEGINS APRIL 5TH
NIGHTLY LANE CLOSURES	9PM TO 5AM

STOP TRAFFIC ADVISORY SYSTEM

SLOW TRAFFIC AHEAD	WATCH FOR BACKUPS
STOPPED TRAFFIC AHEAD	BE PREPARED TO STOP
SLOWED TRAFFIC	XX MILES AHEAD
STOPPED TRAFFIC	XX MILES AHEAD
RD WORK XX MILES AHEAD	TRUCKS USE LEFT(RIGHT) LANE
RD WORK US-24 TO M-39	MOTRCYCLS USE LEFT(RIGHT) LANE

RUMBLE STRIPS

RUMBLE STRIPS AHEAD	ATTENTION MOTOR- CYCLES

RUMBLE STRIPS	XX MILES AHEAD
RUMBLE STRIPS AHEAD	REDUCE SPEED

DETOURS

HAMBURG ROAD CLOSED	FOLLOW DETOUR
HAMBURG ROAD CLOSED	USE EXIT XXX
WB I-94 TRAFFIC	USE 8 MILE RD
WB I-94 CLOSED	FOLLOW DETOUR
US-24 RAMP CLOSED	USE EXIT XXX
US-24 RAMP CLOSED	FOLLOW DETOUR

FREEWAY STOPPAGES

15 MIN CLOSURES	STARTING MON 9PM TO 5AM
15 MIN FWY CLOSURES	SEEK ALT ROUTE
NIGHTLY FWY CLOSURES	MON-FRI 9PM TO 5AM

APPENDIX G

RESOURCE LINKS

For research purposes, the following web sites have information specifically related to work zone operations or organizations and programs that address work zone safety and mobility issues.

MDOT

- MDOT Mobility Map
  http://featuredmaps-mdot.opendata.arcgis.com/app/mobility-restrictions-map

- Work Zone Home Page
  www.michigan.gov/mdotworkzones

- MDOT Manuals and Guides
  http://www.michigan.gov/mdot/0,4616,7-151-9622_11044_11367---,00.html

- MDOT Specifications for Construction
  https://mdotjboss.state.mi.us/SpecProv/specBookHome.htm

- MDOT Standard Plans
  https://mdotjboss.state.mi.us/stdplan/standardPlansHome.htm

- Frequently Used Special Provisions
  https://mdotcf.state.mi.us/public/dessssp/spss/

- Previously approved Special Provisions
  https://mdotjboss.state.mi.us/SpecProv/specProvHome.htm

FHWA

- FHWA Work Zone Operations Best Practice Guidebook
  http://ops.fhwa.dot.gov/wz/practices/practices.htm

- FHWA
  www.fhwa.dot.gov
  http://www.ops.fhwa.dot.gov/wz/index.asp

- FHWA Highway Rail/Grade Crossing
  http://safety.fhwa.dot.gov/xings/

- FHWA MUTCD web site
  http://mutcd.fhwa.dot.gov

- Work Zone Safety Information Clearinghouse
  www.workzonesafety.org

- Countermeasures that Reduce Crash Severity
  https://safety.fhwa.dot.gov/roadway_dept/countermeasures/reduce_crash_severity/

- Work Zone Process Review Toolbox

https://ops.fhwa.dot.gov/wz/prtoolbox/pr_toolbox.htm

MIOSHA

- Department of licensing and Regulatory Affairs
  http://www.michigan.gov/lara/0,4601,7-154-11407---,00.html

- Part 22
  http://www.michigan.gov/documents/lara/lara_miosha_CS_22_419359_7.pdf

Other Resources

- American Road and Transportation Builders Association
  www.artba.org

- American Traffic Safety Services Association
  www.atssa.com

- American General Contractors
  www.agc.org

- American Association of State Highway and Transportation Officials
  http://www.transportation.org

- Synthesis of Intelligent Work Zone Practices
  http://www.enterprise.prog.org/Projects/2010_Present/iwz.html?EventID=1433072641&FirstName=chris&LastName=brookes&Email=brookesc%40michigan.gov&EnrollmentID=

- Institute of Transportation Engineers
  http://www.ite.org

  Local Transportation Assistance Program
- http://www.ltap.org

- National Utilities Contractors Association
  http://www.nuca.com

APPENDIX H

TRAFFIC REGULATOR ZONES

CAPACITY IN TRAFFIC REGULATOR ZONES

LENGTH OF TRAFFIC REGULATOR ZONE MILES (KILOMETERS)	35 MPH POSTED CONSTRUCTION ZONE SPEED	45 MPH POSTED CONSTRUCTION ZONE SPEED	55 MPH POSTED CONSTRUCTION ZONE SPEED
	CAPACITY (VPH)	CAPACITY (VPH)	CAPACITY (VPH)
0.1 (0.16)	1158	1163	1166
0.2 (0.32)	1136	1146	1152
0.3 (0.48)	1112	1128	1138
0.4 (0.64)	1088	1110	1123
0.5 (0.80)	1063	1091	1108
0.6 (0.96)	1037	1072	1093
0.7 (1.12)	1010	1052	1077
0.8 (1.28)	982	1031	1061
0.9 (1.45)	953	1010	1044
1.0 (1.61)	922	988	1027
1.1 (1.77)	890	966	1010
1.2 (1.93)	857	943	992
1.3 (2.10)	822	919	974
1.4 (2.25)	786	894	955
1.5 (2.41)	748	868	936
1.6 (2.57)	708	842	916
1.7 (2.74)	666	814	896
1.8 (2.89)	622	786	875
1.9 (3.05)	575	756	854
2.0 (3.22)	526	726	832
2.1 (3.38)	475	694	809
2.2 (3.54)	420	661	786
2.3 (3.70)	363	627	762
2.4 (3.86)	302	591	737
2.5 (4.02)	237	554	711

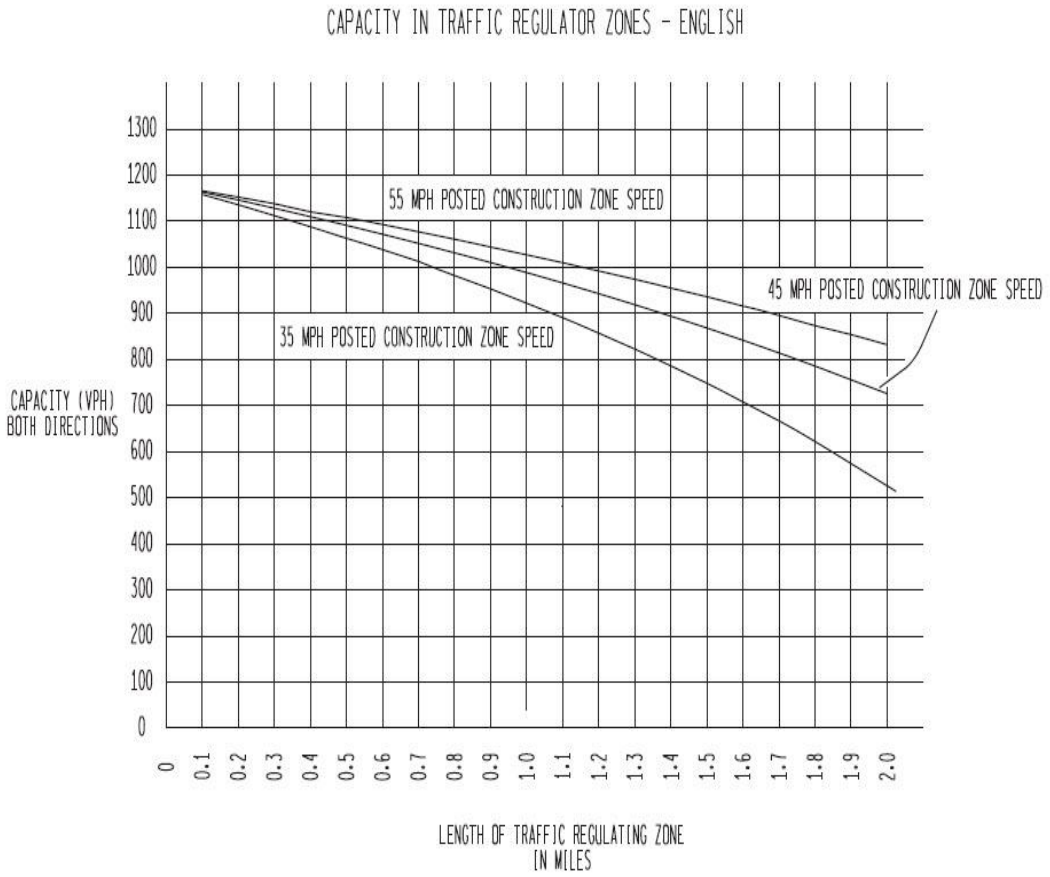
MDOT Michigan Department of Transportation

TRAFFIC AND SAFETY NOTE

CAPACITY IN TRAFFIC REGULATING ZONES

DRAWN BY: DFK
CHECKED BY: JAT
11/14/06
PLAN DATE:
Note 908A
SHEET 2 OF 4

FILE: PW RD TS T Dev Note908A tsn.dgn
REV. 11/14/2006



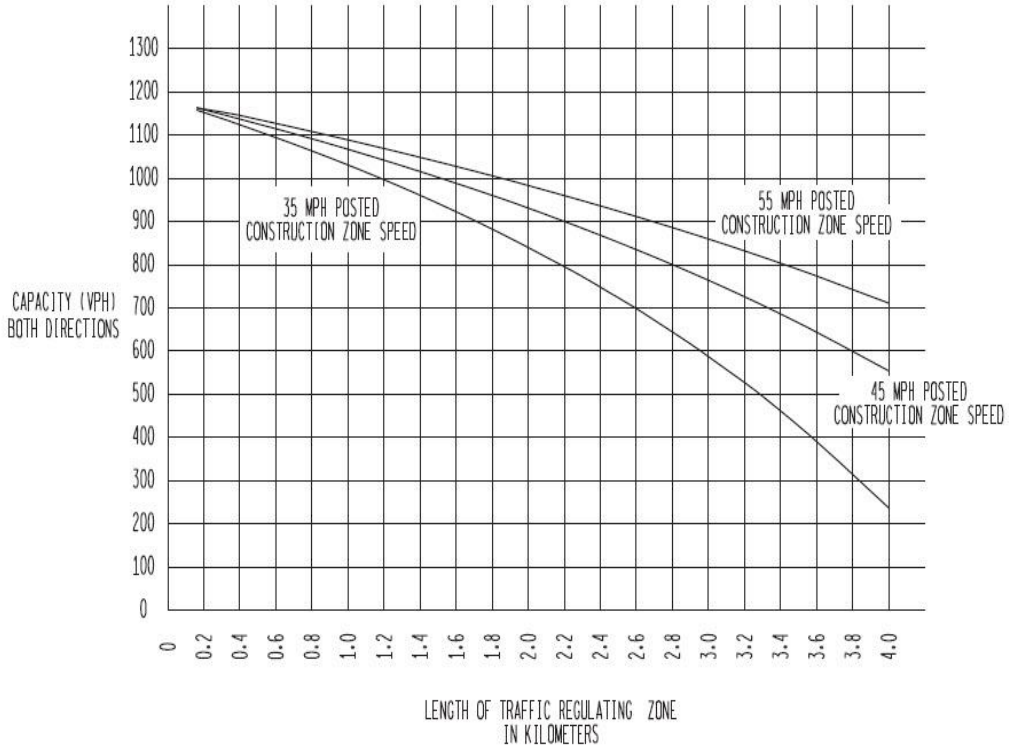
MDOT
Michigan Department of Transportation

TRAFFIC AND SAFETY
NOTE

CAPACITY IN
TRAFFIC REGULATING
ZONES

DRAWN BY: DFK	11/14/06		
CHECKED BY: JAT	PLAN DATE:	Note 908A	SHEET 3 OF 4
FILE: FW RD TS T Dev Note908A tsrt.dgn		REV. 11/14/2006	

CAPACITY IN TRAFFIC REGULATOR ZONES - METRIC



MDOT
Michigan Department of Transportation

TRAFFIC AND SAFETY
NOTE

CAPACITY IN
TRAFFIC REGULATING
ZONES

DRAWN BY: DFK	11/14/06	
CHECKED BY: JAT	PLAN DATE:	Note 908A	SHEET 4 OF 4

FILE: PW RD TS T Dev Note908A tsn.dgn REV. 11/14/2006

APPENDIX I

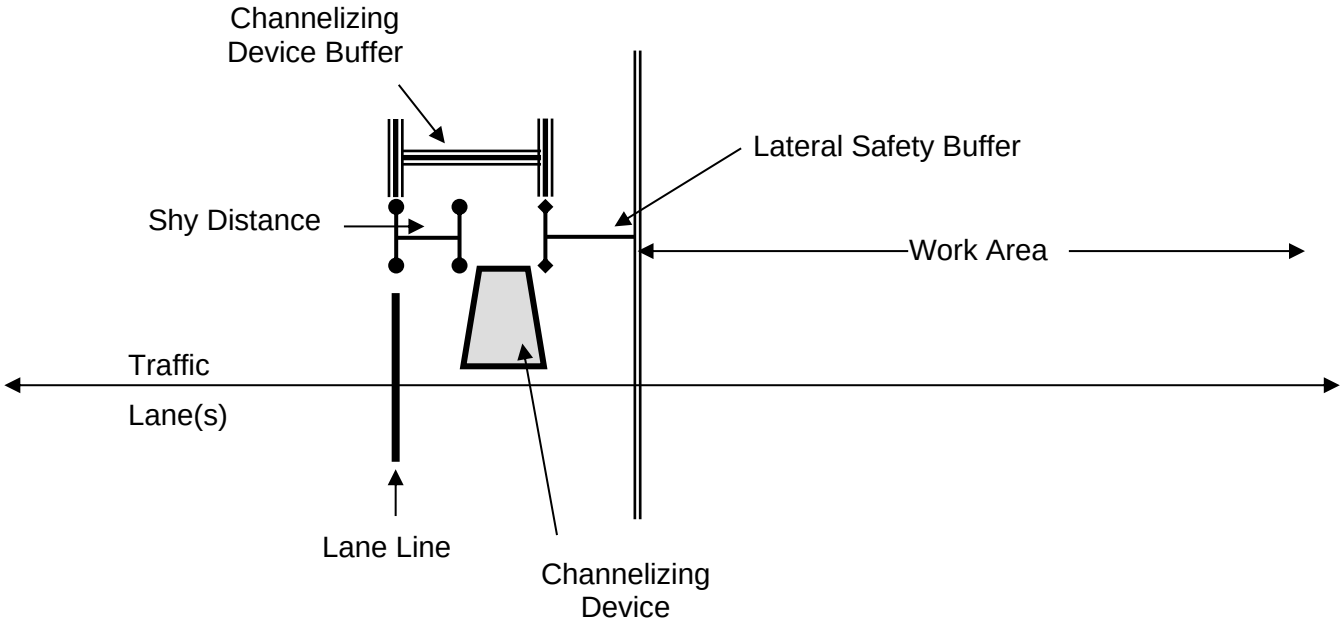
LCCA MAINTENANCE OF TRAFFIC FLOWCHARTS

(Added 1/20/2020)

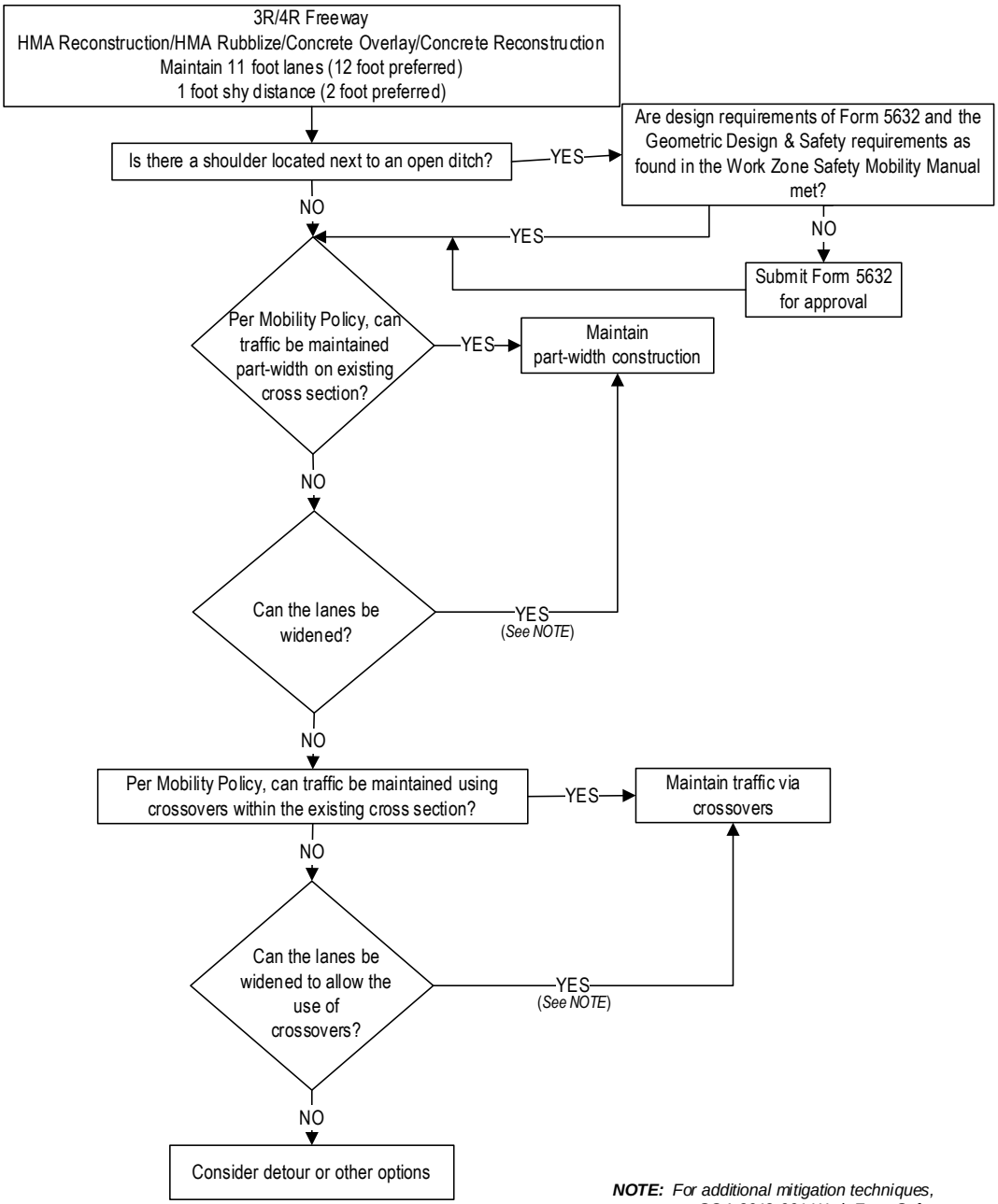
The following flowcharts provide guidelines for maintaining traffic and are to be utilized with projects requiring an LCCA. A Nomenclature diagram is provided to assist in defining some terminology found in the flowcharts.

NOMENCLATURE

(not to scale)



Maintaining Traffic for Freeways



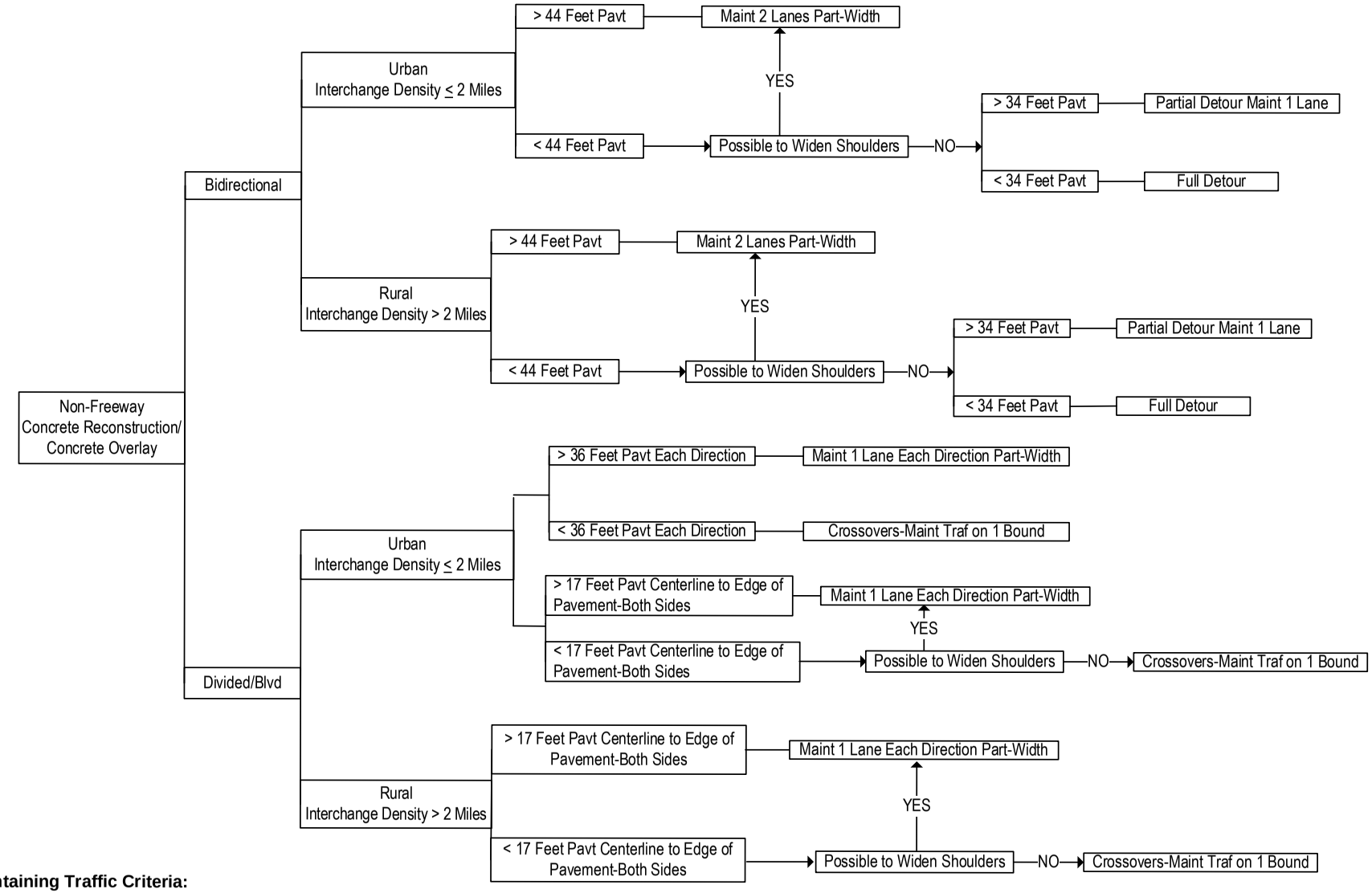
NOTE: *For additional mitigation techniques, see SOA 2013-001 Work Zone Safety Tools for Narrow Shoulders*

Maintaining Traffic Criteria:

1) Traffic will be maintained on a minimum of 11 foot wide lanes.
2) Maintain four-foot wide channelizing device buffer, which includes a minimum of 1 foot of shy distance from the edge of the travel lanes to channelizing devices plus the width of the channelizing devices.
3) Refer to the Work Zone Safety and Mobility Manual for guidance on edge drop protection requirements based on drop off.
4) Construction joints will match lane lines (longitudinal paint lines).
5) Maintain a 4-foot wide lateral safety buffer. For HMA rubblize with ADT < 20,000, this lateral safety buffer shall be a minimum of 1 foot.

10-09-20

Maintaining Traffic for Non-Freeway Concrete Reconstruction/Concrete Overlay

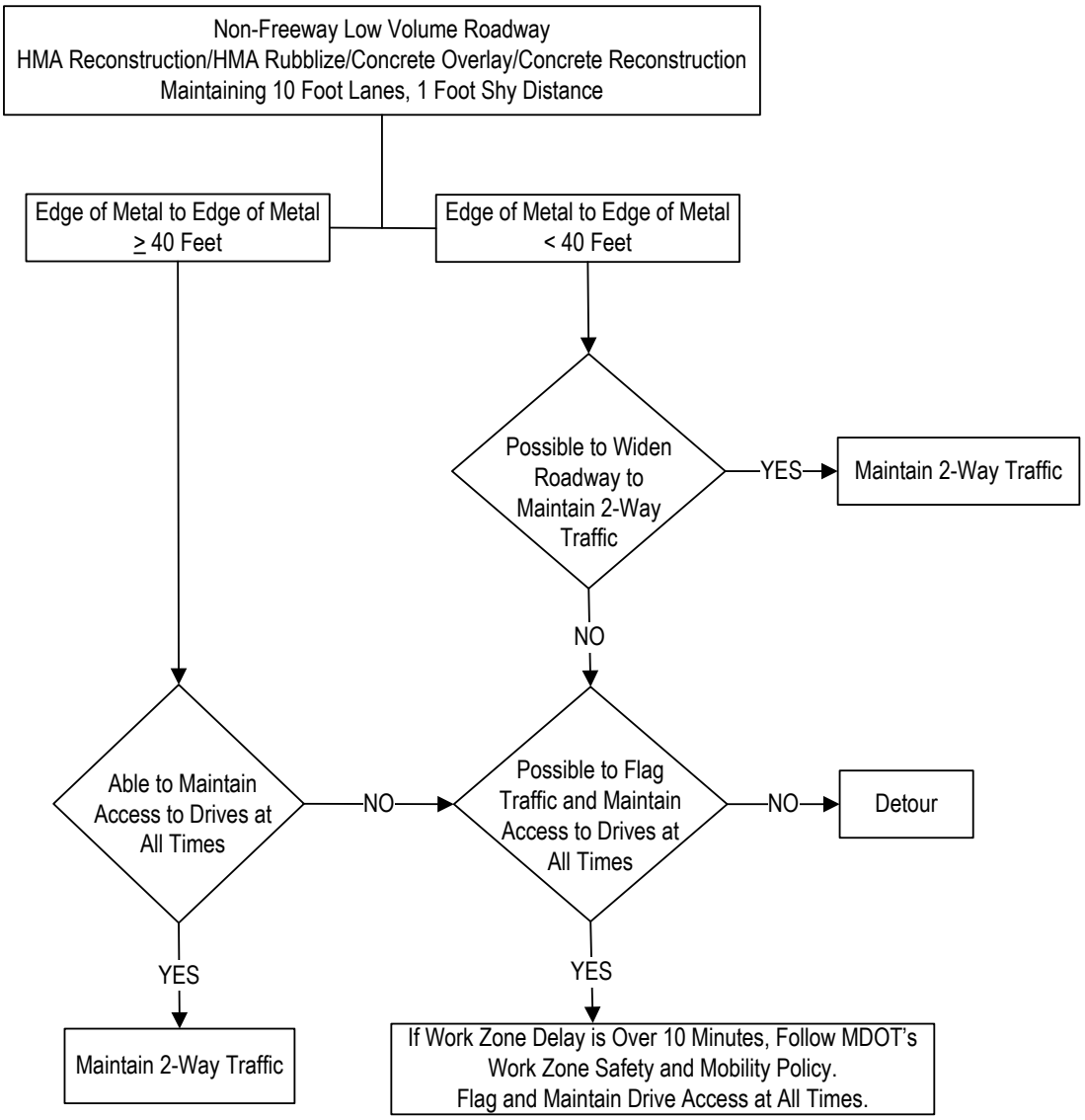


Maintaining Traffic Criteria:

1) Traffic will be maintained on 11-foot wide lanes and 1-foot shy distance.
2) Maintain 4-foot wide channelizing device buffer, which includes a minimum of 1 foot of shy distance from the edge of the travel lanes to channelizing devices plus the width of the channelizing devices.
3) Refer to the Work Zone Safety and Mobility Manual for guidance on edge drop protection requirements based on drop off.
4) Construction joints will match lane lines.
5) Maintain lateral safety buffer of 4 feet minimum.

05-09-16

Maintaining Traffic for Non-Freeway Low Volume Roadway (< 20,000 ADT)
HMA Reconstruction/HMA Rubblize/Concrete Overlay/Concrete Reconstruction

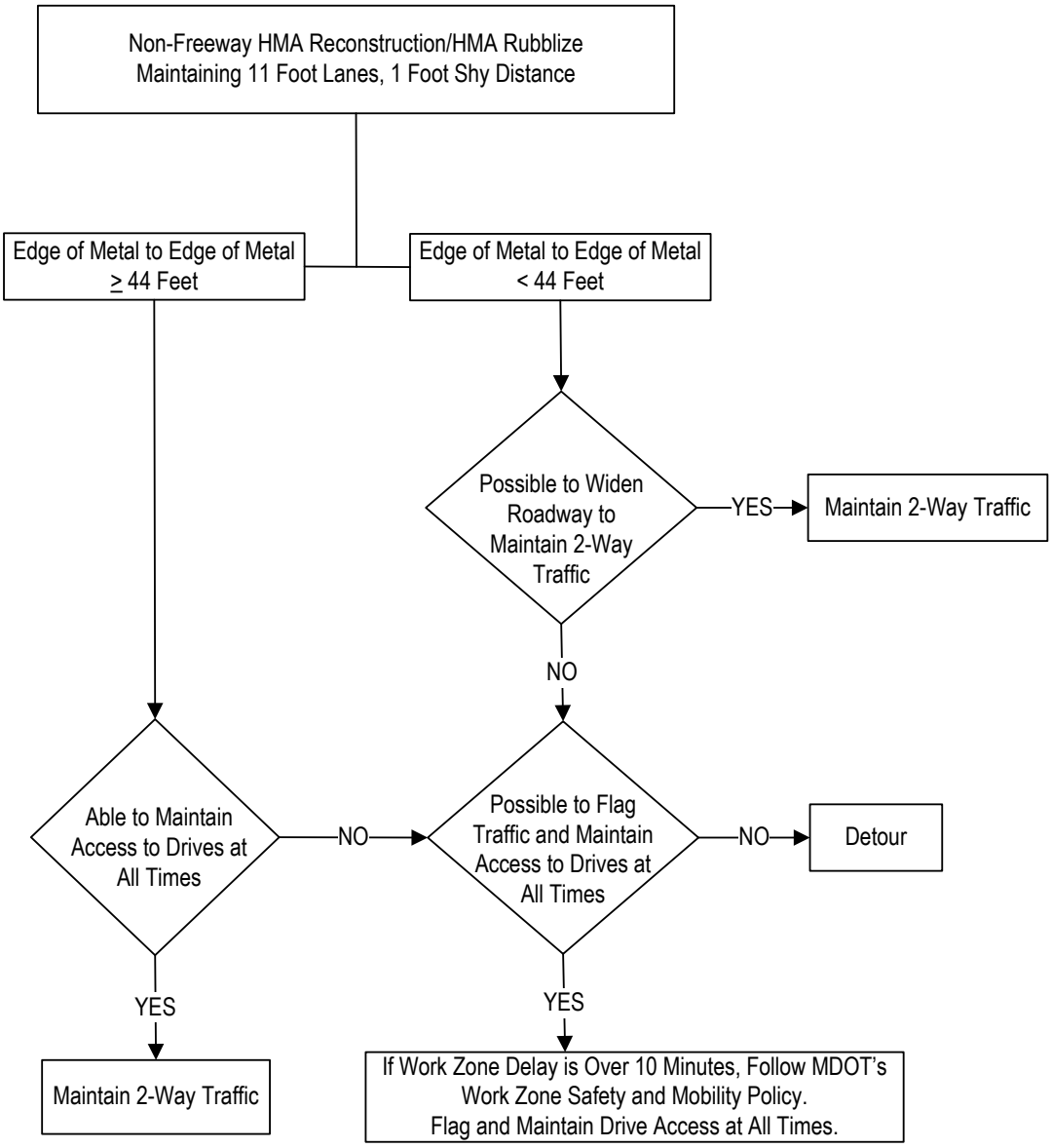


Maintaining Traffic Criteria:

1) Traffic will be maintained on a minimum of 10 foot wide lanes.
2) Maintain a 4-foot wide channelizing device buffer, which includes a minimum of 1 foot of shy distance from the edge of the travel lanes to channelizing devices plus the width of the channelizing devices.
3) Refer to the Work Zone Safety and Mobility Manual for guidance on edge drop protection requirements based on drop off.
4) Construction joints will match lane lines (longitudinal paint lines).
5) Maintain a 4-foot wide lateral safety buffer. For HMA rubblize, this lateral safety buffer shall be a minimum of 1 foot.

05-09-16

Maintaining Traffic for Non-Freeway HMA Reconstruction/HMA Rubblize



Maintaining Traffic Criteria:

1) Traffic will be maintained on 11 foot wide lanes.
2) Maintain four-foot wide channelizing device buffer, which includes a minimum of 1 foot of shy distance from the edge of the travel lanes to channelizing devices plus the width of the channelizing devices.
3) Refer to the Work Zone Safety and Mobility Manual for guidance on edge drop protection requirements based on drop off.
4) Construction joints will match lane lines (longitudinal paint lines).
5) Maintain a 4-foot wide lateral safety buffer.

05-09-16

APPENDIX J

MDOT Work Zone Forms

(Added 12/3/2020)

Inspector's Checklist for Solar Boards

Travel Time Delay Sheet

Work Zone Annual Report.xlsx (PWLink)

Work Zone Audit Report

Work Zone Enforcement Agreement with Local Agency Police and MDOT

Work Zone Enforcement Agreement with Michigan State Police and MDOT

Work Zone Safety and Mobility Peer Review Team (PRT) Form

APPENDIX K

TEMPORARY SIGN DESIGN GUIDELINES

(Added 12/3/2020)

Overview

This document is to be followed when using SignCad to design temporary special signs for use during construction. The guidelines and examples listed below are intended to maximize the size of the legend, while keeping the sign size small enough to meet space limitations and post size requirements. Signs designed must meet all current crash testing requirements.

General Guidelines

- The sign design should be based on the space available, (i.e shoulder width, slope condition, etc) for the sign, taking into account the sign support system to be used.
- It is desirable to have driven special signs not exceed a 4' x 8' sheet of plywood. If necessary, it is allowable to increase the length to 10 feet.
- Signs mounted on two temporary portable supports or barrier mounted signs must be 20 sft or less in size.
- Signs mounted on a single steel portable support must be 9 sft or less in size.
- Start design using the maximum text size requirements. (i.e. using a 6"D letter size will have the same width as a 7"C letter size because of the stroke width. However, the 7"C letter size is preferred if sign height is not an issue).
- Limit the sign message to no more than three lines of text. An additional supplemental message, such as "FOLLOW DETOUR", may be added at the bottom of the sign. Separate the supplemental message from the main body of the sign with a horizontal line that is the same thickness as the sign border.
- Sign widths should be designed to increments of a ½ foot. Post types will vary depending upon the size of the sign as determined by the Sign Support Selection Chart (SIGN-150-D.pdf).
- Sign heights should be in ½ foot increments, with the exception that separate 15 inch tall signs are allowable.
- If both the width and the height of the sign are greater than 4 feet, the sign will require a horizontal splice. Design the sign so splices are not in the middle of a legend or border. Vertical splices are not allowed. Horizontal spliced panels should be designed in ½ foot increments. (i.e. a 78" x 54" sign would need two panels 78" wide. An acceptable option would be a 78" x 36" panel and a 78" x 18" panel if the seam between the panels does not go through a legend or border).

Letter Sizes:

Non-Freeway

Maximum	7"D
	7"C
	6"D
	6"C
	5"D
Minimum	5"C

Freeway

Maximum	8"D
	8"C
	7"D
Minimum	7"C

Vertical Spacing Guidelines:

- Vertical spacing between text lines may range from 2 inches less than the text height to the text height. Vertical spacing between text lines is desirable to be 2 inches less than the text size. (i.e. if using 7 inch text height, 5 inch spacing between lines is desirable but the spacing may increase to 7 inches).
- Signs with multiple lines of text should have the vertical spacing between the text and the top and bottom edge of the sign and the line separating the supplemental message equal the text height but may be reduced by up to 2 inches.
- Signs with a single line of text should have the vertical spacing between the text and the top and bottom edges of the sign be 3 inches less than the text height.
- Vertical spacing between an M1 series route shield and the top/bottom edge of the sign or text above/below the shield should range from 3 inches less than the text height to the text height.

Horizontal Spacing Guidelines:

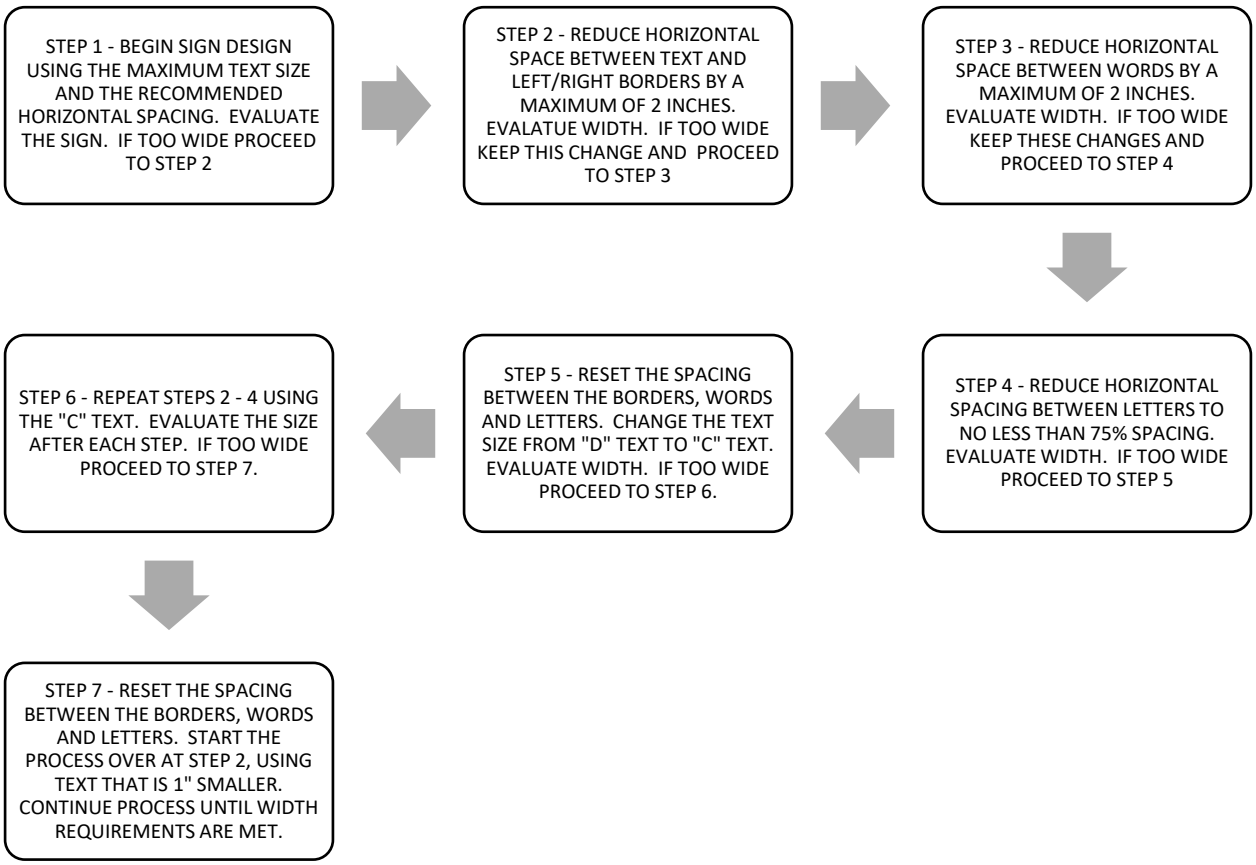
- Horizontal spacing between words in a line of text should equal the text height but may be reduced by up to 2 inches (i.e. the spacing between words with 8 inch text may be reduced to 6 inches).
- Horizontal spacing between text and right or left border should equal the text height but may be reduced by up to 2 inches.
- Letter spacing may be reduced to no less than 75% spacing.

Sign Size Reduction:

Begin the sign design using the maximum letter size and then evaluate the sign size to see if it fits (or can be adjusted to fit) on a 4’ x 8’ piece of plywood.

If the sign height needs to be reduced, begin by reducing the vertical spacing between the text lines and between the top and bottom borders and any supplemental border line. If further height reduction is necessary, then reduce the text height. Splices may be required to meet the necessary sign height.

If the sign width needs to be reduced, follow the steps below.



If the text height changed when reducing the width, go back and check the vertical spacing, adjust as necessary.

Supplemental road name plaques with Diamond signs

- Supplemental signs placed below a 4’x4’ diamond sign on two 3# posts must be 4 sft or less so that the total square footage does not exceed 20sft.
- Supplemental signs should be uniform under the 4’x4’ diamond sign in order to spread the width of the two posts (ie, 48 inch x 12 inch).
- Supplemental route marker signs placed below a 4’x4’ diamond sign must be less than 4 sft including the cardinal direction sign if used.

Detour route clusters

- Detour route sign clusters with M4-8, cardinal direction, route marker shield, and directional arrow must not exceed 9 sft on a single post.

Supplemental road name plaques with M4-9 signs

- Supplemental road name sign sizes above a standard M4-9 detour sign may be 12 inches, 15 inches, or 18 inches in height.
- Signs must be kept below 9 sft for single post installations and 20 sft for double post installations.
- The minimum width of the supplemental sign is the width of the M4-9 sign below it. In general, the maximum width of the supplemental sign should be no more than 6 inches greater than the width of the M4-9 sign below it, so that there is only a 3 inch overhang on each side of the M4-9 unless the word is too long, in which case additional length may be added.
- A second line may be used for a second route name or direction as long as the signs are kept below the 9 sft or 20 sft requirements listed above.
- Do not add a road name suffix (i.e., Rd, Ave, Blvd, etc..) unless the road name is a common name or city, village, etc.
- The first letter of a cardinal direction should be the same size as the remaining letters (for example, all letters in NORTH should be the same size)

Temporary Route Marker Shield Sizes:

Use standard M1 series route shields and sizes for state trunk lines as defined in the standard sign manual (mdot_signs_e03_route.pdf).

If the total special sign size is too small to fit a standard route marker size, then smaller shields may be used. Avoid spelling out the trunk line number (i.e. Do not spell out “I-96”. Use an M1-1 (96) shield).

Borders:

- Border sizes and radii should correspond with the appropriate sign type: W, M, I, D, E series signs in the Standard Highway Signs Manual (Traffic Signing).

Sheeting Sizes:

- Standard sheeting sizes are 24”, 30”, 36”, and 48” in width.

Overhead Signs

- Overhead letter sizes should be 12”D maximum and 10”D minimum.
- Overhead sign covers should be black on orange when conveying a message and orange when a blank cover is used.

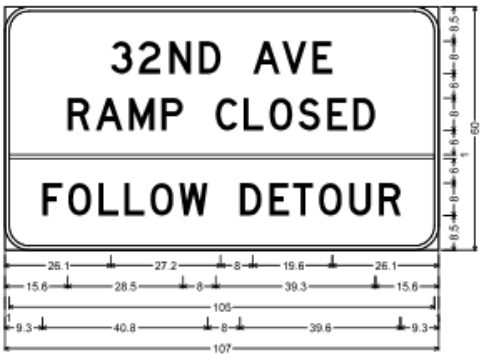
Additional References

Support Hole Placement
mdot_signs_e10_supporthole.pdf

SPECIAL SIGN DESIGN PROCESS
EXAMPLE 1

STEP 1 - Create a sign for use on the freeway

* Start with 8"D for freeway use
* Set default for sign size increment to 6"

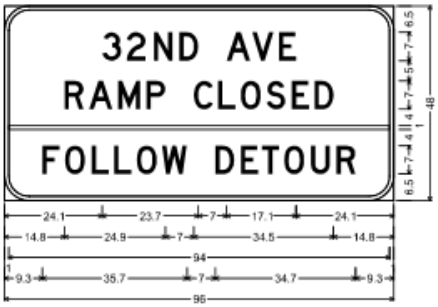


6.0" Radius, 1.0" Border, Black on, Orange;
"32ND AVE", D; "RAMP CLOSED", D; "FOLLOW DETOUR", D;

SignCad default shows sign is too big for 4' x 8' plywood. Would require 10' long plywood to meet width, and a splice to meet height. Try to downsize the sign.

STEP 2 - Try to reduce sign size to fit into 96" x 48" (4' x 8' plywood):

* Start with reducing text size from 8" to 7"D (to not exceed 48" height for plywood)



6.0" Radius, 1.0" Border, Black on, Orange;
"32ND AVE", D; "RAMP CLOSED", D; "FOLLOW DETOUR", D;

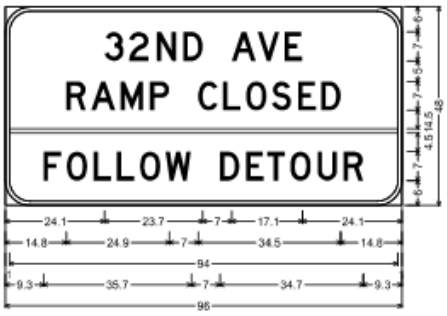
Check vertical spacing.

* Vertical spacing meets the guidelines, but vertical spacing for top and bottom border and horizontal line are not balanced (i.e. 6.5" from text to top/bottom edge of sign, but 5" from text to top/bottom of horizontal line).

EXAMPLE 1 (CONTINUED)

STEP 3 - Adjust vertical spacing to meet guidelines.

* Vertical spacing for horizontal line increased from 4" to 4.5" to have a total of 5.5" between text and edge of horizontal line.
* Vertical spacing at top and bottom borders reduced from 6.5' to 6"

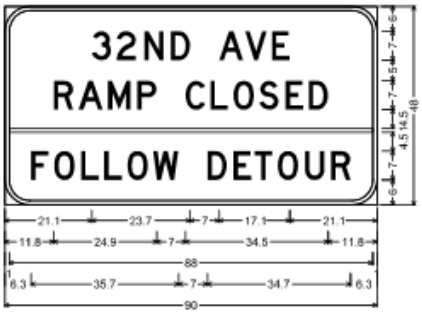


6.0" Radius, 1.0" Border, Black on, Orange;
"32ND AVE", D; "RAMP CLOSED", D; "FOLLOW DETOUR", D;

Vertical spacing meets guidelines and is better balanced than Step 2 version.
(i.e. Top and bottom border spacing more closely match the spacing at the horizontal line - 6" and 5.5" versus previous 6.5" and 5").

Step 4 - Check and adjust horizontal spacing to meet guidelines.

* The horizontal distance between the left/right edges of the sign and the text in the longest line (FOLLOW DETOUR) exceeds the requiremens (i.e. 9.3")
* Reduce the horizontal spacing for (FOLLOW DETOUR).



6.0" Radius, 1.0" Border, Black on, Orange;
"32ND AVE", D; "RAMP CLOSED", D;
"FOLLOW DETOUR", D;

Horizontal spacing meets requirements.

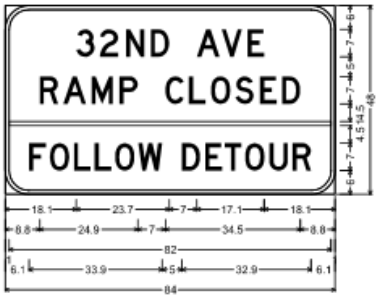
*** THE VERTICAL AND HORIZONTAL SPACING GUIDELINES ARE MET AND THE SIGN SHOWN ABOVE IS ACCEPTABLE ***

If the space available for the sign requires further size reduction then proceed to Step 5.

EXAMPLE 1 (CONTINUED)

STEP 5 - Check location where sign is to be placed.

* Reduce spacing between "FOLLOW" and "DETOUR" (the longest line) from 7" to 5" (Minimum of 2" less than text size).
* Reduce letter spacing of "FOLLOW DETOUR" to 75% (max reduction).

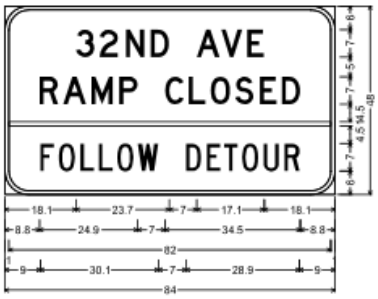


6.0" Radius, 1.0" Border, Black on, Orange;
"32ND AVE", D; "RAMP CLOSED", D;
"FOLLOW DETOUR", D 75% spacing;

Resulting sign is 84" wide.

STEP 6 - If sign is still too wide, make further reductions.

* Reset the spacing between words and letters, then change font of "FOLLOW DETOUR" to 7"C



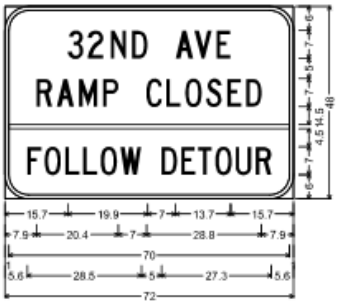
6.0" Radius, 1.0" Border, Black on, Orange;
"32ND AVE", D; "RAMP CLOSED", D;
"FOLLOW DETOUR", C;

The sign remains 84" wide and "RAMP CLOSED" becomes widest line.

Horizontal spacing at sign edges exceeds requirements.

EXAMPLE 1 (CONTINUED)

Continue reducing text font and spacing until the desired sign size is achieved with all spacing requirements met.



6.0" Radius, 1.0" Border, Black on, Orange;
"32ND AVE", C; "RAMP CLOSED", C;
"FOLLOW DETOUR", C 75% spacing;

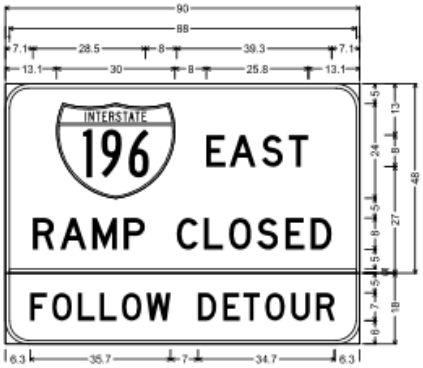
The smallest possible sign that meets the guidelines is shown above:

* All text has been reduced to 7"C, which is the minimum recommended text size for freeways.
* Spacing between words in the longest line reduced to 5", which is 2" less than the text size.
* Spacing between letters in the longest line reduced to 75%

EXAMPLE 2

Create a sign for use on freeway

1. Use 8"D text
2. Use 24" M1-1 route marker shield
3. Use horizontal line to separate main message and supplemental message.



6.0" Radius, 1.0" Border, Black on, Orange;
"EAST", D; "RAMP CLOSED", D;

6.0" Radius, 1.0" Border, Black on, Orange;
"FOLLOW DETOUR", D;

"FOLLOW DETOUR" was reduced to 7"D to best meet vertical spacing guidelines.

CHECK THE FOLLOWING:

1. Vertical spacing guidelines
   a. Vertical spacing between bottom of sign and bottom of text (6" meets minimum requirement of being 2 inches less than the text height).
   b. Vertical spacing between top of text and top of horizontal line (6" meets minimum requirement of being 2 inches less than the text height).
   c. Vertical spacing between bottom of the horizontal line and bottom of the text above it (6" meets minimum requirement of being 2 inches less than the text height).
   d. Vertical spacing between the bottom of the shield and top of the text below it (5"meets minimum requirement of being 3 inches less than the text height).
   e. Vertical spacing between the top of the shield and the top of the sign (5" meets minimum requirement of being 3 inches less than the text height).

2. Horizontal spacing guidelines:
   a. Horizontal spacing between the text and the left and right edges of the sign (6.3" meets minimum requirement of being 2 inches less than the text height).
   b. Horizontal spacing between words in a line is met (minimum is 2 inches less than the text height).
   c. Letter spacing is met (no less than 75% spacing).

3. Splice does not cross the lines of text or go thru the border, and panels are in 6 inch increments. (i.e. 18" and 48")

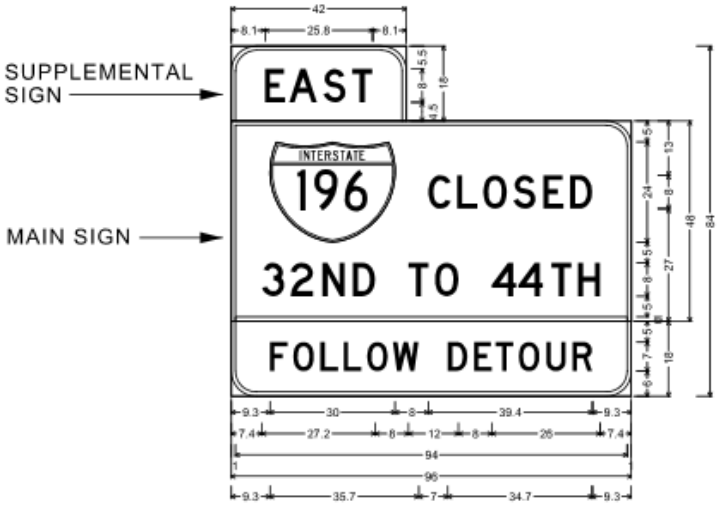
4. Overall size uses portions of 4' x 8' pieces of plywood.

*** SIGN SHOWN MEETS ALL THE DESIGN GUIDELINES***

EXAMPLE 3

Create a sign for use on freeway

1. Use 8"D text
2. Use M1-1 route marker shield
3. Use a horizontal line to separate main message and supplemental message.
4. Use separate plaque for direction above the shield



6.0" Radius, 1.0" Border, Black on, Orange;
"EAST", D;

6.0" Radius, 1.0" Border, Black on, Orange;
Interstate 196 10.0" C; "CLOSED", D; "32ND TO 44TH", D;

6.0" Radius, 1.0" Border, Black on, Orange;
"FOLLOW DETOUR", D;

"FOLLOW DETOUR" Reduced to 7D to best meet vertical spacing guidelines

CHECK THE FOLLOWING:

1. Vertical spacing guidelines - Main Sign
   a. Vertical spacing between bottom of sign and bottom of text (For main sign, 6" meets the minimum requirement of being 2 inches less than the text height.
   b. Vertical spacing between top of text and top of horizontal line (6" meets minimum requirement of being 2 inches less than the text height).
   c. Vertical spacing between bottom of the horizontal line and bottom of the text above it (6" meets minimum requirement of being 2 inches less than the text height).
   d. Vertical spacing between the bottom of the shield and the top of the text below it (5" meets minimum requirement of being 3 inches less than the text height).
   e. Vertical spacing between the top of the shield and the top of the sign (5" meets minimum requirement of being 3 inches less than the text height).

2. Vertical spacing guidelines - Supplemental Sign
   a. Vertical spacing between top of text and top of sign on the single line supplemental sign (5.5" meets the minimum requirement of 3 inches less than the text height.) Vertical spacing between bottom of sign and bottom of text (5.5" meets minimum requirement of 3 inches less than the text height

EXAMPLE 3 (CONTINUED)

3. Horizontal spacing guidelines:
   a. Horizontal spacing between the text and the left and right edges of the sign (minimum is 2 inches less than the text height).
   b. Horizontal spacing between words in a line (meets minimum requirement of being 2 inches less than the text height).
   c. Letter spacing (no less than 75% spacing).
   d. Horizontal spacing between route marker and text is equal to text height.

4. Splice does not cross the lines of text or go thru the border, and panels are in 6 inch increments.

5. Overall size uses portions of 4' x 8' pieces of plywood.

*** SIGN SHOWN MEETS ALL THE DESIGN GUIDELINES ***

EXAMPLE 4a

Create a detour sign for use on the freeway

1. Use 7"D text
2. Use 24" M1-1 route marker shield
3. Arrow size is based on freeway M6-2 (30" x 21")

NOTE: Use detour cluster signs in lieu of boards when possible

3.0" Radius, 1.0" Border, Black on, Orange;
"DETOUR", D; "WEST", D;

*** SIGN MEETS VERTICAL AND HORIZONTAL SPACING GUIDELINES. ***

Resulting sign is 26 sft, which requires driven posts. Signs used on portable supports and barrier mounted signs cannot exceed 20 sft. A smaller sign must be used. Refer to 4b below.

EXAMPLE 4b

Barrier mounted signs cannot exceed 48" in width or 60" in height. Meeting these requirements means compromising the signing guidelines

1. Use 6"D text
2. Use 18" M1-1 route marker shield
3. Arrow size based on a non-freeway M6-2 (21" x 15")

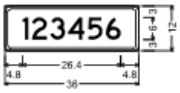
3.0" Radius, 0.8" Border, Black on, Orange;
"DETOUR", D; "WEST", D;

*** SIGN MEETS VERTICAL AND HORIZONTAL SPACING GUIDELINES. ***

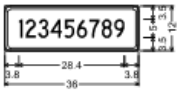
EXAMPLE 5a

Create a supplemental sign for use above an M4-9 on a non-freeway route

1. M4-9 is 30" x 24", therefore max width desirable for supplemental plaque is 36"
2. Min text size for non-freeway is 5C



1.5" Radius, 0.8" Border, Black on, Orange;
"123456", D 75% spacing;



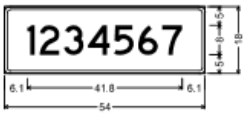
1.5" Radius, 0.8" Border, Black on, Orange;
"123456789", C 75% spacing;

Vertical and horizontal spacing guidelines are met for both sign designs shown above.

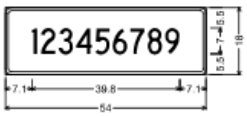
EXAMPLE 5b

Create a supplemental sign for use above an M4-9 on a freeway route

1. M4-9 is 48" x 36", therefore max width desirable for supplemental plaque is 54"
2. 8" text desirable for freeway (min text size for freeway is 7"C)



1.5" Radius, 0.8" Border, Black on, Orange;
"1234567", D 75% spacing;



1.5" Radius, 0.8" Border, Black on, Orange;
"123456789", C 75% spacing;

Vertical and horizontal spacing guidelines are met for both sign designs shown above.

APPENDIX L

Sample of Design Build TMP

(Added 12/3/2020)

18 MAINTENANCE OF TRAFFIC

Conduct all Work necessary to meet the requirements associated with maintenance of traffic (MOT), including providing for the safe and efficient movement of people, goods, and services around the Project while minimizing negative impacts to residents, commuters, and businesses.

Commented [DUC1]: IMPORTANT: Use only the styles available in the Styles Quick List. There is a set style for Normal Text, Section Headings 1-5, Bulleted/Alphabetical/Numbered lists, and Exhibit title pages.

This section is project specific throughout and therefore requires updating to project specific requirements throughout.

18.1 Administrative Requirements

18.1.1 Standards

In the event of a conflict among the standards set forth in Book 3 relating to maintenance of traffic, the order of precedence shall be as set forth below, unless otherwise specified:

- MDOT Special Provision for *NTCIP-Compliant Portable Changeable Message Sign (PCMS)*
- MDOT Special Provision for *Temporary Flexible Delineators*
- MDOT Special Provision for *Moveable Concrete Traffic Barrier*
- MDOT Special Provision for *Wrecker Service*
- MDOT Frequently Used Special Provisions
- MDOT *Work Zone Safety and Mobility Manual*
- MDOT *Work Zone Safety and Mobility Policy*
- *Michigan Manual of Uniform Traffic Control Devices (MMUTCD)*
- MDOT *Maintaining Traffic Typicals*
- MDOT Work Zones - Correspondence/Guidelines
- MDOT Work Zone Devices
- MDOT *Standard Highway Signs*
- MDOT Special Details
- MDOT Standard Plans
- MDOT Supplemental Specifications
- MDOT *Standard Specifications for Construction*
- Remaining standards set forth in Book 3

Commented [DUC2]: Review and update with project specific SP requirements and MDOT Approved / Recommended SPs.

18.2 Design Requirements

18.2.1 Design Vehicle

The design vehicle for this Project shall be a WB-67. Provide turning movements on all local streets and driveways to a minimum turning radius of a WB-67 design vehicle and provide the same operational characteristics as the existing condition, or better.

Commented [DUC3]: Update design vehicle based on project specifics.

18.2.2 Traffic Control Devices

18.2.2.1 Temporary Signing

Non-standard temporary signs and temporary signs with unique legends shall adhere to the Frequently Used Special Provision 12SP-812-G-02.

All diamond warning signs shall be 48 inches x 48 inches.

All temporary signs shall be mounted at a 5-foot minimum bottom height in uncurbed areas and 7-foot minimum bottom height in curbed or pedestrian areas.

The minimum bottom height of the supplemental plaque shall not be less than one foot below the normal bottom height of the parent sign (i.e., minimum bottom height of supplemental plaque is 4 feet on freeways and 6 feet on non-freeways). All supplemental plaques shall be centered under the parent sign.

No signs shall be attached to Type III Barricades.

Place W20-1 (ROAD WORK AHEAD) signs on all intersecting roadways where construction activities may be encountered.

Use Type I Sign Covers to cover existing overhead guide signs for ramps that are closed for more than three (3) consecutive days.

All M4-9 (detour) signs used on freeways shall be 48 inches x 36 inches or larger. Standard size (30 inches x 24 inches) signs may be used on all other roadways.

All M4-8 (detour) signs and M3-series cardinal direction signs used on freeways shall be 30 inches x 15 inches or larger. Standard size (24 inches x 12 inches) signs may be used on all other roadways.

All M1-series route marker signs used on freeways shall be 36 inches or larger. Standard size (24 inches) signs may be used on all other roadways.

All M5-series and M6-series directional arrows used on freeways shall be 30 inches x 21 inches or larger. Standard size (21 inches x 15 inches) signs may be used on all other roadways.

Detour signs should be on both sides of the roadway when the work is taking place on the freeway.

Provide temporary signing on the following freeways, alerting motorists of the Work:

- Northbound I-75 (south of Exit 144)
- Northbound I-75 (south of Exit 136)
- Southbound I-75 (north of I-675 North Junction)
- Southbound I-75 (north of I-675 South Junction)
- Southbound I-675

At minimum, provide temporary signing on the following arterial roads, alerting motorists of the Work:

- Eastbound M-46 (west of Outer Drive)
- Westbound M-46 (east of I-75)
- Northbound Outer Drive (south of M-46)
- Southbound Outer Drive (north of M-46)

Develop a global signing plan, take ownership of the plans, and submit to MDOT for RFC ten (10) Working Days prior to beginning construction activities which effect I-75 or M-46.

Commented [DUC4]: Update based on project specifics.

18.2.2.2 Channelizing Devices

Lighted Arrows, Type C, shall be used when closing a shoulder or traffic lane and shown on the staging plans.

Channelizing devices shall be Plastic Drum, Fluorescent. The use of cones or other channelizing devices are prohibited.

The spacing of channelizing devices shall not exceed those specified in the MMUTCD.

Commented [DUC5]: Update based on project specifics

18.2.2.3 Temporary Concrete Barrier

Use temporary guardrail, barricades, or barrier to protect the traveling public and to provide security of the Project Site.

Temporary Concrete Barrier (TCB) may be needed to protect the work area within the Project limits.

TCB shall be used to separate opposing traffic flows on I-75 at all times when opposing flows of traffic are not otherwise separated by permanent concrete median barrier or moveable concrete traffic barrier.

Traffic shall not be exposed to the blunt end of TCB or permanent barrier wall without attenuation when placed within the clear zone distances specified in MDOT Standard Plans. Where TCB requires attenuation, place attenuation according to the MDOT Standard Plans.

TCB will be required to separate traffic from the construction zone whenever the difference between the proposed elevation and existing elevation exceeds one (1) foot and the lateral distance between the edge of travel lane and construction is eight (8) feet or less. If the distance is greater than 8 feet, plastic drums may be used per the MDOT *Work Zone Safety and Mobility Manual*.

The slope on the traffic side of the TCB shall be 1:10 or flatter. TCB shall not be placed on a slope steeper than 1:10.

Pinning TCB to the existing bridge deck of S04 of 73111 and R01 of 73111 is permitted. Pinning of TCB to new bridge decks is not permitted.

Commented [DUC6]: Update based on project specifics.

18.2.2.4 Moveable Concrete Traffic Barrier

If the Design-Builder elects to use Moveable Concrete Traffic Barrier (MCTB) on the project, it must be in accordance with the *Special Provision for Moveable Concrete Traffic Barrier*. All costs associated with furnishing, installing, maintaining, relocating, and removing the MCTB shall be included in the Contract Price. MTCB may be substituted for TCB as desired, and is subject to the requirements in Book 2, Section 18.2.2.3.

Commented [DUC7]: Update based on project specifics

18.2.2.5 Mobile Attenuators

Mobile Attenuators (MAs) shall be required during all lane and shoulder closures required for all overhead work when working next to active lanes of traffic. MAs shall also be used when placing construction zone and detour signing on M-46 or freeways. One (1) Type C Lighted Arrow (min 48 inch x 96 inch) shall be placed adjacent to the MA. Placement of the MAs and their associated lighted arrows shall be as defined in Frequently Used Special Provision 12SP-812A-02 and shall provide maximum coverage of the work area. Placement of MAs shall be provided by the Design-Builder during design and accepted by MDOT.

MAs shall not be used as permanent barrier or TCB attenuation devices.

18.2.2.6 Barricades

When closing a roadway, ramp, driveway, or access point, place a sufficient number of barricades so as to completely seal off the roadway, ramp, driveway, or access point to traffic. Barricades shall be Type III Barricades, High Intensity, Lighted or Type III Barricades, High Intensity, Double Sided, Lighted.

Placement of Type III Barricades, High Intensity, Lighted and Type III Barricades, High Intensity, Double Sided, Lighted shall be as shown in the staging plans and typicals. Stripes on barricade rails shall be oriented as prescribed in the most current version of the MMUTCD.

18.2.2.7 Portable Changeable Message Signs

Include a minimum of five (5) NTCIP-Compliant Portable Changeable Message Signs (PCMS) for this Project, in accordance with the *Special Provision for National Transportation Communications for Intelligent Transportation System Protocol Compliant Portable Changeable Message Sign*. The PCMS shall be used to warn traffic of upcoming and changing traffic control conditions during the life of the project. Deploy PCMS a minimum of five (5) Working Days prior to the start of work. Locations of each PCMS shall be proposed by the Design-Builder and accepted by the MDOT Project Manager. At no time shall a PCMS be left blank. If a PCMS will not be displaying a priority message per the contract documents, the board shall be removed from the immediate traffic area if work and/or traffic operations are unchanged for seven (7) days.

Commented [DUC8]: Update based on project specifics.

18.2.3 Restricted Hours

Commented [DUC9]: Update based on project specifics. Consider local noise ordinance here as well.

No construction work shall be performed during the holiday periods indicated in the Table below, unless approved by the MDOT Project Manager. Lane rentals as described elsewhere within this Book 2, Section 18 will still be assessed during these periods.

	2019	2020	2021
Memorial Day	N/A	12:00 pm, Thursday, 05/21/20 to 6:00 am, Tuesday, 05/26/20	12:00 pm, Thursday, 05/27/21 to 6:00 am, Tuesday, 06/01/21
Independence Day	N/A	12:00 pm, Wednesday, 07/01/20 to 6:00 am, Monday, 07/06/20	12:00 pm, Thursday, 07/01/21 to 6:00 am, Tuesday, 07/06/21
Labor Day	N/A	12:00 pm, Thursday, 09/03/20 to 6:00 am, Tuesday, 09/08/20	12:00 pm, Thursday, 09/02/21 to 6:00 am, Tuesday, 09/07/21
Thanksgiving	3:00 pm, Wednesday, 11/27/19 to 6:00 am, Monday, 12/02/19	3:00 pm, Wednesday, 11/25/20 to 6:00 am, Monday, 11/30/20	3:00 pm, Wednesday, 11/24/21 to 6:00 am, Monday, 11/29/21
Christmas/New Year's	3:00 pm, Friday, 12/20/19 to 6:00 am, Thursday, 01/02/20	3:00 pm, Wednesday, 12/23/20 to 6:00 am, Monday, 01/04/21	N/A

The Winter Period is defined as November 15th through April 15th. All traffic must be in their normal lanes with no lane closures during the Winter Period. Work that does not impact traffic may be allowed during the Winter Period at the discretion of the MDOT Project Manager. MDOT will not participate in extra costs associated with performing work during the Winter Period.

Failure to meet the traffic restriction in this Book 2, Section 18.2.3 will result in the assessment of liquidated damages in accordance with Book 2, Section 18.6.

18.2.4 Traffic Restrictions and Design Requirements

Commented [DUC10]: Update based on project specifics. Minimize restrictions whenever possible.

Closely coordinate all lane closures, ramp closures, and construction signing with the MDOT Project Manager and with contractors working on other projects in the vicinity. Prior to closing any roads or ramps, and prior to making any changes to signing, pavement markings, lanes, barricades, or closure locations, carefully coordinate with the MDOT Project Manager and contractors working on other projects in the vicinity to avoid conflicts. The Design-Builder may have to adjust work hours, work locations, or work sequence in order to coordinate with other contracts in the vicinity.

18.2.4.1 I-75

A shoulder closure is permitted at any time except when in conflict with staging operations as determined by the Engineer, or as directed by the Engineer.

Maintain a minimum of two (2) lanes in each direction from April 15 to the start of the Memorial Day holiday period.

Maintain a minimum of three (3) lanes northbound and two (2) lanes southbound from Wednesday afternoon through Saturday morning from the start of the Memorial Day holiday period to the end of the Thanksgiving holiday period. The timeframe for shifting traffic for this stage will be Wednesday from 9:00 am to 3:00 pm. The time frames for switching traffic may be adjusted by the Engineer at no additional cost to MDOT.

Maintain a minimum of three (3) lanes southbound and two (2) lanes northbound from Saturday afternoon through Wednesday morning from the start of the Memorial Day holiday period to the end of the Thanksgiving holiday period. The timeframe for shifting traffic for this stage will be Saturdays from 2:00 pm to 6:00 pm. The time frames for switching traffic may be adjusted by the Engineer at no additional cost to MDOT.

I-75 may be reduced to one (1) lane in each direction from 9:00 PM to 5:00 AM Monday through Thursday (except during restricted holiday periods).

Lane closures on I-75 will be subject to Lane Rentals.

Maintain full access to and from the M-46 interchange at all times (except when I-75 is closed for bridge demolition or beam placement), including maintaining these movements: NB-to-EB, NB-to-WB, SB-to-EB, and SB-to-WB. A single ramp may be used to maintain multiple movements. Provide separate dedicated left- and right-turn lanes at ramp terminals to facilitate turning movements and to prevent backups from reaching the 22-foot point. A minimum of 250 feet of storage shall be provided for left- and right-turn lanes.

Maintain full access to and from I-675 at all times with the following exception: The NB I-75 to NB I-675 ramp may be closed and detoured for 14 calendar days for reconstruction. The closure must be continuous, and must take place between April 15 and the start of the Memorial Day holiday period. The conceptually approved detour route for northbound traffic is northbound I-75 to westbound M-81 to southbound I-75 to northbound I-675. See Exhibit 2-18-A for more information.

Total closure of I-75 is allowed from 9:00 pm to 5:00 am on Monday, Tuesday, Wednesday, and Thursday nights (except for during restricted holiday periods) for a maximum of 8 different nights to allow for bridge demolition and beam placement at structure S04 of 73111. During these closures, reduce each direction of I-75 traffic to one (1) lane and detour traffic onto the M-46 diamond ramps. Provide free-flowing movements through the M-46 interchange using temporary pavement as necessary. The design speed for these movements shall be 30 MPH. Do not allow turns to and from M-46. Completely block access to and from M-46 using tightly spaced barrels and side-by-side Type III barricades.

Temporary lane widths on I-75 shall be 11 feet. Temporary shy distances to concrete barrier, guardrail, TCB, MCTB, or other traffic control devices shall be a minimum of 2 feet, except on or below bridges where shy distances may be reduced to 1 foot if constraints exist. Where concrete barrier, guardrail, TBC, MCTB, or other traffic control devices are not used, provide a minimum of 2 feet of paved shoulder.

I-75 freeway traffic stoppages for erection of truss boxes are only allowed on Monday, Tuesday, Wednesday, or Thursday nights (except during restricted holiday periods) from 12:01 am to 5:00 am the following morning for a maximum of 15 minutes at a time, allowing all stopped traffic to clear the closure area between stoppages. The Michigan State Police (MSP) shall be utilized during any freeway stoppage.

The speed limit for I-75 during construction, when requiring a lane closure or traffic shift, will be 60 mph (45 mph where workers are present and the work area is not protected by TCB). The speed limit for I-75 during construction, when requiring a shoulder closure, will be 70 mph (45 mph where workers are present and the work area is not protected by TCB).

Design all tapers and traffic shifts to the existing posted speed limit, except for crossovers as specified herein.

Failure to meet the traffic restriction in this Book 2, Section 18.2.4.1 will result in the assessment of liquidated damages in accordance with Book 2, Section 18.6.

18.2.4.2 M-46

A shoulder closure is permitted at any time except when in conflict with staging operations as determined by the Engineer, or as directed by the Engineer.

Maintain a minimum of one (1) through lane in each direction at all times, except when I-75 is closed for bridge demolition and beam placement.

Lane closures on M-46 will be subject to Lane Rentals.

Maintain full access to and from the I-75 interchange at all times (except when I-75 is closed for bridge demolition or beam placement), including maintaining these movements: EB-to-NB, EB-to-SB, WB-to-NB, and WB-to-SB. Provide separate dedicated left- and right-turn lanes along M-46 at ramps to facilitate turning movements. A minimum of 250 feet of storage shall be provided for left- and right-turn lanes.

Temporary lane widths on M-46 shall be 11 feet. Temporary shy distances to concrete barrier, guardrail, TCB, or other traffic control devices shall be a minimum of 2 feet, except on or below bridges where shy distances may be reduced to 1 foot if constraints exist. Where concrete barrier, guardrail, TBC, or other traffic control devices are not used, provide a minimum of 2 feet of paved shoulder.

The temporary posted speed limit for M-46 during construction, when requiring a lane closure or traffic shift, will be 35 mph. When requiring a shoulder closure, maintain the existing posted speed limit.

Design all tapers and traffic shifts to the existing posted speed limit, except for crossovers as specified herein.

Total closure of M-46 within the limits of the interchange is allowed during the bridge demolition and beam placement activities outlined in Book 2, Section 18.2.4.1. Do not allow turns to and from I-75. The conceptually approved detour route for eastbound traffic is eastbound M-46 to northbound Outer Drive to eastbound M-81 to southbound Portsmouth Road to M-46. The conceptually approved detour route for westbound traffic is westbound M-46 to northbound Portsmouth Road to westbound M-81 to southbound Outer Drive to M-46. See Exhibit 2-18-A for more information.

Provide continuous access to all properties on M-46, unless temporary closure is approved by the property owner and MDOT.

Any construction impacts to M-46 shall be coordinated with MDOT, the Saginaw County Road Commission, and with residents and businesses in the project area as required in Book 2, Section 3.

All M-46 work shall be completed and opened to final traffic operations according to Book 1, Section 4.

Failure to meet the traffic restriction in this Book 2, Section 18.2.4.2 will result in the assessment of liquidated damages in accordance with Book 2, Section 18.6.

18.2.4.3 Outer Drive

Maintain a minimum of one (1) through lane in each direction at all times.

Maintain all left- and right-turn movements at the M-46/Outer Drive intersection at all times, except during bridge demolition and beam placement activities outlined in Book 2, Section 18.2.4.1. Provide a dedicated left-turn lane on all approaches with a minimum of 250 feet of storage at all times.

Temporary lane widths on Outer Drive shall be 11 feet. Temporary shy distances to concrete barrier, guardrail, TCB, or other traffic control devices shall be a minimum of 2 feet. Where concrete barrier, guardrail, TCB, or other traffic control devices are not used, provide a minimum of 2 feet of paved shoulder.

The temporary posted speed limit for Outer Drive during construction, when requiring a lane closure or traffic shift, will be 25 mph north of M-46, and 30 mph south of M-46.

Design all tapers and traffic shifts to the existing posted speed limit, except for crossovers as specified herein.

Provide continuous access to all properties on Outer Drive, unless temporary closure is approved by the property owner and MDOT.

Any construction impacts to Outer Drive shall be coordinated with MDOT, the Saginaw County Road Commission, and with residents and businesses in the project area as required in Book 2, Section 3.

All Outer Drive work shall be completed and opened to final traffic operations according to Book 1, Section 4.

Failure to meet the traffic restriction in this Book 2, Section 18.2.4.3 will result in the assessment of liquidated damages in accordance with Book 2, Section 18.6.

18.2.5 Temporary Pavements and Crossovers

Ensure that all lanes are maintained on Project roadways in accordance with Book 2 Section 18.2.4. Use temporary pavement as necessary to meet these requirements. Provide a temporary pavement design for all temporary pavement that will be used on the project. Submit the proposed temporary pavement design with supporting documentation including design inputs, analysis, traffic data, intended use, duration, and mitigation plan for addressing issues with the temporary pavement after installation, to MDOT for review and Acceptance. MDOT's Acceptance of the temporary pavement design does not relieve the Design-Builder of their responsibility to provide and maintain temporary pavements for maintained traffic. Failure of any temporary pavement will be subject to liquidated damages in accordance with Book 2, Section 18.6 until the failure is repaired by the Design-Builder.

Maintain a 4% max rollover rate between the existing or proposed pavement and the temporary pavement.

Maintain an 8% max slope differential when the temporary pavement widening results in an inverted crown between the existing or proposed pavement and the temporary pavement.

Maintaining traffic on a milled surface is prohibited.

Remove all temporary pavement that is no longer needed to maintain traffic.

18.2.5.1 Temporary Freeway and Ramp Crossover Design Requirements

Design freeway and ramp crossovers using MDOT Standard Plan R-113 series. The minimum design speed for freeway and ramp crossovers is 60 mph. Provide 12' lane widths (11' when adjacent to mainline). Cross slopes must not exceed 4%. Cross slope rollover rate and/or inverted crown must not exceed 8%.

Provide acceleration and deceleration storage and taper lengths as specified in the MDOT Geometric Design Guides using a design speed of 60 mph on I-75 mainline.

Temporary crossovers shall provide smooth transitions that do not disrupt traffic and provide adequate drainage. Provide temporary drainage culverts and/or structures as needed to avoid disruption of existing drainage flow patterns.

When not in use, close all temporary crossovers constructed on this project in order to prohibit access.

See Book 2, Section 18.2.5 for information on proposed temporary pavement designs.

18.2.5.2 Maintaining Traffic on Existing Shoulders

If the Design-Builder elects to maintain traffic on existing HMA/composite shoulders, remove and replace the existing shoulders full depth. See Book 2, Section 18.2.5 for information on proposed temporary pavement designs. Replace shoulder corrugations upon completion of the stage.

If the Design-Builder elects to maintain traffic on existing concrete shoulders, fill the existing shoulder corrugations with HMA hand patching with the following exception: If the existing shoulder corrugations fall within the center 1/3 of a temporary lane, hand patching is not required. Remove all hand patching and restore shoulder corrugations upon completion of the stage.

Roadside delineators/markers are required along the temporary shoulder of I-75 spaced every 200 feet if the distance to the hinge point does not exceed five (5) feet, unless temporary concrete barrier or guardrail is used. Refer to MDOT Special Provision for *Temporary Flexible Delineators*.

Shoulders along I-75 shall be paved with Safety Edge per MDOT Standard Plan R-110-A series and MDOT FUSP 12SP-501(BB-01) when they are four (4) feet or less in width and not adjacent to temporary concrete barrier or guardrail. No shoulder drop-off will be allowed when traffic is using the lane adjacent to the shoulder.

18.2.6 Temporary Underclearances

For bridges over I-75, maintain 16 feet minimum bridge underclearances at all times during construction, with the following exception: If the existing bridge underclearance is less than 16 feet, maintain the existing bridge underclearance during construction.

18.2.7 Pedestrian Access and Trails

Maintain pedestrian access on all sidewalks, trails, and intersections along all streets as much as possible. If access cannot be maintained, obtain approval from MDOT to close or modify the pedestrian access and furnish and install proper detour signing for pedestrians. At the intersection of M-46 and Outer Drive, a minimum of one crossing of Outer Drive and one crossing of M-46 shall be maintained at all times.

All pedestrian detours shall have the same level of accessibility for disabled persons as the pedestrian crossing that is being closed.

Notify MDOT ten (10) Working Days prior to any closure, and advanced signing shall be provided notifying all users of the upcoming closure five (5) Working Days prior to any closure.

18.2.8 Temporary Pavement Markings

Log existing pavement markings on portions of surface streets prior to removing the markings for stage construction or mill and resurface work. Submit a copy of this log to MDOT prior to removing the markings. Upon completion of the Project, return the surface streets to their original configuration with material replaced in kind and marked accordingly.

Remove conflicting pavement markings prior to placing temporary pavement markings. Over-painting of existing markings with temporary markings will not be allowed.

When existing pavement markings are removed, temporary pavement markings shall be placed before opening lanes to traffic.

Temporary, Wet Reflective, Type R markings shall be used on all pavements where the traffic patterns are subject to change and on pavements not being removed or resurfaced. Temporary, Wet Reflective, Type NR markings shall be used on all pavements where the traffic patterns are not subject to change and on pavements being removed in later stages.

All temporary special markings shall be Overlay Cold Plastic, with the exception of temporary stop bars which may use six (6) 4-inch strips of Temporary, Wet Reflective, Type R, Tape. All temporary stop bars must be 24 inches.

When lane closures or shifts are in place for more than three (3) days, skip lines in lane closure tapers or shifts shall be removed or covered and an edge line of the appropriate color shall be painted along the taper.

18.2.9 Temporary Signalization

See Book 2 Section 16 for temporary signalization requirements.

18.3 Construction Requirements

18.3.1 General

A sample construction staging concept is included in the Reference Information Documents.

Commented [URS11]: Verify this is included, else delete statement.

The Design-Builder is responsible for maintenance of traffic starting at 12:01 a.m. on the day work begins on the Project while traffic control devices are present in the work zone. The traffic control devices must be continually and adequately monitored and maintained to ensure proper placement and the safe and efficient flow of all

construction traffic and motorists into and out of the Project as stated in the Mobility Policy. Such responsibility shall continue during all periods where Work is being performed that impact traffic. MDOT may, in writing, temporarily suspend such responsibility in conjunction with an official suspension.

Provide written notice to MDOT ten (10) Working Days prior to closing, restricting, or detouring traffic, and prior to stage changes. Advanced messaging on I-75 and M-46 shall be provided per the Mobility Policy. This signing shall be erected a minimum of five (5) Working Days prior to the closure, restriction, detour or stage change, and shall note the closure duration and covered when not in use. Advanced messaging shall be included in the MOT plans.

Commented [DUC12]: Update based on project specifics.

Obtain approvals from local agencies for using non-MDOT roadways as detour routes, except for those conceptual detours identified in Exhibit 2-18-A which are already approved.

Any existing barrier or pavement removed by the Design-Builder outside the construction limits to maintain traffic shall be replaced in kind by the Design-Builder.

18.3.2 Traffic Control Devices

All traffic control devices shall conform to the current version of the MMUTCD.

All temporary signs, plastic drums, and Type III barricades used for maintaining traffic shall comply with the MDOT *Standard Specifications for Construction.* The Design-Builder shall provide the Engineer with certification and an FHWA acceptance letter stating that the materials and devices meet the requirements specified in the MDOT *Standard Specifications for Construction.*

Implement a field identification system to identify all temporary signs, arrow boards, barricades and PCMS used on this Project. Identification shall be located as allowed by the MMUTCD and shall include the name of the Design-Builder.

Routinely maintain all traffic control devices. Replace any damaged or lost traffic control devices, including, but not limited to, plastic drums, Type A signs, Type B signs, Type III barricades, PCMS, lighted arrows, high-intensity lights, mobile attenuators, Moveable Concrete Traffic Batter, Temporary Concrete Barrier, and Temporary Concrete Barrier Endings.

Protect the work area and supply the necessary traffic control devices apart from those called for on the Design-Builder's plans to delineate the work area from the adjacent property.

All Test Level 1, Test Level 2, and Test Level 3 traffic control devices shall be NCHRP 350 compliant or meet the requirements of the Manual for Assessing Safety Hardware (MASH).

All temporary traffic control devices shall meet the "Acceptable" requirements of the American Traffic Safety Services Association (ATSSA), "Quality Standard for Work Zone Traffic Control Devices" when initially placed on the site. Replace devices in the field that do not meet these guidelines in the field at their own cost and time. Copies of this publication are available from ATSSA at 15 Riverside Parkway, Suite 100, Fredericksburg, VA 22406.

The operation of construction equipment shall always maintain a minimum 4-foot buffer from the back of the channelizing device used.

18.3.2.1 Temporary Signing

All temporary signs used on this Project shall be fabricated utilizing prismatic retro-reflective sheeting Type VIII or higher per the MDOT *Standard Specifications for Construction*.

All temporary signs shall be fabricated to meet NCHRP-350 crashworthy requirements or the requirements of the Manual for Assessing Safety Hardware (MASH), as applicable. The light and its maintenance shall be included.

Temporary special signs shall be installed on driven posts in accordance with the MDOT *Standard Specifications for Construction and Frequently Used Special Provision 12SP812L.*

Temporary sign supports are designed in accordance with the MDOT chart for wind loading. All driven sign supports used for temporary signs shall be installed in accordance with MDOT Traffic Special Detail WZD-100-A, including meeting all requirements for breakaway supports.

Temporary signs shall be installed on driven posts, except where located in pavement. In areas where driven supports are not possible, the Design-Builder shall propose options to MDOT. If signs will be used for less than fourteen (14) consecutive calendar days, the Design-Builder may request that the driven support requirement be omitted. Refer to MDOT Traffic Special Detail WZD-125-A for portable supports. The Design-Builder shall remove the driven sign supports or post studs when the sign is removed.

Temporary warning, regulatory, and guide signs on portable supports that are not required for that particular lane closure or shift, shall be either removed or laid down with the feet removed and the legs pointing downstream of traffic. Temporary warning, regulatory, and guide signs on driven supports shall be either removed or covered when no longer necessary.

All applicable existing/proposed ground mounted and overhead signs are assumed to be in place during construction. All existing ground mounted and overhead signs in conflict with the temporary traffic control shall be covered by the Design-Builder. Conflicting Type I, Type II and III signs shall be identified in the field by MDOT and the Design-Builder. When signs on this Project are to be covered, they shall be covered in accordance with the MDOT *Standard Specifications for Construction*.

All signs, temporary or permanent, that are damaged as a result of improper sign covering, shall be replaced.

18.3.3 Haul Roads

Any haul roads must be pre-approved by the appropriate governing agency. Restore haul roads to levels specified by the appropriate governing agency.

Commented [DUC13]: Update based on project specifics. If haul roads are anticipated, additional information may need to be included in other sections such as Section 4 - Environmental.

18.3.4 Emergency Vehicle Access

At a minimum, the Design-Builder shall provide emergency vehicle access points at each end of the Project Site at all times. Emergency vehicle access shall meet the following design standards:

Design Standard	Emergency Vehicle Access
Design Vehicle	S-BUS-40 (AASHTO 2004)
Roadway Type	6 in minimum Class 21AA, compacted per standards
Clear Roadway Width	20 feet min.
Special Features: 1. The maximum grade shall be 8 percent with 4 percent as the maximum in turn around areas. 2. The vertical clearance shall meet at a minimum 16 feet, 3 inches. 3. Emergency vehicle access path must be free from obstructions at all times to minimize emergency response times. No parking of vehicles, equipment, or stockpiling of materials shall be allowed along the emergency access roadway. The Design-Builder may use this as a haul road, but at the first notice of an approaching emergency vehicle, the Design-Builder shall remove vehicles from the emergency path and stop using the emergency access roadway until the emergency vehicle leaves the area.	

Provide Light Duty Wrecker, Medium Duty Wrecker, and Heavy Duty Wrecker services as described in the MDOT Special Provision for *Wrecker Service*. It is anticipated that a minimum of 60 Light Duty, 20 Medium Duty, and 10 Light Duty Wrecker services will be needed during construction. All costs for this work is included in the Contract Price.

Commented [DUC14]: Update based on project specifics.

18.3.5 Mail Boxes and Trash

At a minimum, provide vehicle and pedestrian access points to all roadside mailboxes within the Project limits.

Provide commercial refuse hauler truck access to residential lot frontages to collect trash and yard waste.

18.3.6 Work Zone Management

Per the *Work Zone Safety and Mobility Manual*, the Design-Builder shall be responsible for work zone management during the construction, maintenance, or permitted activity work phase. Work zone safety, mobility, and mitigation impacts shall be monitored and documented using field observations, crash data analysis, and other pertinent operational information. The Design-Builder shall be responsible for any revisions or modifications necessary to improve the TMP during construction.

18.4 Deliverables

Commented [DUC15]: Update deliverables based on project specific requirements. Not all projects require all submittals.

Submit the following documents to MDOT for Approval. These plans must be Approved by MDOT prior to any restriction in traffic or pedestrian access. They shall be signed and sealed by the Design Lead Traffic Engineer and signed by the Maintenance of Traffic Manager.

18.4.1 Transportation Management Plan

This Project has been identified as "non-significant" for potential mobility impacts. The Design-Builder shall develop, implement, and maintain a Transportation Management Plan (TMP) that includes the following elements:

This Project has been identified as "significant" for potential mobility impacts. Evaluate potential mobility impacts accordingly per the MDOT *Work Zone Safety and Mobility Manual* and the MDOT *Work Zone Safety and Mobility Policy* and develop, implement, and maintain a Transportation Management Plan (TMP), including the Temporary Traffic Control Plan (TTCP), Transportation Operations Plan (TOP), Internal Traffic Control Plan (ITCP), Public Information Plan (PIP), and Incident Management Plan (IMP).

Include the following additional items in the TMP:

Commented [DUC16]: Update based on project specifics. If the project is deemed non-significant, use only the top paragraph. If the project is deemed significant, use the next two paragraphs and include the items list for the TMP.

- Plans identifying traffic control configurations for each stage of the Work.
- Descriptions of the duties of a MOT Manager or designee and other personnel with maintenance of traffic (MOT) responsibilities. These duties shall include responsibility of all traffic control, maintenance and modifications to traffic control during construction, and 24-hour/7-day availability.
- Contact methods, personnel available, and response times for responses to any conditions needing attention during on and off-hours.
- Procedures and strategies proposed to manage incidents that occur in the work zone. See Section 18.2.9.
- Procedures to provide access for emergency service providers to all parts of the Project Site in case of emergency.
- Methods and frequency of inspection and maintenance of all traffic control throughout the Project's limits.
- Procedures to communicate TMP information to MDOT's public information personnel and notify the public of MOT. Coordinate with requirements in Book 2, Section 3 for PIP requirements.

18.4.2 Temporary Traffic Control Plans (TTCP)

The Temporary Traffic Control Plans (TTCP) shall be prepared under the direction of the Design Lead Traffic Engineer. MOT plans shall be submitted, approved, and provided to field personnel prior to the implementation of traffic control, so that temporary signing and other traffic control devices are installed correctly the first time.

The TTCP shall include the following items:

- Complete plan sheets and typicals for construction access, security, and appropriate traffic control.
- Plan sheets and/or details for handling construction operations such as material delivery and storage, access and exit of construction and delivery vehicles, haul roads, and other items that may impact traffic.

- The appropriate details when temporary construction of any of the following is required to maintain traffic: detour roadways, bridges, retaining structures, drainage, and other miscellaneous construction.
- Roadway plan sheets showing all in-place traffic control devices that need to be retained, relocated, or removed and all temporary traffic control devices that need to be installed, retained, relocated, or removed.
- Drawings showing dimensions for fabricating any sign not detailed in the MDOT *Standard Highway Signs*, along with the background color and legend.
- The size and color of all standard traffic control devices.
- Roadway plan sheets with the approximate location of each sign so it can be easily read in relation to the roadway and other traffic control devices. No number or letter may be on the roadway plan sheets as a reference for sign placement.
- Provisions for using temporary guardrail, temporary concrete barrier wall, or attenuators to protect the traveling public and to provide security of the Project Site.
- Provisions for opening new bridges and roadways to the traveling public.

18.4.3 Transportation Operations Plan (TOP)

The TOP must outline strategies that will be used to mitigate work zone impacts. Prepare a TOP in accordance with the MDOT *Work Zone Safety and Mobility Policy* and MDOT *Work Zone Safety and Mobility Manual*.

18.4.4 Internal Traffic Control Plan (ITCP)

Develop and submit to MDOT an Internal Traffic Control Plan (ITCP) per subsection 104.11.B of the Standard Specifications for Construction. The MDOT will have 10 Working Days to review the ITCP for approval or provide comments for revisions required to obtain approval. Include in the ITCP, at a minimum, the proposed ingress/egress locations for construction equipment and vehicles, haul routes, material delivery/storage areas, and traffic control devices that will be utilized to warn the motoring public of ingress/egress locations, and measures that will be taken to ensure compliance with the ITCP. Ensure that the ITCP minimizes conflicts between construction vehicles and motorists and maintains overall safety and mobility within the work zone. No work may begin prior to approval of the ITCP. Additional time required to obtain an approved ITCP will not be cause for delay or impact claims. All costs associated with obtaining an approved ITCP, providing and executing all parts of the approved ITCP including required traffic control devices, or resolving an incomplete or unacceptable ITCP will be borne by the Design-Builder.

Construction traffic is prohibited from crossing open ramps. Include a plan for safely entering and exiting the work zone in the vicinity of open ramps.

18.4.5 Public Information Plan (PIP)

See Book 2, Section 3 for Public Information Plan requirements.

18.4.6 Incident Management Plan (IMP)

Provide contact information of one (1) individual and a designated alternate who are available 24 hours per day, seven days per week, for incident response to MDOT prior to the start of construction. This shall be included with the Transportation Management Plan (TMP)

18.4.7 Performance Assessment Plan

Per the *Work Zone Safety and Mobility Manual*, work zone safety and mobility shall be monitored, measured, and documented during the construction phase of the Project by the Design-Builder to verify the mitigation measures and strategies are performing as expected. This documentation to be prepared by the Design-Builder and provided to MDOT will be the basis for the project-specific Performance Assessment Plan (PAP) and will include documentation of the traffic delays, travel times, queues, volumes, and associated information.

Collect travel time runs along I-75 and M-46 prior to construction in order to determine a "baseline" travel time condition. A minimum of three (3) travel time runs shall be collected in each direction during the weekday AM-peak (7:30-8:30 AM) and PM-peak timeframes (4:00-6:00 PM) to determine the "baseline" travel times. Construction travel time runs (three runs in each direction during the weekday AM- and PM-peak timeframes) shall be collected within the first week of any new stage change in order to compare with the "baseline" travel time runs. Additional weekday peak-hour travel time runs will be completed thereafter at regular intervals not to exceed weekly if delays are occurring, or otherwise approved by MDOT.

Synchro simulation models of each construction stage along M-46 shall be created in order to determine traffic signal timings along M-46 during construction. Weekday peak-hour turning movement counts (7:00-9:00 AM and 4:00-6:00 PM) along M-46 at Outer Drive, the I-75 ramps, and at the Nexteer signalized driveway shall be collected within five (5) Working Days after any new stage change and analyzed in Synchro to optimize the construction traffic signal timings. Develop revised traffic signal timing permits for review, approval, and implementation by MDOT. Revised timing permits shall be submitted to MDOT within ten (10) Working Days after any new stage change.

Commented [DUC17]: Update based on project specifics.

18.5 Lane Rental

Commented [DUC18]: Include this section if lane rentals apply and update based on project specifics. Also include in ITP. Do not use lane rental SP.

The Design-Builder shall be subject to Lane Rental as specified herein.

18.5.1 Description

This contract includes a procedure under which the Design-Builder is assessed lane rental for each day of lane closure on the mainline I-75 roadway and on M-46.

18.5.2 Proposal Submission, Award and Execution of Contract

1. Preparation of Proposal. In addition to the requirements of subsection 102.05 of the MDOT Standard Specifications for Construction, the following will apply to this Contract. This Contract includes **Lane Rental**, as a lump sum item. **Lane Rental** must be bid. A negative amount will not be permitted for this item. If the Design-Builder leaves this item blank, the Department will consider the Bid to be irregular as specified by subsection 102.06 of the MDOT Standard Specifications for Construction (as modified by Book 1, Exhibit 1-C). The amount for this item must be based on the Bidder's estimate of the number of lane closure days on designated traffic lanes and the assessment values as described in Section 18.5.5.1.

The amount bid for this item will affect the determination of the lowest Bidder. The Design-Builder should not include the anticipated lane rental assessments to the Department in other items of the contract, as unbalancing may occur and the Bid may be rejected.

2. Considerations of Proposals. In addition to the requirements of subsection 102.13 of the MDOT Standard Specifications for Construction (as modified by Book 1, Exhibit 1-C), the following will apply to this Contract. The item **Lane Rental** will become part of the Design-Builder's total Bid for the purpose of determining the low Bidder. The total Bid is equal to the Proposal Price. Each Bid submitted must contain the total of the following sections:

Section 1: Dollar amount of Common Road Work

Section 2: Dollar amount of HMA Alternative

Section 3: Dollar amount of Concrete Alternative

Section 4: Dollar amount of Common Structure Work

Section 5: User Delay: Dollar amount of **Lane Rental**

For HMA Proposers:

Total Bid = Section 1 + 2 + 4 + 5

For Concrete Proposers:

Total Bid = Section 1 + 3 + 4 + 5

The total bid of these sections, as verified by the Department, will be the apparent low Bid and will be reviewed according to subsection 102.10 of the MDOT Standard Specifications for Construction. This project is an Alternative Pavement Bid project. The cost submitted by each Design-Builder will be equated into an Equivalent Uniform Actual Cost (EUAC) according to Section 5.3 in the Instruction to Proposers (ITP) to determine the Design-Builder selected for this project.

It will not be necessary for the bid guaranty to include the amount bid for the item of **Lane Rental**. The bid amount for the item of **Lane Rental** will not be used in the calculation of the Design-Builder's prequalification limit; the net classification for this Contract; contract modification approval thresholds, the subcontracting limitation for this Contract or the original total contract amount that is used to determine payment for Mobilization according to subsection 150.04 of the MDOT Standard Specifications for Construction (as modified in Book 1, Exhibit 1-C).

Any other reference to the total Contract Price will be considered to be modified and will not include the bid amount for the item of **Lane Rental**.

18.5.3 Definition of Terms

The following definitions apply.

1. Designated Traffic Lane – Any traffic lane in use by traffic prior to the beginning of the project. Designated traffic lanes include lanes closed to traffic by any staging or requirements contained within this contract.

2. Lane Closure – For the purpose of assessing lane rental, lane closure means denying traffic to any designated traffic lane or any portion thereof for I-75 mainline and M-46, including traffic stoppages. A lane closure will be required when the Design-Builder's operations have resulted in a traffic lane width less than 11 feet, or a reduction in the minimum vertical clearance allowed of a traffic lane.

3. Rental Assessment – The amount, as shown in Subsection 18.5.5.1, which represents the average daily cost for each designated traffic lane closure. Any portion of a day that a designated traffic lane closure exists will be considered as a full day for assessing lane rental.

18.5.4 Lane Rental

Lane rental applies at any time during the contract unless otherwise specified in the contract documents or by the MDOT Project Manager. Lane rental applies to lane closures during periods of work activity and no work activities, unless otherwise specified. Lane rental will not apply during excusable delays changing the duration of the critical path as described in Book 1, Section 13.4.1.1.

18.5.5 Measurement and Payment

Lane Rental will be measured in days, and will be the total count of days that designated traffic lanes have lane closures within the project limits.

Pay Item	Pay Unit
Lane Rental	Lump Sum

18.5.5.1 Lane Rental Assesments

The MDOT Project Manager will keep records of the days assessed for lane rental. The Design-Builder and the MDOT Project Manager will compare records of the days assessed for lane rental and bring these records into agreement at least once a week. The dollar value of lane rental assessments will be determined by multiplying the number of days of lane closure for designated traffic lanes by the applicable rental assessment daily rate from Table 1: Lane Rental Assessment, and summing the products. Lane rental assessments will be maintained by the

MDOT Project Manager and will be subtracted from the original **Lane Rental** lump sum bid, on a biweekly basis. This process will continue until completion of the contract work.

Table 1: Lane Rental Assessment	
Location	**Daily Assessment**
NB I-75 Single Lane Closure	$13,269.84
NB I-75 Double Lane Closure	$26,539.68
NB I-75 Triple Lane Closure	$39,809.52
SB I-75 Single Lane Closure	$13,269.84
SB I-75 Double Lane Closure	$26,539.68
SB I-75 Triple Lane Closure	$39,809.52
EB M-46 Single Lane Closure	$1,741.47
EB M-46 Double Lane Closure	$3,482.94
WB M-46 Single Lane Closure	$1,741.47
WB M-46 Double Lane Closure	$3,482.94

If the cumulative lane rental assessments exceed the contract lump sum bid for **Lane Rental**, the difference will be offset against monies otherwise due to the Design-Builder for other items of work, either in the bi-weekly estimate for which the contact **Lane Rental** lump sum is exceeded or in the final estimate. If the cumulative lane rental assessments do not exceed the contract lump sum bid for **Lane Rental**, no deduction will be made from the biweekly or final estimate against monies otherwise due to the Design-Builder for other items of work for lane rental assessments, and the Design-Builder will not receive additional payments.

If the Design-Builder proposes changes in the maintaining traffic requirements, and these changes are approved by the MDOT Project Manager, the cost of these changes will be the Design-Builder's responsibility.

18.5.5.2 Adjustments to Work That Affect Lane Rental

When the MDOT Project Manager makes adjustments to work quantities or changes to the work as defined in Book 1, Section 13 or Division 1 of the MDOT Standard Specifications for Construction (as modified by Book 1, Exhibit 1-C), consideration will be given to modifying the contract lump sum bid amount for **Lane Rental** to coordinate with the changes made by the MDOT Project Manager.

18.6 Liquidated Damages Schedule

Commented [DUC19]: Use this section if liquidated damages apply and update based on project specifics.

The following schedule of liquidated damages applies to any situation in which the Design-Builder fails to remove the lane/shoulder shifts/closures and/or detours and fully open the roadway and ramps to traffic in the manner and within the time limits specified in this Book 2, Section 18, herein referred to as the Maintaining Traffic Requirements.

Damages will be assessed on a daily basis for each and every 15 minute interval for the first hour and every 1 hour interval thereafter. The damages will apply for any time on which the lane/shoulder shifts/closures and/or detours exceeds or is started before the time limitation specified in this Book 2, Section 18. Time assessments will be determined by the Engineer between the begin/end time stated in the specifications and when the Engineer determines full compliance with all requirements for safely opening or closing the roadways. Costs for portions of the full hour intervals will not be prorated and the damages will be cumulative as shown in Tables 2 and 3.

Table 2: Liquidated Damages for First Day Outside Maintaining Traffic Requirements

Amount of time outside of Maintaining Traffic Requirements	Liquidated Damages	
	Per Period	Cumulative
0 - 15 minutes	$625	$625
≥15 - 30 minutes	$625	$1250
≥30 - 45 minutes	$625	$1875
≥45 - 60 minutes	$625	$2500
≥60 minutes up to 2 hours	$2500	$5000
≥2 hours up to 3 hours	$2500	$7500
≥3 hours up to 4 hours	$2500	$10000
≥4 hours up to 5 hours	$2500	$12500
≥5 hours up to 6 hours	$2500	$15000
≥6 hours up to 7 hours	$2500	$17500
≥7 hours up to 8 hours	$2500	$20000
≥8 hours up to 9 hours	$2500	$22500
≥9 hours up to 10 hours	$2500	$25000
≥10 hours up to 11 hours	$2500	$27500
≥11 hours up to 12 hours	$2500	$30000
≥12 hours up to 13 hours	$2500	$32500
≥13 hours up to 14 hours	$2500	$35000
≥14 hours up to 15 hours	$2500	$37500
≥15 hours up to 16 hours	$2500	$40000
≥16 hours up to 17 hours	$2500	$42500
≥17 hours up to 18 hours	$2500	$45000
≥18 hours up to 19 hours	$2500	$47500
≥19 hours up to 20 hours	$2500	$50000
≥20 hours up to 21 hours	$2500	$52500
≥21 hours up to 22 hours	$2500	$55000
≥22 hours up to 23 hours	$2500	$57500
≥23 hours up to 24 hours	$2500	$60000

Table 3: Liquidated Damages for the Second or More Days Outside Maintaining Traffic Requirements

Amount of time outside of Maintaining Traffic Requirements	Liquidated Damages	
	Per Period	Cumulative
0 - 60 minutes	$2500	$2500
≥60 minutes up to 2 hours	$2500	$5000
≥2 hours up to 3 hours	$2500	$7500
≥3 hours up to 4 hours	$2500	$10000
≥4 hours up to 5 hours	$2500	$12500
≥5 hours up to 6 hours	$2500	$15000
≥6 hours up to 7 hours	$2500	$17500
≥7 hours up to 8 hours	$2500	$20000
≥8 hours up to 9 hours	$2500	$22500
≥9 hours up to 10 hours	$2500	$25000
≥10 hours up to 11 hours	$2500	$27500
≥11 hours up to 12 hours	$2500	$30000
≥12 hours up to 13 hours	$2500	$32500
≥13 hours up to 14 hours	$2500	$35000
≥14 hours up to 15 hours	$2500	$37500
≥15 hours up to 16 hours	$2500	$40000
≥16 hours up to 17 hours	$2500	$42500
≥17 hours up to 18 hours	$2500	$45000
≥18 hours up to 19 hours	$2500	$47500
≥19 hours up to 20 hours	$2500	$50000
≥20 hours up to 21 hours	$2500	$52500
≥21 hours up to 22 hours	$2500	$55000
≥22 hours up to 23 hours	$2500	$57500
≥23 hours up to 24 hours	$2500	$60000

EXHIBIT 2-18-A Conceptually Approved Detours

Commented [DUC20]: Provide detour maps for allowable detour routes after seeking MDOT and local agency approvals.

APPENDIX M

Sign Face Types – A, B, and C

(Added 12/3/2020)

The aim of this document is to illustrate and give examples for the different sign face types as described in the Standard Specifications.

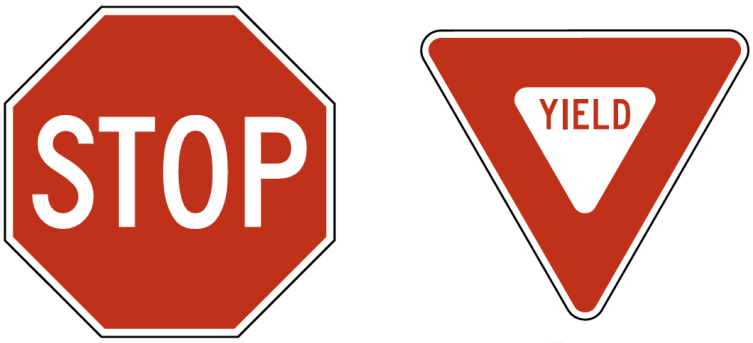
The Department's classifications of different signs can be found in Section 919 of the Standard Specifications. Section 922 describes the reflectivity requirements of temporary signs, and additional requirements can be found in Section 812.

Type A

Type A signs are signs that have both a retroreflective legend, border, and background. A common example of a Type A sign is a stop sign. This sign has a white legend, and a red background. Both the background and legend are reflectorized so they are visible at night. Since the background and the legend are reflectorized, this is a Type A sign.

Exhibit M-1:

Examples of Type A Signs, R1-1 and R1-2



R1-1 R1-2

Type B

Type B signs are signs that have a non-reflective legend and border but a reflective background. An example of a Type B sign is a common work zone warning sign, like W21-5a. The orange background on the sign is reflective, but the black legend and border on the sign are not. Since the background is reflective but the legend and border are not, this sign is a Type B sign.

Exhibit M-2:

Examples of Type B Signs, W3-3, W21-5a, R4-1

W3-3

W21-5a

R4-1

Type C

Type C signs are signs that have a reflective legend and border but a non-reflective background. These signs are less common. An example of this sign is the night speed limit signs that have a non-reflective black background and a reflective white legend and border.

Exhibit M-3:

Example of a Type C Sign, R2-3P

R2-3P