

**MINNESOTA DEPARTMENT OF TRANSPORTATION
APPLICATION GUIDELINES, OPERATIONAL STRATEGY and
IWZ DYNAMIC LATE MERGE SYSTEM SPECIFICATIONS**

The Dynamic Late Merge (DLM) System is a type of Intelligent Work Zone System (IWZ) which is considered as a Stand-Alone system with minimal Mn/DOT support services or equipment required for full deployment and operation.

APPLICATION GUIDELINES:

The IWZ DLM System is designed to utilize the best aspects of the Early and Late merge strategies. Through the use of technology, the DLM System traffic control strategy can dynamically change its lane use instructions based on the current traffic conditions. It changes the location of drivers' merge point from the closed to the open lane, i.e., from an early merge strategy under light traffic demand to a late merge strategy during periods of congestion. The motivation for this approach stems from a desire to make the roadways safer and eliminate conditions where motorists typically exhibit conflicting driver behaviors.

The DLM System, which is an addition to the standard orange and black warning signs placed in advance of a lane closure, consists of appropriately placed Portable Changeable Message Signs (PCMS) and Non-intrusive Traffic Detectors (NITD). Through the monitoring of the NITD, the Equipment Control Unit (ECU) assesses current traffic conditions and determines an appropriate merging strategy following a pre-specified procedure. The selected merging strategy is automatically implemented with messages displayed on approved PCMS (or utilize permanent CMS where available) through a communications network. The DLM System will consist of furnishing, installing, and placing into operation all the needed NITD, ECU, PCMS, and communications networking that are required for the project, the daily monitoring of the system and timely response to system problems.

The DLM System should be considered for all temporary traffic control situations where a lane closure is reducing the mainline roadway from two continuous lanes to one lane. Consideration should address the estimated traffic volumes, duration of the lane closure, roadway geometrics and the effects of congestion and large traffic queues at the particular project location.

A DLM System should be considered for deployment as part of a project's temporary traffic control plan when the following conditions are anticipated:

- The lane closure is will be in place for a duration of 2 days or more.
- The traffic volumes exceed 1500 vehicles/hour for at least 2 hours per day.
- During congested periods, the estimated traffic queue lengths (without the DLM system implemented) may encroach on upstream intersection/interchange operations.

SYSTEM OPERATION STRATEGY:

The DLM System shall detect a minimum of 2 distinct traffic conditions:

- **Free Flow:**
 - Definitions of free-flow may vary by project, but typical traffic condition warrants may include:
 - A trend of vehicle speeds at two points above an adjustable parameter. This parameter should be set for optimal results based on on-site monitoring and review as directed by the engineer. Typically greater than 50 mph may be utilized as a guideline.
 - A trend of vehicle volume between two points below an adjustable parameter. This parameter should be set for optimal results based on on-site monitoring and review as directed by the engineer. Typically less than 1000 vehicles/hour may be utilized as a guideline.

- A trend including reduced vehicle speeds together with increased volume. These parameters should be set for optimal results based on on-site monitoring and review as directed by the engineer.
- During Free Flow conditions, the DLM System shall display no lane use messages, and therefore allow traffic to resume typical early merge operation.
- **Congestion:**
 - Definitions of congestion may vary by project, but typical traffic condition warrants may include:
 - A trend of vehicle speeds at two points below an adjustable parameter. This parameter should be set for optimal results based on on-site monitoring and review as directed by the engineer. Typically less than 20 to 35 mph may be utilized as a guideline.
 - A trend of vehicle volume between two points above an adjustable parameter. This parameter should be set for optimal results based on on-site monitoring and review as directed by the engineer. Typically greater than 1500 to 1700 vehicles/hour may be utilized as a guideline.
 - A trend including reduced vehicle speeds together with increased volume. These parameters should be set for optimal results based on on-site monitoring and review as directed by the engineer.
 - When traffic conditions warrant a change to the late merge strategy, the DLM System shall display lane use messages on the PCMS. The messages shall consist of two alternating displays as described below. The PCMS shall be located in advance of the lane closure as determined by the engineer based upon estimated queue lengths and project geometry. Approximate locations for various stages will be shown on the plans.
 - PCMS located at point of merge shall display:
MERGE HERE – TAKE TURNS
 - Intermediate PCMS located beyond estimated queue length at the time when DLM System activation will occur
MERGE AHEAD – USE BOTH LANES
 - PCMS located beyond estimated maximum queue length
STOPPED TRAFFIC AHEAD – USE BOTH LANES

DLM SYSTEM SPECIFICATIONS:

DLM Systems will utilize a performance and reliability specification. Due to the ever-changing technology, it is impossible to specify the specific type of detection, data computations or communication network that is required for the system. In general, the vendor/ manufacturer shall supply equipment that is fully functional and quickly/easily repaired/replaced if damaged. The vendor/ manufacturer shall provide technical personnel for all system calibration, operation, maintenance and timely on-call support services. The vendor/ manufacturer shall certify that the system will perform to the operational strategy as outlined above. The IWZ DLM System provider must be listed on the Mn/DOT OTSO Work Zone Qualified Product List as either approved or in provisional approval status. Mn/DOT will conduct field reviews and require event logs for performance measures and the project's special provisions will prevail for the IWZ DML System. Systems provided by provisionally approved vendor/ manufacturers must also adhere to the provisional approval requirements as outlined in the IWZ Systems Qualification and Acceptance Process.

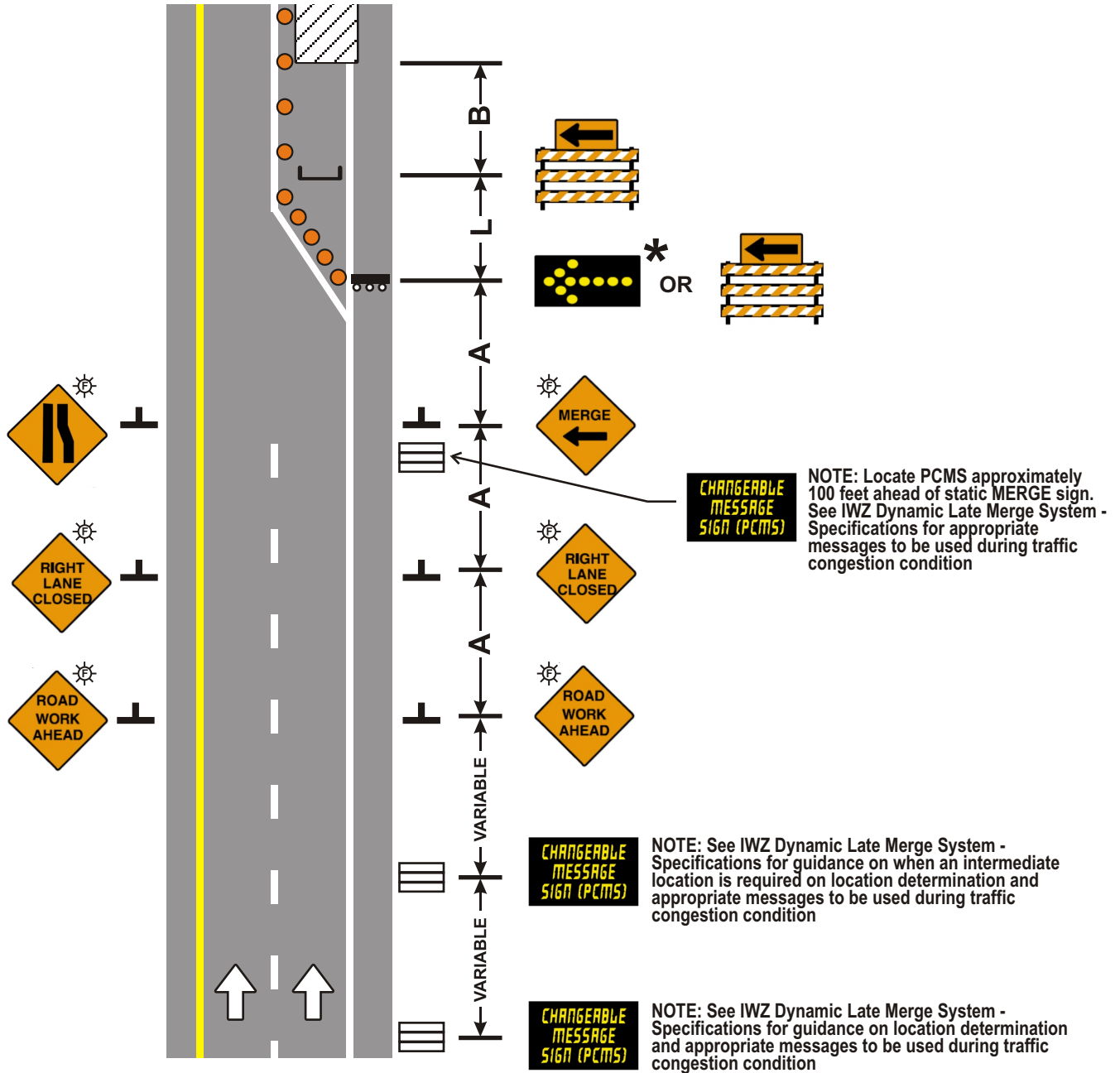
NOTES:

1. For nighttime and Intermediate Term operations, Type A flashers are required on advance warning signs unless PCMS's and flashing arrowboards are used.
2. See appropriate lane closure layouts for proper placement of signs, drums, barricades and pavement markings

* Required for speeds greater than 40 mph.

○ Drums, Type I or Type II Barricade or Vertical Panel

Posted Speed Limit Prior to Work Starting (mph)	Spacing of Advance Warning Signs (A)		Taper Length (L)		Decision Sight Distance	
	meters	feet	meters	feet	meters	feet
0 - 30	80	250	30	100	170	550
35 - 40	100	325	50	175	210	700
45 - 50	180	600	90	300	270	900
55	230	750	110	350	370	1200
60 - 65	300	1000	120	400	430	1400
70 - 75	370	1200	140	450	480	1600



LANE CLOSED - 2 LANE DIVIDED ROAD DYNAMIC LATE MERGE (DLM) SYSTEM