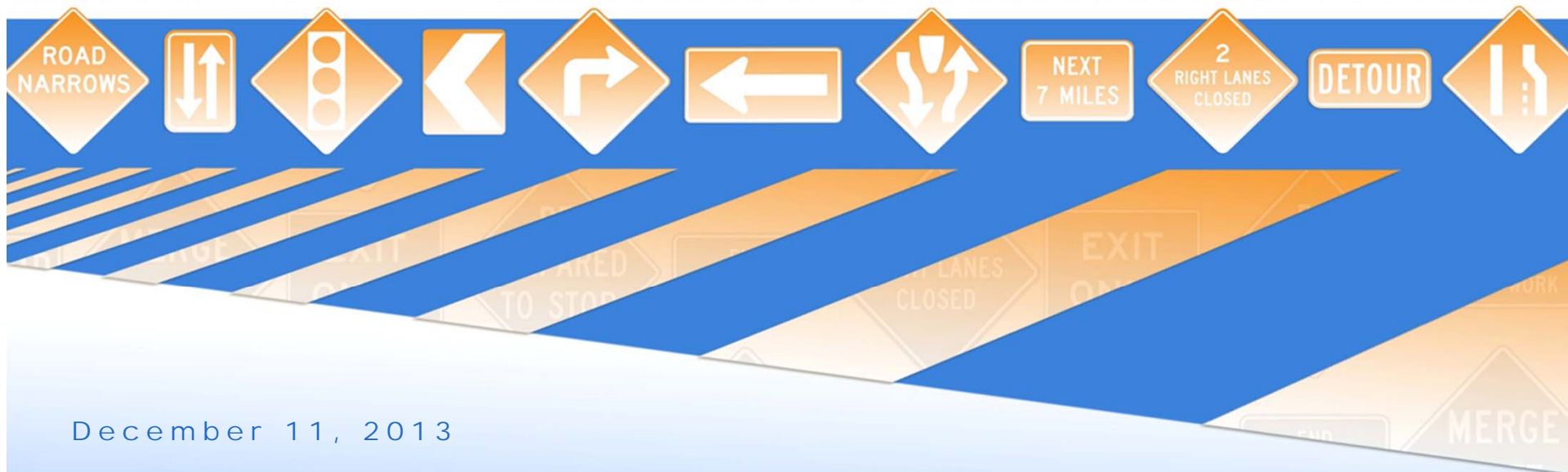


DELDOT WORK ZONE TRAINING

FOR CONSTRUCTION & INSPECTION STAFF



December 11, 2013



Introduction

Who Should Be Here?



- Construction staff
- Inspectors





- Provide Delaware-specific guidance and procedures related to work zones
- Improve work zone compliance through properly trained construction/inspection staff
- Fulfill FHWA requirements (Work Zone Safety and Mobility Final Rule)

States shall require that personnel involved in the development, design, implementation, operation, inspection, and enforcement of work zone related transportation management and traffic control be trained, appropriate to the job decisions each individual is required to make. States shall require periodic training updates that reflect changing industry practices and State processes and procedures.

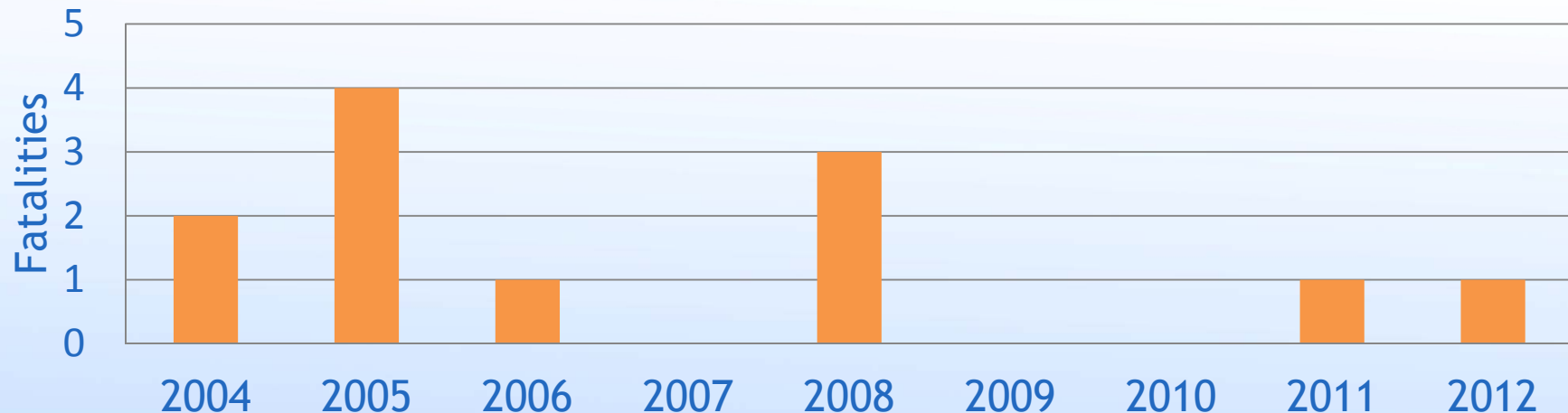
Why is this Important?



- 576 fatal work zone-related crashes reported nationally in 2010 (FARS) - less than 2% of all fatal crashes
- DE Strategic Highway Safety Plan Emphasis Area: Designing Safer Work Zones



Delaware Work Zone Fatalities





7 Fundamental Principles of TTC (DE MUTCD)

1. Develop plans to accommodate all road users, workers, and equipment
2. Minimize impacts on road users
3. Provide clear guidance to road users
4. Routinely inspect and maintain TTC devices
5. Maintain roadside safety
6. Train individuals involved in TTC operations
7. Disseminate information to public



- Common recurring compliance issues
 - Typical issues occur from job-to-job
 - Same inspection staff
 - Same contractors
- Lack of trained inspection staff
 - Both in-house and consultant inspectors
- Lack of respect by contractors
 - Toward inspection staff and Traffic Safety staff
 - Toward own MOT personnel



- Lack of adherence to time restrictions
 - Typically during daytime, ending after allotted time
 - Excuses include equipment breakdown, just wanted to pave another 100 feet, etc.
- Productivity vs. safety
- Lack of coordination with Traffic Safety
 - Improving, but could be better
 - Easier to wait for the “slap on the wrist”



- High-visibility safety apparel not being worn
- Signing issues
 - Sign stands being left along side of road at end of work operation
 - Inappropriate use of skid-mounted sign stands
 - Incorrect placement of skid-mounted sign stands
 - Incorrect installation of sign posts
- Poor device quality
 - Non-compliant drum sheeting
 - Damaged PCC barrier
 - Poor reflectivity
- Improper storage of equipment



- **DE MUTCD**
 - Standards are requirements that SHALL be followed (allowing engineering judgment) unless there is an Option
 - *Guidance is recommended and SHOULD be followed*
 - Options MAY be followed and are sometimes modifications to Standards and Guidance
- **Work Zone Safety and Mobility Procedures and Guidelines (Sept 2007)**
- **DelDOT Road Design Manual**
- **DelDOT Construction Manual**
- **DelDOT Standard Construction Details**
- **DelDOT Standard Specifications**
- **NCHRP/MASH**
- **AASHTO Roadside Design Guide**
- **OSHA**



Liability and Risk



- **Tort:** a civil wrong arising from an act or failure to act, independently of any contract, for which an action for personal injury or property damages may be brought
- In order to succeed in a tort claim, a plaintiff must prove four elements:
 - Duty
 - Breach of Duty (i.e., negligence)
 - Proximate Cause
 - Damage



Duty: A responsibility to exercise the standard of care necessary to reasonably protect the safety of persons and property

Examples of Standard of Care

- National policies and guidelines
- DelDOT directives
- Contract requirements
- Industry standards



Breach of Duty (i.e., negligence): Through actions, or failure to act, failure to meet the standard of care required under the circumstances



What would a reasonably prudent person do in the same or similar circumstances?





- **Gross Negligence:** conscious and voluntary disregard for attention to the standard of care

*Can result in the
award of higher
damages
\$\$\$\$\$\$\$\$*



Proximate Cause: An act or an omission that results in an event that otherwise would not have occurred



A plaintiff must prove that negligence was one of the contributing causes of the damages/injury



- **Damage:** Death, personal injury, consequential damages (e.g., lost wages), or property damage resulting from negligence



Failure to behave responsibly must have caused the damages



- DelDOT cannot be sued (*per DelDOT Title 10 § 4001*) as long as “the act or omission complained of was done without gross or wanton negligence”
- A contractor has no cap limitations
- A contractor’s employee has no cap limitations

In most tort cases, the injured party’s attorney is looking for the party with the “deepest pockets”



Ten Daily Steps To Minimize Your Liability Exposure

1. Have an approved Temporary Traffic Control Plan
2. Personnel with appropriate training shall be present during installation, maintenance & removal of TTC devices
 - Train all personnel in proper work zone safety techniques
3. Follow the Delaware MUTCD and its latest revisions
 - Including Interim Guidance memorandums



Ten Daily Steps To Minimize Your Liability Exposure

4. Minimize traffic disruptions
5. Inspect WZ sites daily for conformance
 - Immediately after set-up
 - Periodically throughout the day and as traffic patterns change (e.g., congestion)



Ten Daily Steps To Minimize Your Liability Exposure

6. Promptly repair or replace damaged devices
7. Promptly remove unneeded devices
8. Properly install and remove temporary traffic control devices from the roadway
9. View the work zone from the road user's perspective



Ten Daily Steps To Minimize Your Liability Exposure

10. Keep comprehensive documentation

- Written checklist form / inspection reports
- Daily diary
- Photographs
- Video/audio recordings

Why? Ensures integrity/reputation, identifies deficiencies, initiates corrective actions

DOCUMENT ! DOCUMENT ! DOCUMENT !



Inspection Form Used by DelDOT Safety Officers



DELAWARE DEPARTMENT OF TRANSPORTATION WORK ZONE TRAFFIC CONTROL INSPECTION

Date of Inspection _____
Time of Inspection _____
Maint. District _____
Contract/Permit No. _____
Project Name _____
Project Supervisor _____
On-Site Inspector _____
Contractor Name _____

SIGNS

☐ No Problem Found ☐ Corrective Action Required
1

PORTABLE VARIABLE MESSAGE SIGNS

☐ No Problem Found ☐ Corrective Action Required
1

ARROW PANEL

☐ No Problem Found ☐ Corrective Action Required
1

FLAGGERS

☐ No Problem Found ☐ Corrective Action Required
1

CHANELIZING DEVICES (CONES, DRUMS, ETC)

☐ No Problem Found ☐ Corrective Action Required
1

PAVEMENT MARKINGS

☐ No Problem Found ☐ Corrective Action Required
1

TEMPORARY BARRIER/CRASH CUSHIONS

☐ No Problem Found ☐ Corrective Action Required
1

MISCELLANEOUS

☐ No Problem Found ☐ Corrective Action Required
1

OTHER COMMENTS & RECOMMENDATIONS

Corrective actions by: ☐ Immediate ☐ Urgent (24 hrs)
☐ 5 days ☐ Other

Special Notes: _____

Additional information/
photographs attached? ☐ Yes ☐ No

Safety Officer: _____

Copies to:

☐ On-Site Inspector ☐ Project Supervisor ☐ Area Engineer
☐ Chief Safety Officer ☐ Safety Programs Mgr ☐ Group Engineer
☐ Public Works Eng. ☐ Contractor ☐ ATSSA Supervisor
☐ Yard Supervisor ☐ Maint. Superintendent ☐ Maint. Engineer



What to do if there is an incident in the work zone?

- The contractor and/or DelDOT construction/inspection staff shall contact the Transportation Management Center (TMC) and the District Safety Officer immediately when an incident occurs in or near the work zone
 - TMC will contact appropriate additional DelDOT Safety staff
- Document work zone incidents, even if very minor



What to do if there is an incident in the work zone?

- Identify corrective actions needed to reduce the potential for additional incidents
- There is a potential that:
 - DelDOT or contractor equipment (traffic control devices) may be used for emergency closures during the initial response
 - Contractor equipment may be used to remove damaged vehicles and debris
 - Safety Officers may be required to shut down work operations on roadways (e.g., the removal of traffic control devices in closures) in order to facilitate traffic flow in the event of an incident
 - Traffic control devices available from an adjacent work zone may be used for the initial response to the incident, as long as it does not create additional hazards



Human Factors



Human Factors

- Age
- Judgment
- Driver skills
- Attention
- Fatigue
- Experience
- Sobriety



Vehicle Factors

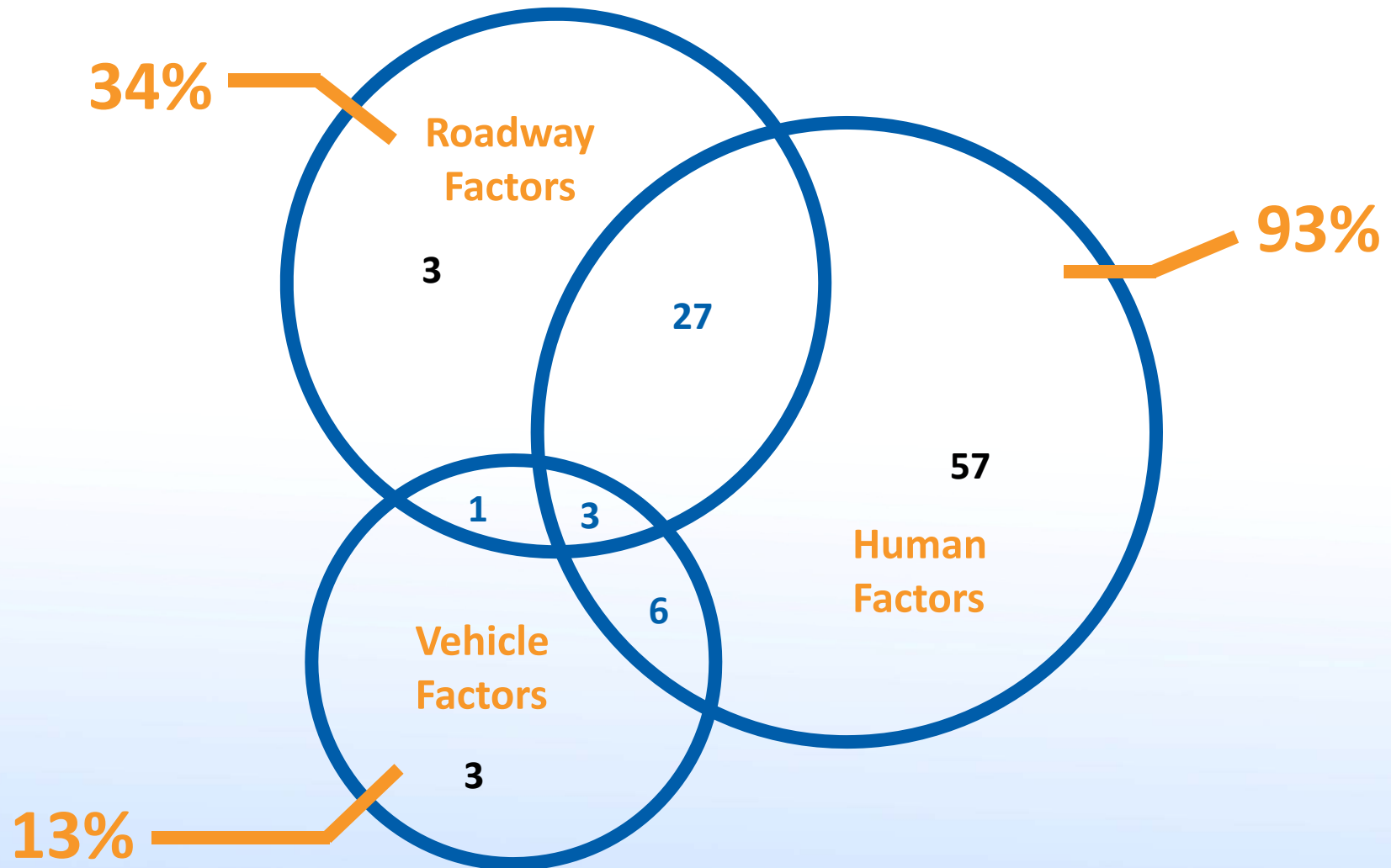
- Design
- Manufacturer
- Maintenance



Roadway Factors

- Geometric alignment
- Cross-section
- Traffic control devices
- Surface friction
- Grade
- Signage
- Weather
- Visibility

Crash Factors



Perception / Reaction Cycle



PIEV



Perception
(*situation
detected*)



Intellection
(*situation
identified*)



Emotion
(*action
made*)



Volition
(*action
executed*)





- Perception-reaction time (PIEV) = **2.5** seconds (per AASHTO) for “familiar” conditions



INCREASES TO 5+ SECONDS IN UNFAVORABLE CONDITIONS
(e.g., wet weather, poor visibility, glare from oncoming vehicles)

- Multiply the speed in miles per hour (mph) by **1.47** to obtain the distance a vehicle travels in 1 second

ABOUT 1.5 FOR QUICK REFERENCE

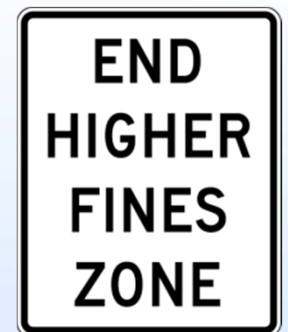
Example: 45 mph → 45 (1.47) = 66 ft / sec



- Drivers make their own decisions
- Decisions are based upon available information and past experiences
- Traffic control must be designed and installed to obtain the desired response from drivers
- Penalties and enforcement alone have little effect on forcing driver responses



R2-10



R2-11



- When expectations are met and reinforced, they aid the driving task and performance tends to be error-free
- When expectations are violated, drivers need more time to respond, performance is poorer, and they may make errors





Work Zone Types, Durations, and Components



Work zones types are typically determined by:

- Work location
- Roadway type
- Work duration
- Work type & equipment needs

Use these factors to select the appropriate DE MUTCD Typical Application (TA)





Work locations:

- Outside of the shoulder
- On the shoulder
- Within the traveled way
- Vicinity of a grade crossing
- Above the traveled way
- Along sidewalks





DE MUTCD Roadway Types:

- Two-lane highways
- Urban streets
- Intersections and sidewalks
- Multi-lane, non-access controlled highways (divided and undivided)
- Interstates, freeways, and expressways
- Entrance and exit ramps

Other Roadway Factors

- Traffic volumes
- Speeds ← Important factor
- Road user mix
 - Buses
 - Trucks
 - Cars
 - Motorcycles
 - Bicyclists
 - Pedestrians (sidewalks or visual evidence)
- Roadside character
 - Rural vs. urban
 - Commercial, residential, etc.



The posted speed limit affects the installation of TTC devices:

- Distance between signs
- Length of transitions - merging, shifting and shoulder tapers
- Spacing of channelizing devices
- Buffer spacing
- Use of TMA
- Clear zone values
- Barrier flare rate



Prevailing / 85th percentile speed should be considered
if it differs significantly from posted speed limit

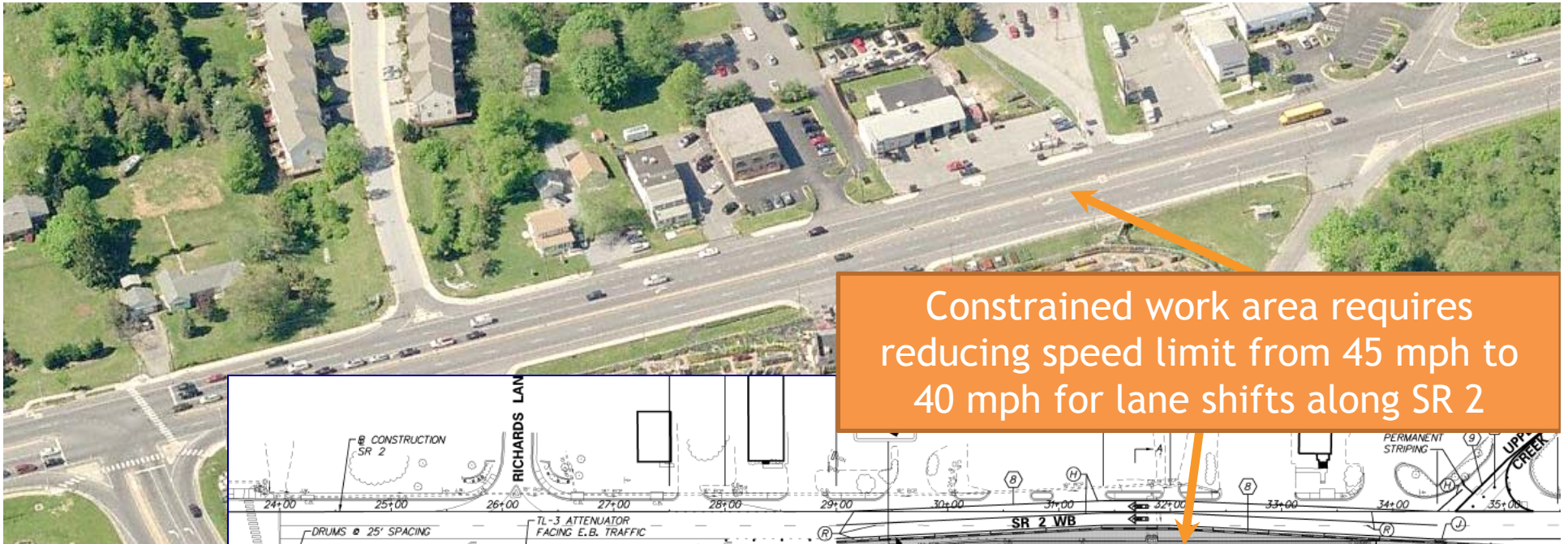
Work Zone Speed Limit



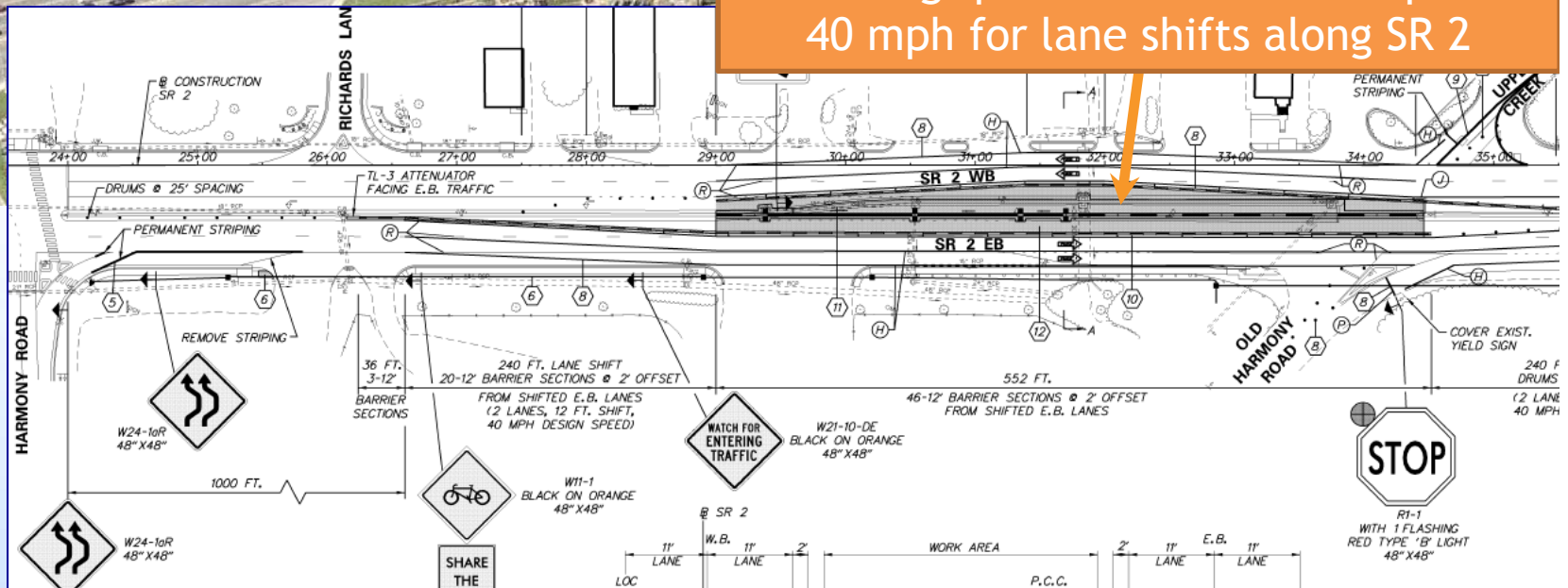
- Require approval from DelDOT Traffic Safety
- Permitted if design is restricted or special conditions exist:
 - Speed limit reduction should not exceed 10 mph
 - Reduction greater than 10 mph should be “stepped down”
- Typically discouraged unless there is a documented need
 - Often create a higher differential in speeds which leads to crashes and increases the likelihood of aggressive driving
 - Compliance issues (frequently disregarded by motorists)
 - Appropriate safe speed changes throughout the day (e.g., congested vs. free flow conditions)
 - Reduced speed limit when there is no activity (e.g., nighttime) encourages non-compliance



Work Zone Speed Limit



Constrained work area requires reducing speed limit from 45 mph to 40 mph for lane shifts along SR 2



SR 2 & Upper Pike Creek Intersection Improvements



- Long-term stationary: > 3 days
- Intermediate stationary: > 1 daylight period or 1 hr at night
- Short-term stationary: > 1 hr within single daylight period
- Short duration: \leq 1 hr
- Mobile: Moving intermittently or continuously

> Greater than
 \geq Greater than or equal to

< Less than
 \leq Less than or equal to

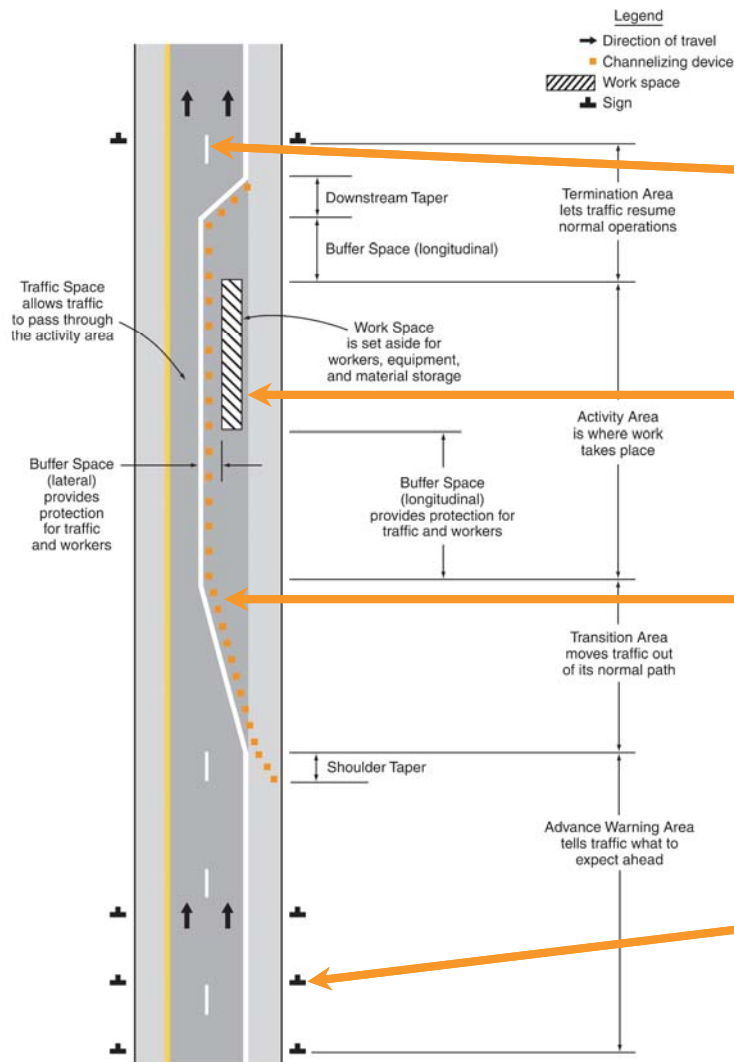


Work zone types are also influenced by the following factors:

- Nature of work
- Size (length and width) of work area
- Construction equipment types
- Type of materials needed
- Access requirements
- Presence of workers
- Work hour restrictions

Components of a Work Zone

Figure 6C-1. Component Parts of a Temporary Traffic Control Zone



Termination area

Activity area

Transition area

Advance warning area



- Function of speed, environment, roadway type
- DE MUTCD Table 6C-1: Recommended Advance Warning Sign Minimum Spacing

DE Guidance

Roads \leq 40 mph = “low speed”
Roads $>$ 40 mph = “high speed”

Road Type	Distance Between Signs**		
	A	B	C
Urban (low speed)*	100 feet	100 feet	100 feet
Urban (high speed)*	350 feet	350 feet	350 feet
Rural	500 feet	500 feet	500 feet
Interstate/Expressway/Freeway	1,000 feet	1,640 feet	2,640 feet

* 40 mph or less is “low speed” and over 40 mph is “high speed” on state-maintained roadways.

** The column headings A, B, and C are the dimensions shown in Figures 6H-1 through 6H-46. The A dimension is the distance from the transition or point of restriction to the first sign. The B dimension is the distance between the first and second signs. The C dimension is the distance between the second and third signs. (The “first sign” is the sign in a three-sign series that is closest to the TTC zone. The “third-sign” is the sign that is farthest upstream from the TTC Zone.)

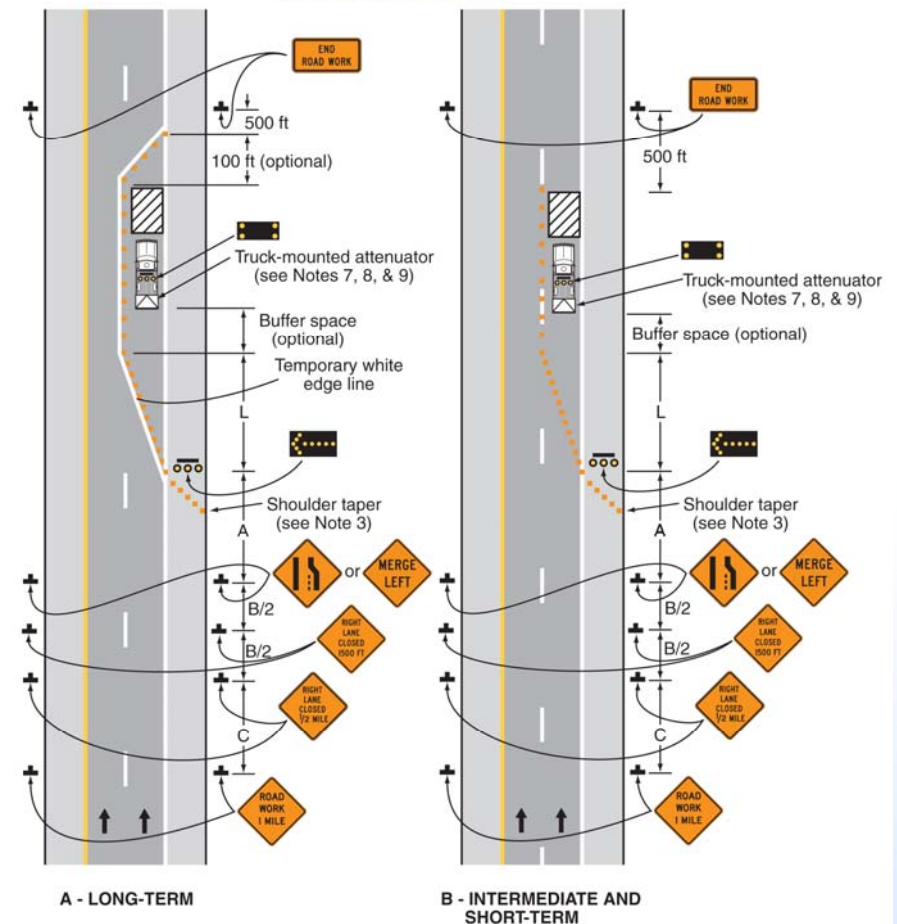


Multi-Lane, Divided Highways

- Distance between advance warning signs based on the interstate/expressway/freeway criteria

Road Type	Distance Between Signs		
	A	B	C
Interstate/ Expressway/ Freeway	1,000 feet	1,640 feet	2,640 feet

Figure 6H-33. Stationary Lane Closure on a Multi-Lane, Divided Highway (TA-33)
(Delaware Revision)





COMMON PROBLEMS

Inadequate spacing

Minimum advance warning sign spacing should be 350 ft for urban, high-speed roads



SR 2 at SR 7



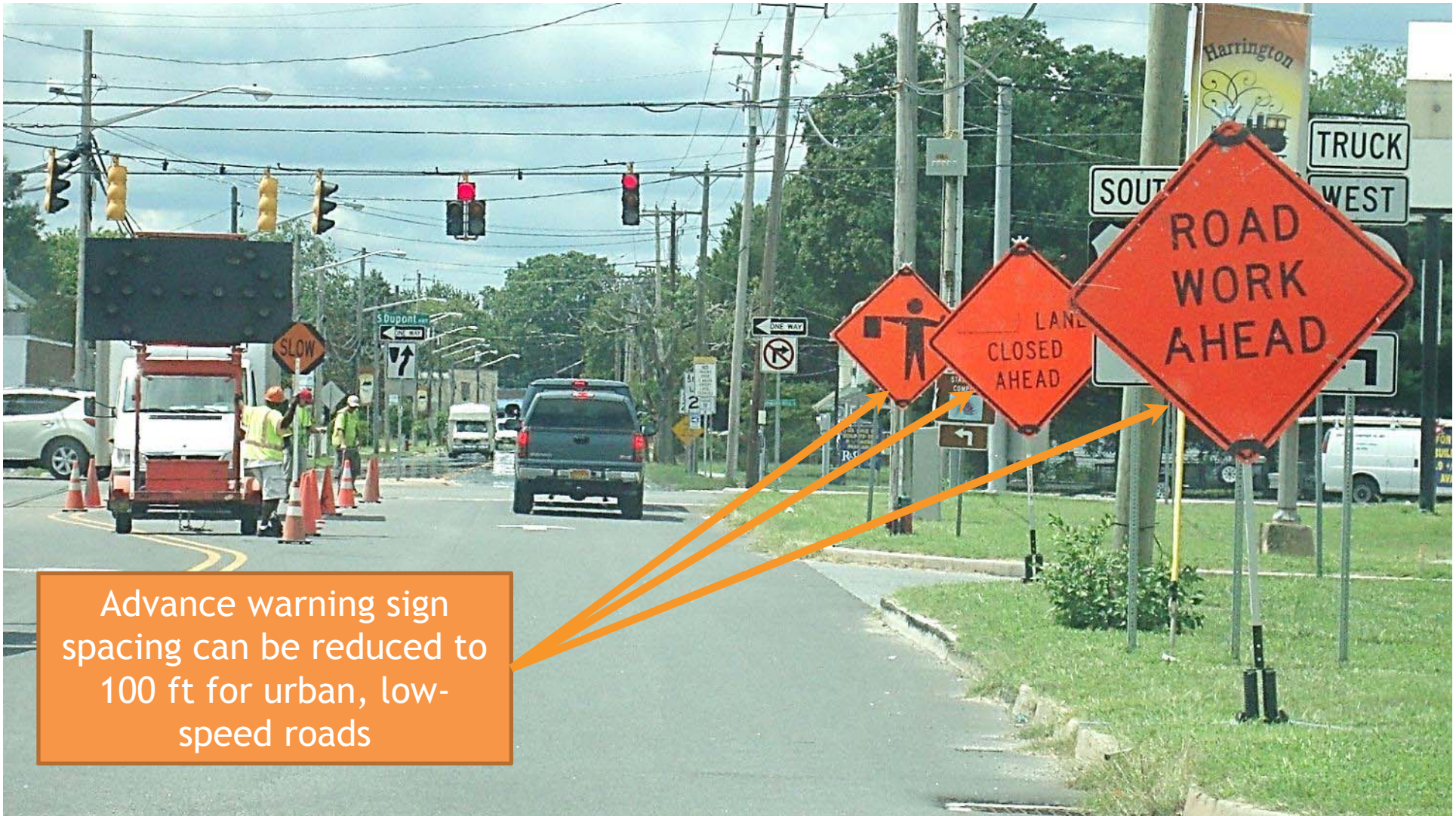
COMMON PROBLEMS

Inadequate spacing

Minimum advance warning sign spacing should be 500 ft on rural roads



US 13 / DE 404 Intersection Realignment and Bridgeville Service Road



Advance warning sign spacing can be reduced to 100 ft for urban, low-speed roads

Taper Types



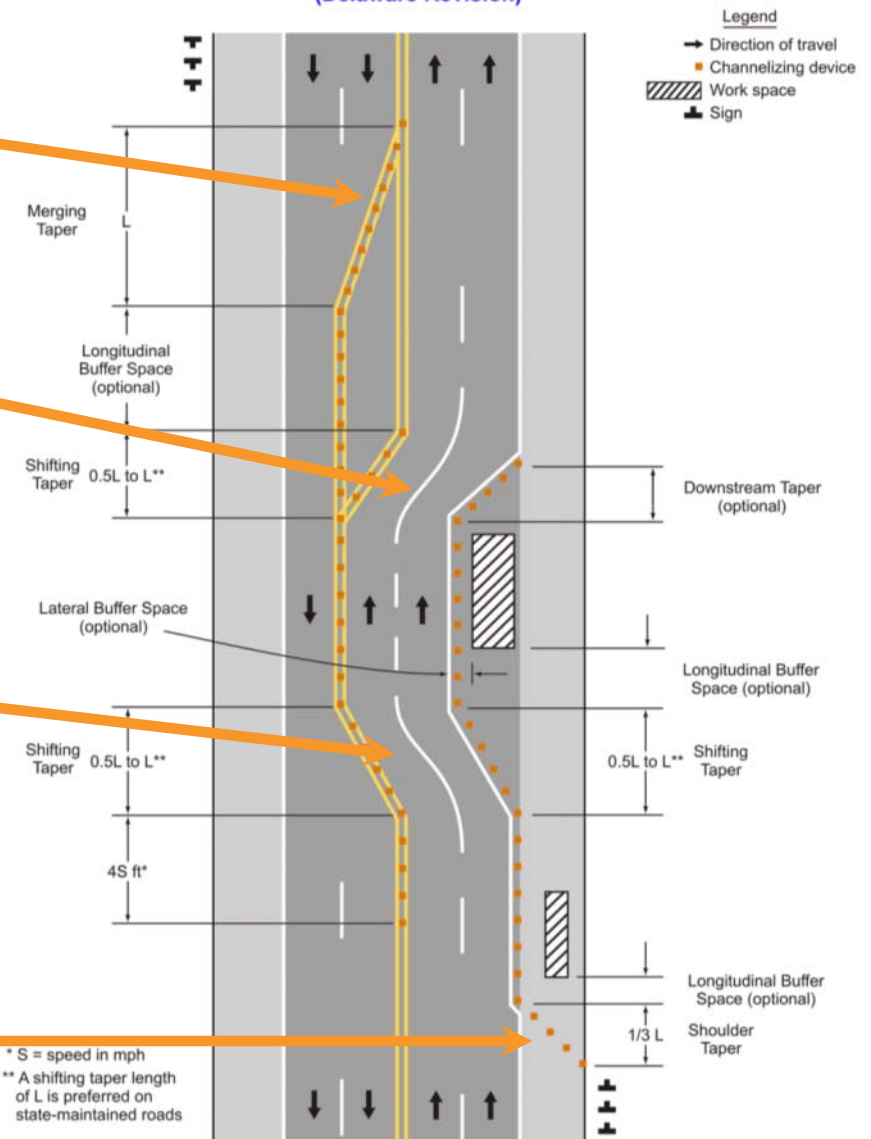
Figure 6C-2. Types of Tapers and Buffer Spaces
(Delaware Revision)

Merging = L

Downstream = 50-100 ft

Shifting = L (preferred);
 $0.5L$ (minimum)

Shoulder = $1/3 L$





DE MUTCD Table 6C-3

Type of Taper	Taper Length
Merging Taper	At least L
Shifting Taper	L (preferred); 0.5 L (minimum)
Shoulder Taper	At least 0.33 L
One-Lane, Two-Way Traffic Taper	50 feet minimum, 100 feet maximum
Downstream Taper	50 feet minimum, 100 feet maximum

Calculate L: $L = WS$ ($S > 40$ mph)

$$L = \frac{WS^2}{60} \quad (S \leq 40 \text{ mph})$$

Prevailing / 85th percentile speed should be considered if it differs significantly from posted speed

where:

W = width of lane or shoulder to be closed (merging and shoulder tapers) or distance shifted laterally (shifting taper) (ft)

S = posted speed limit (mph)



- DE Guidance: Shifting taper equal to L
- DE Option: Minimum shifting taper of $0.5L$

Figure 6H-36. Lane Shift on a Multi-Lane, Divided Highway (TA-36)
(Delaware Revision)

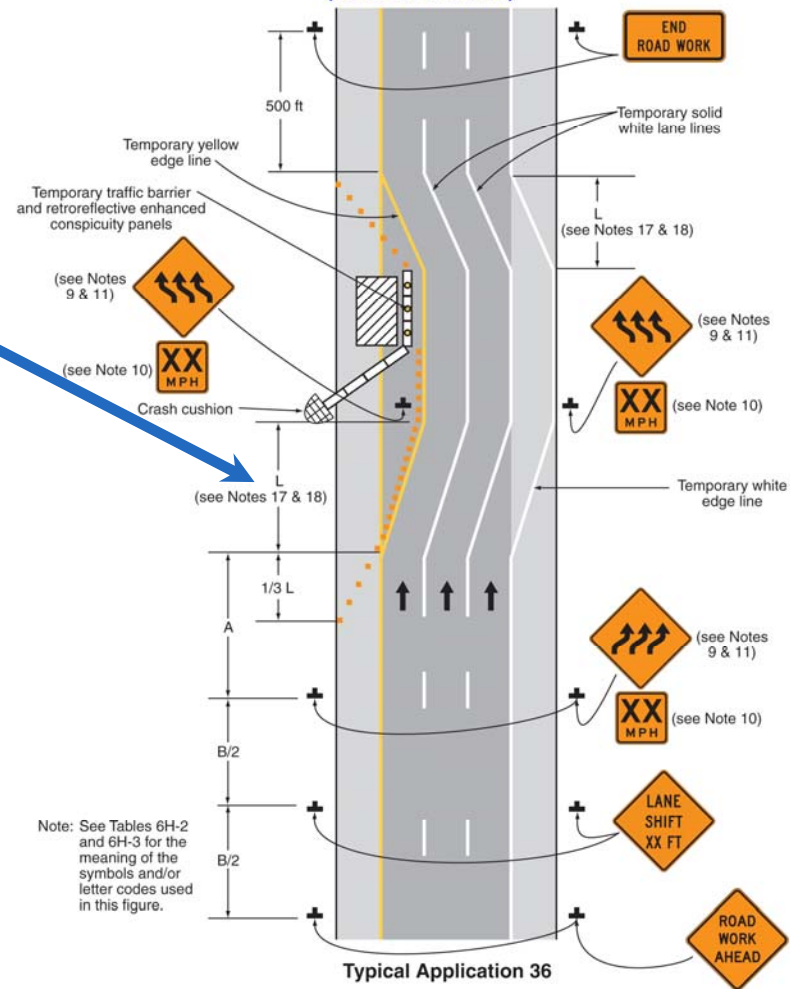
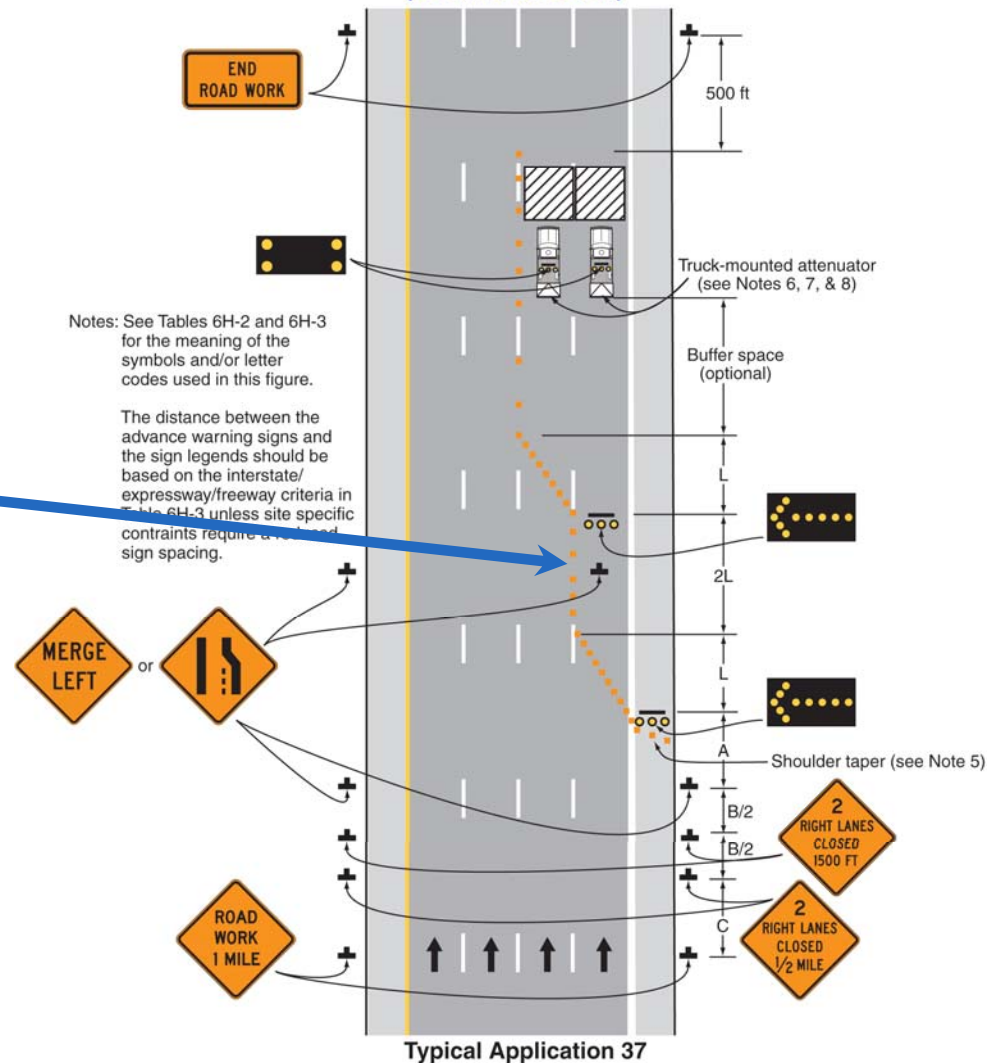


Figure 6H-37. Double Lane Closure on a Multi-Lane, Divided Highway (TA-37)
(Delaware Revision)

- Must be separated by a tangent
- Two merging tapers - separated by a distance of $2L$





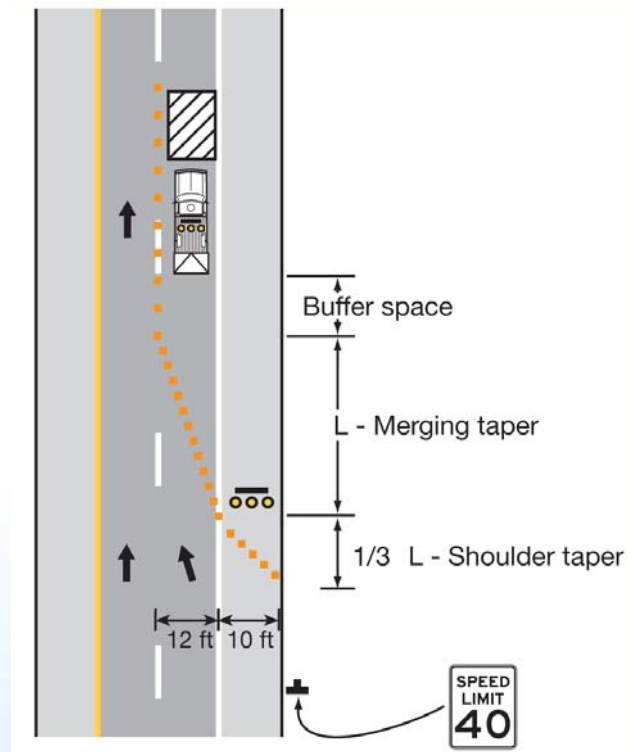
Taper Exercise

- Multi-lane, divided highway
- Speed limit = 40 mph
- Lane width = 12 feet
- Shoulder width = 10 feet

What is the merging taper length?

Speed \leq 40 mph; use $L = \frac{WS^2}{60}$

$$\text{Merging taper} = L = \frac{(12) \times (40)^2}{60} = 320 \text{ ft}$$





Taper Exercise

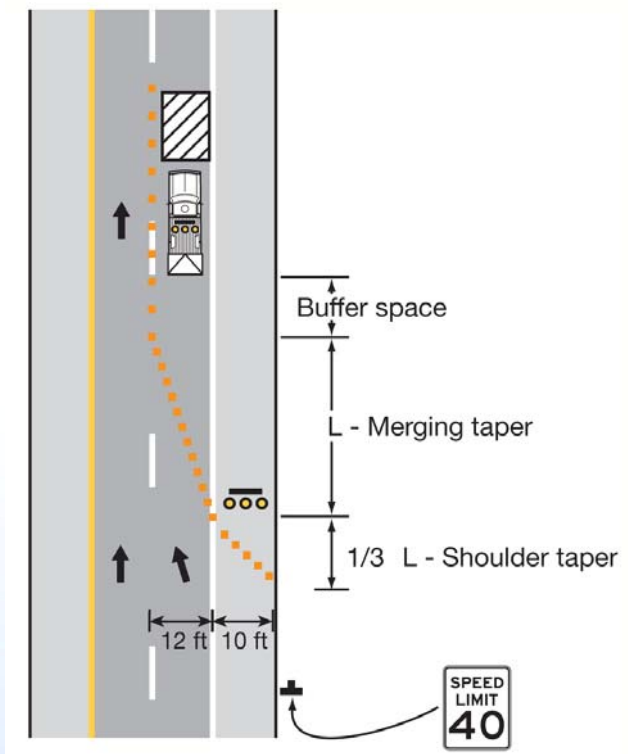
- Multi-lane, divided highway
- Speed limit = 40 mph
- Lane width = 12 feet
- Shoulder width = 10 feet

What is the shoulder taper length?

Speed \leq 40 mph; use $L = \frac{WS^2}{60}$

Shoulder taper = $\frac{1}{3} L$

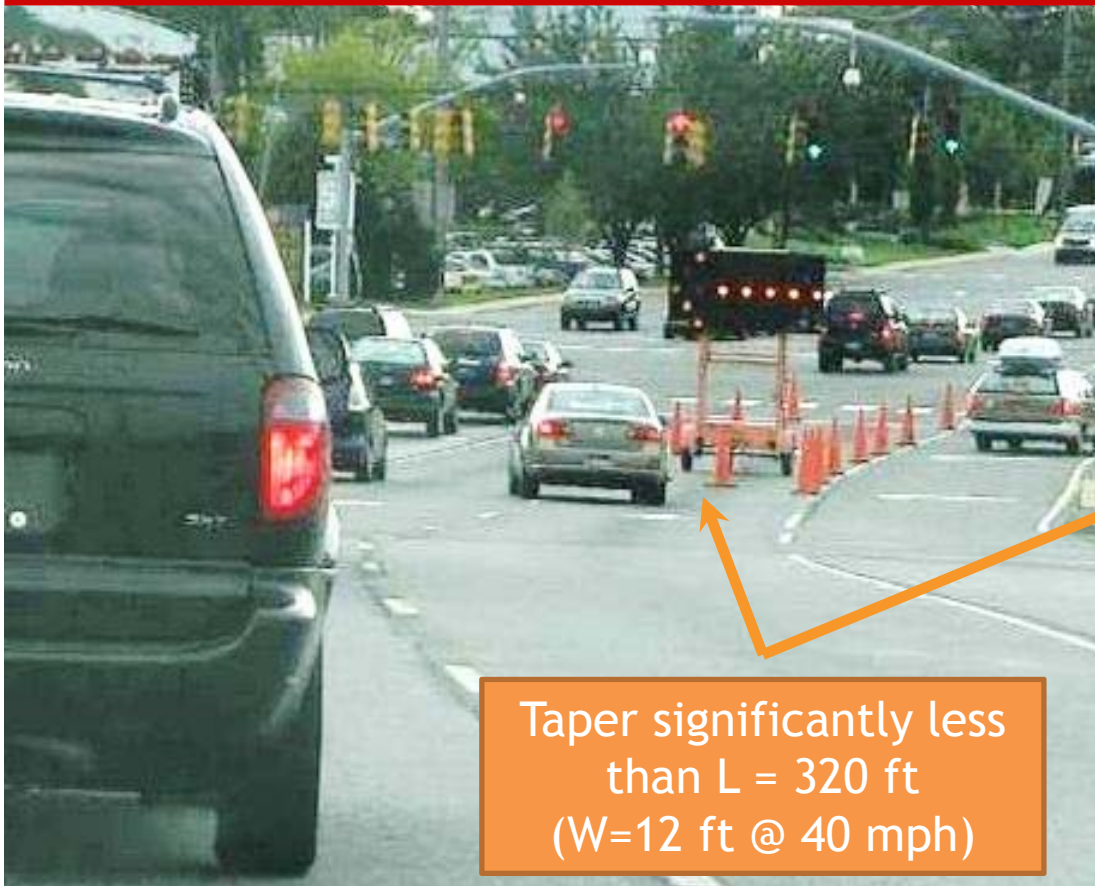
Where, $L = \frac{(10) \times (40)^2}{60} = 267 \text{ ft}$ and $\frac{1}{3} L = 89 \text{ ft}$





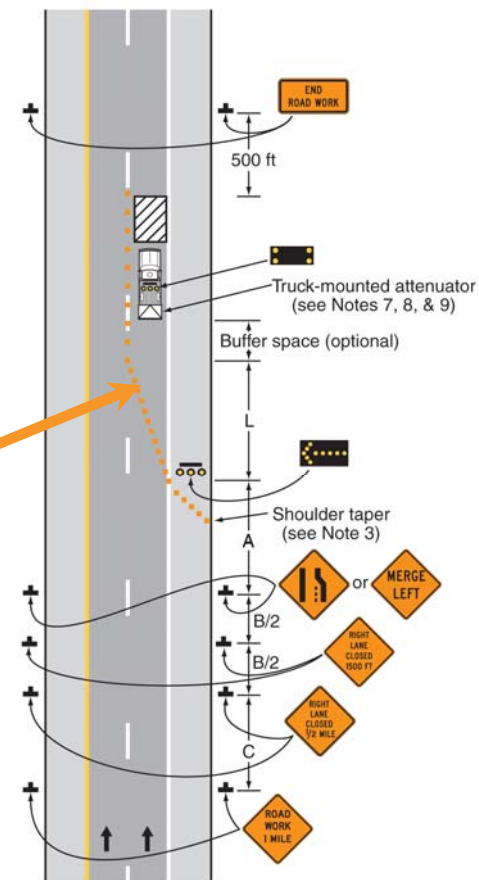
COMMON PROBLEMS

Inadequate taper lengths



Taper significantly less than $L = 320$ ft
($W=12$ ft @ 40 mph)

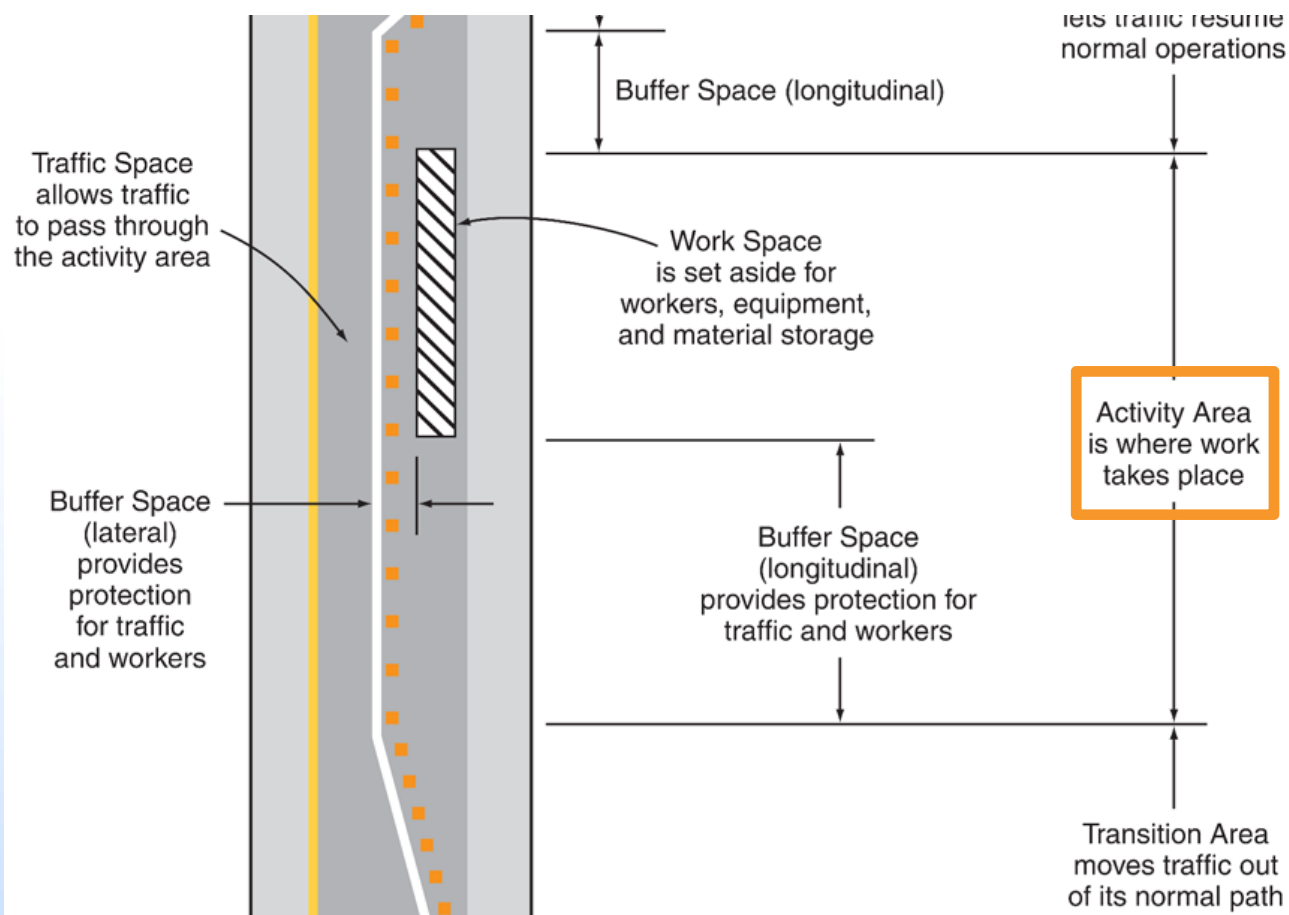
SR 7 at SR 2



B - INTERMEDIATE AND SHORT-TERM



- Activity Area - where work takes place (includes buffer area & work space)



Channelizing Device Spacing



- Longitudinal spacing (feet) = Speed limit (mph); 60-ft maximum spacing
- First 4 devices in taper = 25-ft maximum spacing





Determining the Number of Devices Needed

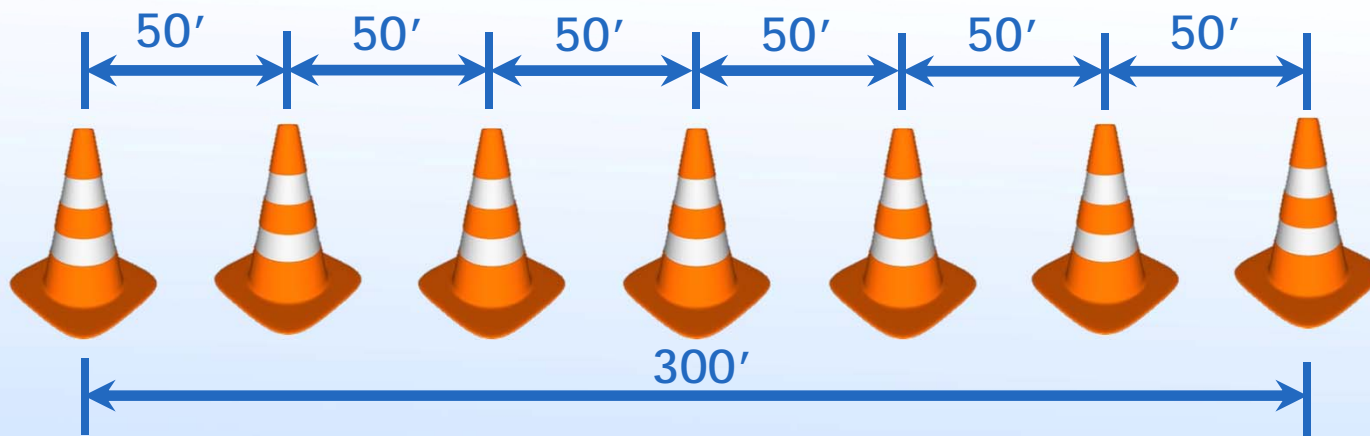
$$\text{Minimum Number of Devices} = \frac{\text{Length of Devices}}{\text{Spacing}} + 1$$

■ Example

- Length = 300 feet
- Spacing = 50 feet

How many devices are needed?

$$\text{Minimum Number of Devices} = \frac{300 \text{ ft}}{50 \text{ ft}} + 1 = 7 \text{ devices}$$



Plus additional devices to account for 25-ft spacing for the first 4 devices in the taper



COMMON PROBLEMS

Inadequate longitudinal spacing

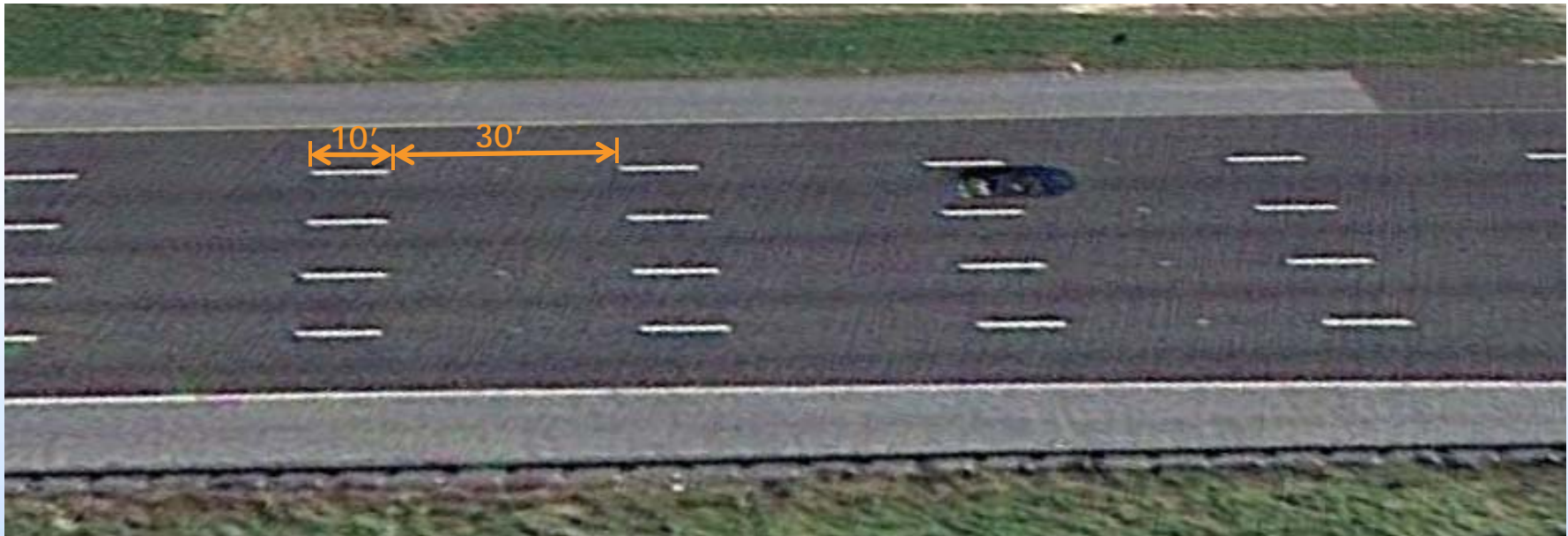


I-95 Sign Structure Inspection



■ Line lengths

- Broken (long) lines: 10-ft line / 30-ft gap
- Dotted (short) lines
 - Interstates, expressways freeways: 3-ft line / 9-ft gap
 - All other roads: 2-ft line / 6-ft gap



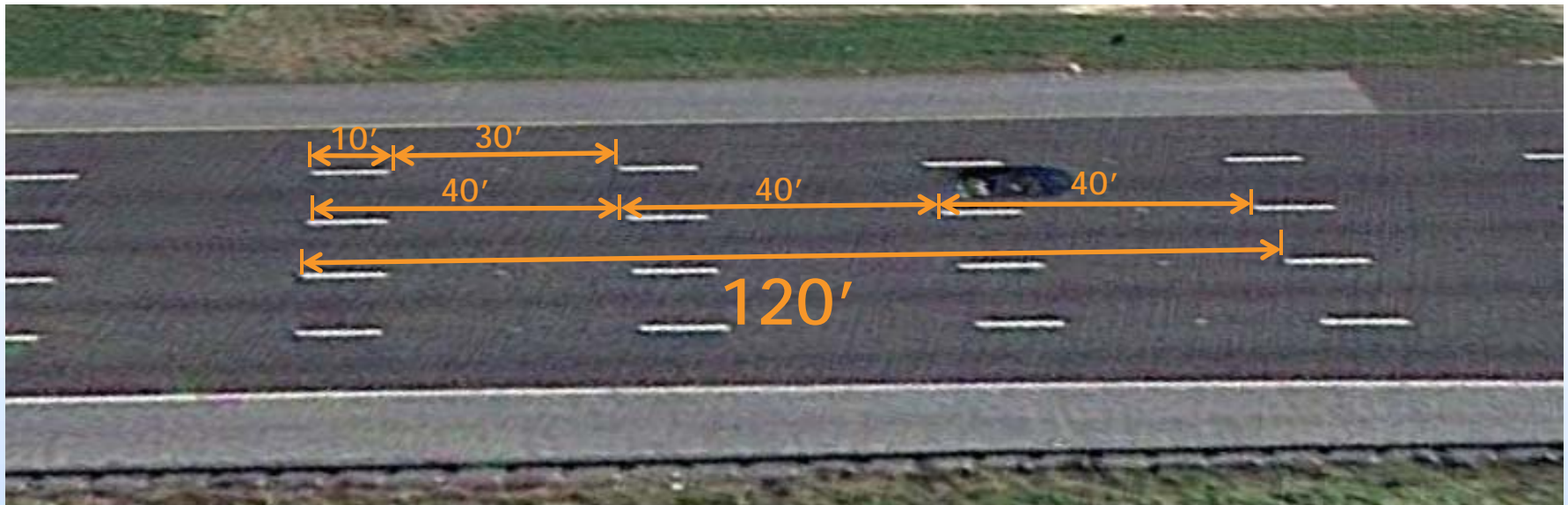
Field Measurement Tip

Exercise

$$\# \text{ of lines} = \frac{\text{Distance (ft)}}{\text{Line length (ft)} \times 4}$$

How many lines do you count to measure 120 feet along an interstate?

$$\# \text{ of lines} = \frac{120 \text{ ft}}{10 \text{ ft} \times 4} = 3 \text{ lines}$$





Group Exercises