FDM 11-55-1 Boat Ramps

May 15, 2019

1.1 Site Layout

The layout of facilities such as access roads, parking lots, ramps, piers, etc., will depend greatly on the size, shape, and contour of the site, and on the location of existing vegetations. Each case will be different, but some general guides can be given.

One of the most desirable attributes of a site is its natural beauty. Ramps should be located and designed so as to blend in with and maintain the natural beauty of the shoreline. Parking lots should be set into the landscape so as not to disrupt it. Existing trees and shrubs should be preserved if at all possible. Before deciding to retain a tree, however, consideration should be given to the length of its remaining lifespan. Generally, protective islands can be employed to retain trees and shrubs in parking lots. It is not generally practical to plant or retain trees without these islands, because they are frequently hit by automobiles. Native trees or shrubs retained or planted along the shore, between the ramp or parking lot and other properties, and between the parking lot and any roadways that may be nearby will enhance the natural beauty of the access site and aid in controlling erosion.

It is recommended that a buffer strip of trees at least 40 feet wide be used between any parking lot and the shore (see Attachment 1.3 and Attachment 1.4).

In locating parking lots, sufficient room should be provided for future expansion. A typical method of doing this is shown in Attachment 1.1. In general, there should be no more than one car-trailer stall per ten acres of water to be served by the site. The aisle serving automobile and trailer parking should be aligned as straight as possible with the ramp to reduce the amount of turning required in backing up the rig. If this is not possible, the ramp should be offset to the left of the aisle, as one faces the lake. In this way, the driver may back down the ramp while viewing the maneuver from the operator side of the car rather than from the blind side. When backing around corners is required, the corners should not turn more than 90 degrees. In placing the parking lot and ramp on the site, both should be centered as much as possible to provide an equal buffer zone for each adjacent property owner. Some typical layouts of access points are shown in Attachment 1.3 and Attachment 1.4.

1.2 Launching Ramps

A typical plan and profile view and typical cross sections of a launching ramp are depicted in Attachment 1.1 and Attachment 1.2, respectively. Several items are worth noting here.

For grades more than 15 percent, it is difficult to obtain good traction on wet ramps; therefore, ramp grades should not exceed 15 percent. Desirably they should be at least ten percent or greater, especially for shorter boats. To aid in keeping the upper portion of the ramp as dry as possible, grades on the approach road or parking lot just above the ramp may be warped to prevent storm water from running down the ramp.

Quite often fill slopes, especially steep ones with light soils, will erode in heavy rains. As noted in Attachment 1.2, this can be minimized by inverting the ramp crown to eliminate runoff from the approach roadway. While this is contradictory to the previously mentioned consideration of keeping the water off the ramp, it should take precedence where erosion is a potentially serious problem. In some cases, riprap or a similar type of protection can be provided at the toe or side of the ramp to prevent erosion.

In most cases it is advisable to surface the ramp and the ramp approach. The surface may consist entirely of coarse gravel, but a combination of P.C. concrete planking on the ramp and bituminous concrete on the approach is preferred. Bituminous concrete surfacing should not extend into the water but should end where the P.C. concrete planking begins. Details for P.C. concrete plank are given in Attachment 1.2. These details outline the dimensional and material characteristics of the preferred plank. However, where these are not readily available, or a cost savings could be affected, comparable planks may be used at the designer's discretion.

Base course requirements are shown in the typical cross sections in Attachment 1.2. If the ramp is not surfaced, it is important to use a coarse material (maximum aggregate size of two inches) to prevent it from becoming too slippery when wet.

Piers should be provided where adequate maintenance is available and where ramp usage warrants them. The recommended placement of a pier with respect to a ramp is shown in Attachment 1.1. Where a high degree of resiliency is desired, wooden Piers are best. Details for two types of simple wooden piers (permanent

installation) are given in Attachment 1.2. Where ice damage is the primary consideration, a removable pier is recommended. Any of the various commercially sold floating piers with either a steel or wooden treadway would be best in this instance, but a semi-permanent pier with removable supports and deck could be employed also. Floating piers can also be used to good advantage where water levels fluctuate greatly. Cleats and padding should be added to piers to protect the boats.

Ramps should be provided on the basis of approximately one per 20 parking spaces. The optimum width of top for a single-lane ramp is about 16 feet. This will permit the use of the normal 10-foot concrete plank with 3-foot gravel shoulders on each side. When a pier is included, this could be reduced to 14 feet as shown in Attachment 1.1, with a 3 feet shoulder on one side and a one-foot shoulder between the plank and the pier. When multiple installations are required, the recommended method is to build a series of single-lane ramps side by side with piers separating them in the manner depicted in Attachment 1.1. For the most part piers can then be used to service two ramps.

1.3 Parking Lots

It is preferable to pave parking lots whenever feasible, although gravel surfaces have proven satisfactory. The planting or retention of native trees and shrubs in the parking lot is optional but is very much preferred. Plantings that are susceptible to damage by turning vehicles should be protected with posts or enclosed with islands formed by a concrete curb at least six inches high. On a surfaced lot where plantings are omitted, required island areas can be adequately delineated with paint. Where there is a single row of car-trailer parking, it may be desirable to omit bumper blocks and permit the rigs to pull out the front of the parking stall; otherwise, bumper curbs of any acceptable material are recommended for delineating the front of vehicle parking spaces. Plastic and fiberglass curbs have been used but are not durable enough to withstand vehicle loading. Wood and concrete curbs are preferred. Since parking stalls cannot be easily delineated on gravel lots, their sizing and arrangement are more difficult to plan for. Somewhat wider stalls may be necessary under these conditions.

Desirable parking angles, aisle widths, and turning radii are all depicted in Attachment 1.1. An automobile requires a 10' x 20' parking space and an auto-trailer-boat combination requires a 10' x 40' area.

1.4 Miscellaneous Design

When practical, toilet facilities, picnic tables, grills, trash containers, and drinking facilities should be included as part of the access site improvement, especially if the site is remote from other such facilities. This should be conditioned, however, on the existence of adequate space and maintenance services. Toilet facilities are particularly desirable on many sites and possibly necessary on heavily used ones. In planning for them, a review should be made of DNR and Department of Health regulations.

Some projects will require only very short access roads. When longer ones are required, typical cross sections should be prepared to show the applicable significant requirements of the access roads. An example of a typical access road cross section is given in Attachment 1.2.

Since many of the items of work are not covered by the Standard Specifications, it will be necessary to include the description of work in the Special Provisions, listed as 90000 bid items. Some examples are Grade and Shape Parking lot, Grade and Shape Access Road, Grade and Shape Ramp, Install Concrete Ramp and Pier, Install Bumper Blocks, etc.

LIST OF ATTACHMENTS

Attachment 1.1	Boat Ramp Details
Attachment 1.2	Pier Details
Attachment 1.3	Boat Ramp Example Parking Layouts
Attachment 1.4	Boat Ramp Example Parking Layouts

FDM 11-55-3 Timber Management

June 18, 1999

WisDOT is committed to the preservation or proper management of trees within the highway right-of-way. As such, the designer is encouraged to regard the forest/timber as a resource having both aesthetic and commercial value.

Aesthetically, the existing trees and vegetation present an opportunity and basis for sculpting a pleasing and efficiently maintainable roadside. In this regard, the landscape architects in the Bureau of Highway Operations should be consulted.

When new right of way is acquired, the seller is compensated for the value of the marketable timber on that

property. The Department expects to recover that value in some form, nominally in the contractor's competitive bid. Unless otherwise specified in DOT contracts, the merchantable timber removed in clearing the right of way becomes the property of the contractor. The contractor is required to make the timber available for commercial or fuel use before disposing by other means. Contractors will generally make a good effort to market the timber and give consideration to anticipated revenue in preparation of their bid.

However, timber management in the form of advanced timber sale by the Department should be considered. This requires that right of way acquisition be completed sufficiently in advance of construction to allow for the sale and harvest; and that there be a desirable species of timber in sufficient concentration to be attractive to logging contractors.

Advance marketing of timber assures that the resource is properly utilized and, if properly undertaken, may expedite the construction contractor's operations. Active management also provides a response to the public, which occasionally perceives clearing operations as a waste of valuable resources.

FDM 11-55-5 Retaining Walls

March 28, 2014

5.1 General

Retaining structures are used to hold back earth where an abrupt change in ground elevation is required. They are useful in cases of restricted right-of-way or where existing features must be avoided.

The Bridge Manual (https://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnslt-rsrces/strct/bridge-manual.aspx) contains guidance on all aspects of incorporating a retaining wall into a highway project. It is important that the designer be familiar with this guidance. That guidance will not be duplicated here, but will be briefly described:

Chapter 2 - *General*.

Section 2.5 (Bridge Numbers) shows the criteria for assigning structure numbers. Retaining walls receive R numbers which are assigned by the region in the same manner as bridge numbers. Only retaining walls with R numbers require structure survey reports. These are prepared using the Separation Structure Survey form and sent to the Structures Design Section. Also, as a rule, all retaining walls with R numbers will require a geotechnical analysis.

Chapter 14 - *Retaining Walls*.

Section 14.1.1.1 (Wall Numbering System) states the criteria for assigning an R number to a retaining wall.

Section 14.2 (Wall Types) lists the proprietary and non- proprietary wall systems considered for use on WisDOT projects.

Section 14.3 (Wall Selection Criteria) and Section 14.15 (Construction Documents) describe the process for selecting a suitable wall system for a given wall location and for incorporating the design for that wall into the construction contract documents respectively.

WisDOT may provide a complete design of one of the following types of walls on a project:

- Cast-in-place walls
- Gabion walls
- Post and panel walls
- Sheet piling walls

For a proprietary wall system (except as described below under "Minor Retaining Wall), WisDOT will provide a conceptual design including location (horizontal and vertical). The wall supplier is then responsible for the structural design and furnishing of complete design plans. Only one wall system shall be specified from the list of suitable systems.

All proprietary wall systems must be pre-approved by the Bureau of Structures (BOS) prior to being considered or used on WisDOT projects. Design all systems in accordance with the procedure specified by the WisDOT Bridge Manual and the appropriate Standardized Special Provisions (STSP 532-030 through 532-035, Item 90031) or Special Provisions (refer to BOS website) must be inserted into the contract. See the Approved Products List for pre-approval wall systems.

For proprietary walls (except as described below under "Minor Retaining Wall") BOS is responsible for reviewing the structural aspects of the design and construction plans provided by the wall company before construction can begin. Note that the structural design of proprietary wall systems is the responsibility of the wall supplier

(vendor).

Within 25 days after the award of the contract, the contractor must provide the region project engineer with the name of the vendor who will be supplying the proprietary wall system. A wall submittal package shall be submitted electronically to the project engineer and BOS no later than 30 days prior to beginning construction of the wall.

WisDOT will consider cost reduction incentive (CRI) proposals per the WisDOT Standard Specifications, provided the proposal is equivalent both functionally and aesthetically and does not violate any usage restrictions as stated in the WisDOT Bridge Manual.

Wall systems which are designed in compliance with the procedures specified by the WisDOT Bridge Manual are considered functionally equivalent. Aesthetic equivalence may vary from project to project because of public perception and site specifics and can best be determined by the designer involved in the project. See Chapter 14 of the WisDOT Bridge Manual for more details.

Bid each wall separately by the type of wall and either the R-X-XXX number or the sta.- sta. Limits, LT or RT. Include each wall in a list on the plan's miscellaneous quantity sheets.

Note: All retaining walls assigned an R number (such as R-XX-XXXX) are to be included in the 8.X sheet section of the plan set. Submit preliminary plans, final plans and shop drawings to BOS for review and acceptance.

5.2 Minor Retaining Wall

A "Minor Retaining Wall" is a proprietary MSE wall with a modular block face that is less than 5.5 feet tall or a proprietary modular block gravity wall that is less than 4.0 feet tall as measured from the bottom of wall or top of the leveling pad to the top of the wall.

Minor retaining wall details are to be included in the 2.X sheet section of the plan set and quantities in the 3.X sheet sections of the plan set under Miscellaneous Quantities". The minimum required details to be included in a minor retaining wall plan include: a plan view layout, an elevation view, estimated soil parameters, and a typical cross section view of the wall. See BOS LRFD Standard Detail Drawing 14.03 for a sample plan and WisDOT Bridge Manual 14.15.2 Special Provisions for bid items. This information constitutes a minor retaining wall plan.

Note: "Minor Retaining Walls" are not intended to support vehicle traffic or slopes equal to or steeper than 2.5H:1V. Additionally, tiered walls are not considered "Minor Retaining Walls" and should be assigned a structure number. In most cases, a geotechnical analysis is not required for "Minor Retaining Walls"; however, it is the designer's responsibility to determine if an analysis is required. Contact the BOS region liaison, regional soils engineer, or Bureau of Technical Services Geotechnical Unit for more information. Submit shop drawings to BOS for review and acceptance.

5.3 Barriers on Top of Retaining Walls

When designing a retaining wall, determine if vehicles, bicycles, pedestrians or children are likely to be present near the top of the wall. Install a barrier at the top of any wall which is over 1 foot tall if the top of the wall is to be adjacent to a sidewalk, trail, parking lot or stairway landing. Walls located farther from human or vehicular activity may be higher before a barrier is considered necessary. In any case, provide a barrier if it is determined to be necessary, regardless of the height of the wall.

The barrier on top of a wall could be a fence, beam guard, or a railing. Coordinate the selection, location and installation details of a proposed barrier with the structural designer. Consider aesthetics of any barrier, especially in urban areas where the wall and barrier are located adjacent to private property.

5.4 Right-of-Way Requirements

All segments of a retaining wall system must be under the control of WisDOT. This includes the area behind a MSE type wall containing the soil reinforcing elements. This area is considered part of the wall. Do not allow permanent improvements, including utility construction, in this area.

Fee simple purchase of the right of way is the best option. A permanent easement may be used, but this is not recommended. If sufficient right of way cannot be obtained for a particular type of wall, then specify a different type of wall.

Mature trees or structures on private property can also affect the choice of wall type. Wall types having tie backs may require clearing vegetation that would affect adjacent properties. Also, consider buildings that are near the right of way that could be undermined.

Sometimes a right-of-way estimate is needed before the wall type is selected. In these cases, estimate the R/W need at 6 feet from the back of the proposed wall, or use the height of the wall, whichever is greater. This

estimate is for planning purposes only. The exact distance must be determined after a geo-technical investigation is completed. This investigation may reveal the need for even more right-of-way at the site.

FDM 11-55-10 Cattle Pass Design

August 17, 2020

10.1 General

A stockpass is defined as any structure which allows domestic animals to cross a highway without interfering with traffic. In Wisconsin, the applicable domestic animal population ranges in size from sheep to llama to buffalo. While the general principles of this policy are applicable to all livestock, the policy will be directed and referenced to cattle and cattle passes.

A cattle pass is generally considered to be either a land service facility or a highway service facility. The land service facility is for the benefit of a business or non-public land owner, whereas the highway service facility benefits highway users. FHWA generally considers a cattle pass to be a land service facility; therefore, it is up to the state to document that a proposed cattle pass is for the benefit of the traveling public.

Public funds designated for the improvement of highways are limited to that purpose. Highway funds used for the installation of a cattle pass and related appurtenances on the highway right of way must be in the public interest and for the benefit of highway users. The benefits accruing to the landowner or occupant whose stock uses these highway service facilities are considered incidental. A landowner may request that the Department provide a cattle pass for his convenience or safety (i.e., a land service facility). In such instance, the Department can reasonably recognize that any installation results in some benefit to the highway user (although likely not sufficient to justify the total cost of the installation). Highway funds could therefore participate to the limit of public benefit perceived, and the remaining cost would be the responsibility of the requester.

Refer to FDM 11-45-30 for the definition of hazardous cross drain or cattle pass, treatment options, and warrants for various treatment options.

10.2 Criteria

Past, present, and potential future use of the lands may demonstrate the need to provide for or perpetuate the circulation of stock and therefore the need to provide for the safety and convenience of the highway user. Designers should meet with stock owners to discuss their need for and willingness to use the facility as well as any restrictions which require that the facility be used.

New construction, or reconstruction involving grading, allow the opportunity to design in safety features in a more cost-effective manner. A retrofit situation, which would be initiated in response to a changed land use or evolving hazard, will likely be costlier and hence more difficult to justify, and may also probably provide less-than-ideal service.

10.2.1 On New Grading Sections

Highways warranting design criteria A2 or above should provide cattle passes at locations where herds of 20 or more will cross the highway on a regular (daily) basis.

On highways of lower volumes or function, cattle passes may be considered if sight distance limitations make an at-grade herd crossing hazardous or if herd size causes lengthy delays to highway traffic. These installations must be justified and supported on the basis of cost effectiveness and safety.

The separation of livestock from designated freeways and expressways is always warranted regardless of conditions, by definition of the access. This restriction should be recognized during the real estate phase of project development, preferably through payment of damages or whole takings but also by land exchanges. A cattle pass on this type of facility would likely be of such length and size and resultant cost as to justify a change in land use.

Designers should note that if a cattle pass is provided as a real estate consideration, it becomes part of the value of the property and therefore cannot be taken away without compensation. For example, if lands are taken with payment based on acreage taken, and the remnant has diminished value due to severance, and that diminished value is not compensated with dollars but rather restored to value by a cattle pass, then the cattle pass becomes a compensable part of that property (until such time as ownership and use of the remnant changes or becomes unrelated to the rest of the property.)

10.2.2 Non-grading Situations:

The Department may respond to a request from an abutting owner for a cattle pass in the same manner as any other land service facility request.

Proper attention to visibility, adjusting the location of an at-grade crossing, and the use of advance warning

signs are often the most cost-effective and feasible treatment.

10.2.3 Documentation

Prior to committing resources to the design and construction of a cattle pass, the “Documentation for Cattle pass” worksheet (Attachment 10.1) should be completed, accepted by the designated region authority, and filed both in region and central office project files. The ‘Basis for Consideration’ portion of the worksheet is meant to identify such items as a private request, an identified safety problem, new construction of a high-volume facility, combination of the above or other. Note that the worksheet may also be used to document the decision not to include a considered, or to turn down a requested, cattle pass. The inclusion and location of each cattle pass should be discussed in the “Unique Features” section of the Design Study Report.

10.3 Design Guidelines

Cattle passes, due to lower minimum size requirements, are expensive to construct and shield. The most expensive cattle passes are those that are not used due to inadequate design, or subsequently abandoned due to avoidable deterioration. Therefore, if a cattle pass is warranted, it should be sized and located to be attractive for use and should be designed to avoid bog ends.

In most cases a structure should be built to accommodate either livestock or drainage, not both. In some cases, however, a combined facility may be unavoidable. This includes river crossings being lengthened to accommodate a stock path on the bank or in the case of a dry run or overflow structure. When a combined facility is being considered, it should be designed to carry water only when runoff exceeds that expected from a 10-year storm.

The cattle pass and its approach path should never be placed at a drainage low point; there must always be drainage away from the facility. In addition, aprons or paved walkways will aid in preventing bogs or mudholes. Placement and drainage influence the attitude of the user; a stockowner will make a greater effort to use a well-drained structure than a poorly drained one. Bogs resulting from poor drainage conditions can become breeding grounds for disease, a factor which is critical to dairy farmers.

Placement of the cattle pass as high up in a fill section as possible, considering cover and clearzone, will result in the shortest length.

The longer a cattle pass is in relation to its size, the more hesitant stock are to pass through it. For that reason, the opening size may be varied, depending on cattle pass length and size of herd. A lower minimum usable opening of 4' x 6' may be acceptable for lengths up to 75 feet. Beyond that, sizes of 6'x 6' to a practical maximum of 7' x 7' can be considered, the larger for lengths in excess of 150 feet passing herds of more than 70 head.

The cattle pass should always have a lower minimum gradient of 1%, desirable 3%, sloped one way to allow flushing, but not so steep that the stock will slip. Gradients steeper than 5% should be textured.

Fences should be constructed to the highway right of way as part of the facility.

As with the consideration of necessity and location, the design of the facility should be discussed with the stockowner.

10.4 Other Considerations

As part of the highway, the physical facility on the right of way is maintainable by the state. To that end the installation should be designed, constructed, and maintained so that it is functional and serviceable, with due consideration to minimizing erosion, providing adequate drainage, and with walkways sufficiently stable to permit the passage of the livestock without undue soft and muddy conditions developing on the right of way.

The owner or occupant of the property served shall be required to maintain practical and serviceable fences along the stockpath approach with due regard to not impairing surface water drainage or the function of the structure. Such owner or occupant shall also be responsible for cleaning the structure floor and walkway approach.

An understanding of cooperation and responsibilities should be reached and documented for the protection of all concerned. It must be further understood that the state will have the right to gate or remove the facility at such time as it may no longer be needed for livestock operations or if the facility becomes a nuisance.

If the cattle pass is provided at the request of an abutting owner, the basis of participation should be included in the above agreement.

Existing cattle passes within a proposed improvement project should be reviewed to determine usage and condition. If it is determined that a stockpass is unused, the property owner is informed by letter that the department proposes to either abandon or remove it. The property owner should be allowed ample time to

respond. A desire on the part of the property owner to perpetuate the cattle pass should carry with it some tangible evidence of legitimate future need. If no response is received from the property owner, it is assumed they have no further interest in the facility. Experience would suggest that a second notification effort is desirable to avoid misunderstanding.

If the cattle pass is to be perpetuated it should be evaluated for structural condition, improvements if needed, or replacement.

If no longer needed as a cattle pass, its condition and effect on safety is evaluated. If in good condition, it is normally abandoned by removing the end sections and filling with earth. If in poor structural condition, it must be removed. In instances where the stockpass also serves as a drainage facility, determination is made as to the cost effectiveness of retaining it for that purpose, or replacing it with a smaller, safer drainage pipe.

It is currently accepted that the presence or absence of a cattle pass has little bearing on the value of farm property as this item is only of value to a single use of the land. However, each cattle pass should be reviewed to determine that any action by the Department is appropriate, fair to the property owner, and to the benefit of the traveling public.

LIST OF ATTACHMENTS

Attachment 10.1 Documentation for Cattle Pass

FDM 11-55-20 Overhead Sign Structures *February 15, 2024*

20.1 General

20.1.1 Introduction

Overhead Sign Structures (OSS) are structural supports for mounting signs over roadways. OSS span configurations include cantilever and butterfly structures with a single vertical support post and full-span structures with vertical supports at each end of the structure. OSS superstructure types include monotube, (one horizontally spanning member), 2-chord planar trusses, and 4-chord space trusses. The superstructure for an OSS defines the portion of the structure above the foundation and includes the anchor rods. See Attachment 20.1 for a graphical description of the various types. All OSS are required to be structurally designed per the applicable provisions of the AASHTO LRFD Design Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (LRFDLTS-1) and the Wisconsin Department of Transportation (WisDOT) Bridge Manual (BM). All OSS are assigned a structure number and inventoried in the WisDOT Highway Structures Information (HSI) System.

Roadside sign supports are ground mounted posts supporting signs adjacent to roadways. Roadside sign supports are not considered OSS, are not assigned a structure number nor inventoried in the HSI system.

20.2 OSS Selection and Usage Criteria

20.2.1 General

The following criteria and guidance are used for determining the sign structure type to be used in a given situation. In general, the selection is determined by the following controlling criteria:

- Required Cantilever Arm or Full-Span Length
- Maximum Sign Panel Height
- Maximum Total Sign Panel Area
- Maximum DMS Dimensions
- Maximum DMS Weight

Based on the above parameters, the smallest sign structure type for the controlling parameters is selected for use at a given location. Use the figures in 20.2.3 (static signs) and 20.2.4 (DMS) to determine which sign structure type is appropriate. The sign structure types are arranged from most economical at the top to least economical at the bottom. Once the OSS type is selected, making note of whether it is *Contractor Designed*, *Standard Design* or *Non-standard Design*, follow the appropriate design and plan submittal process discussed in section 20.3. For Contractor Designed OSS, figure 20.2.5 is used to match the standard foundation and superstructure.

Due to the variability of factors that can influence the selection of structure type, designers are encouraged to contact the WisDOT Bureau of Structures (BOS) Design Section for further assistance when structural layout geometry, sign sizes or total sign area are in question or to address any unique or special situations. See section 20.4.3 for examples of unique situations.

20.2.2 Selection Figures

Figures 20.2.3, 20.2.4 and 20.2.5 were created to assist in selection of OSS. The sign areas shown in the figures apply to overhead signs only. Signs panels mounted on the structure posts are limited to a maximum of 54" wide x 96" tall (36 square feet) mounted 10'-0" from the bottom of sign to the base plate of the post. See Chapter 39.6 Appendix Details of the WisDOT Bridge Manual for details. Sign panels mounted to the structure posts are not included in the areas listed in the following figures.

Standard foundations have been created for all structure types shown in the figures. Standard superstructures are available for butterfly, 4-chord cantilever and 4-chord full span structures. Monotube and 2-chord truss type superstructures are to be designed by the contractor and will match the type selected using figure 20.2.5.

The overall structure height should be checked and is limited to the values shown in the WisDOT Bridge Manual 39.1.5 and 39.1.6. Generally, it is not an issue with typical roadside embankments. Prior to initiating design, contact the Bureau of Structures Design Section for questions regarding OSS selection or if the signage demands warrant a *Non-standard Design*.

20.2.3 Overhead Sign Structure with Static Signs

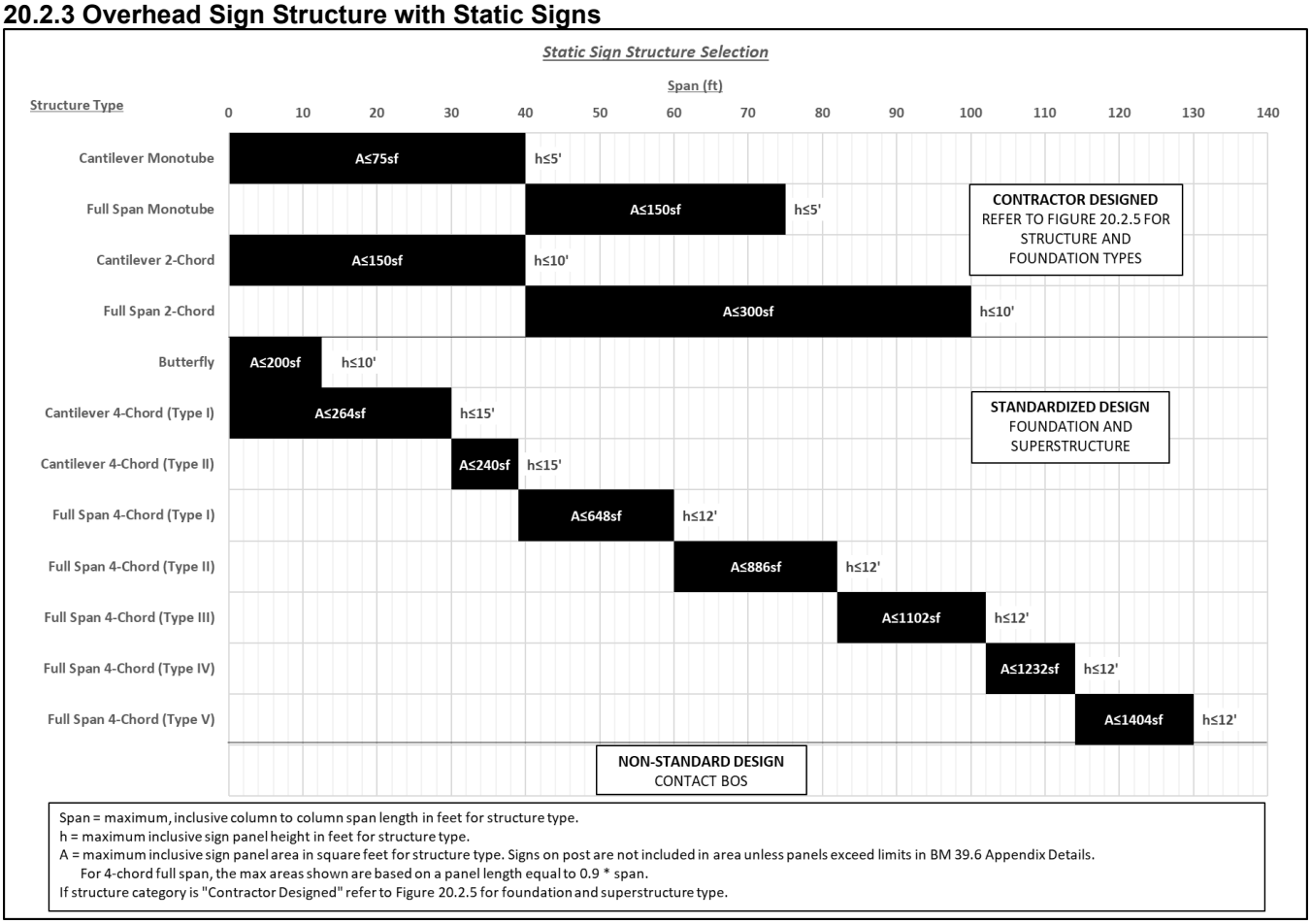

Figure 20.2.3
OSS Type Selection for Static Signs

Notes:

1. An example for sign structure selection using this figure is provided in Attachment 20.2.
2. The sign areas shown for the *Full Span 4-Chord* types are maximums. The actual allowable sign area will be less and is limited to 90% of the span length x max sign height (12') – see Attachment 20.2 example.
3. Standard foundations are included with all *Standard Design*s. Standard foundations are also available for *Contractor Designed* OSS but must be selected using Figure 20.2.5.

4. The overall structure height should be checked and is limited to the values shown in the WisDOT Bridge Manual 39.1.5 and 39.1.6. Generally, it is not an issue with typical roadside embankments.
5. Prior to initiating design, contact the Bureau of Structures Design Section for questions regarding OSS selection or if the signage demands warrant a *Non-standard Design*.

20.2.4 Overhead Sign Structure with Digital Message Signs

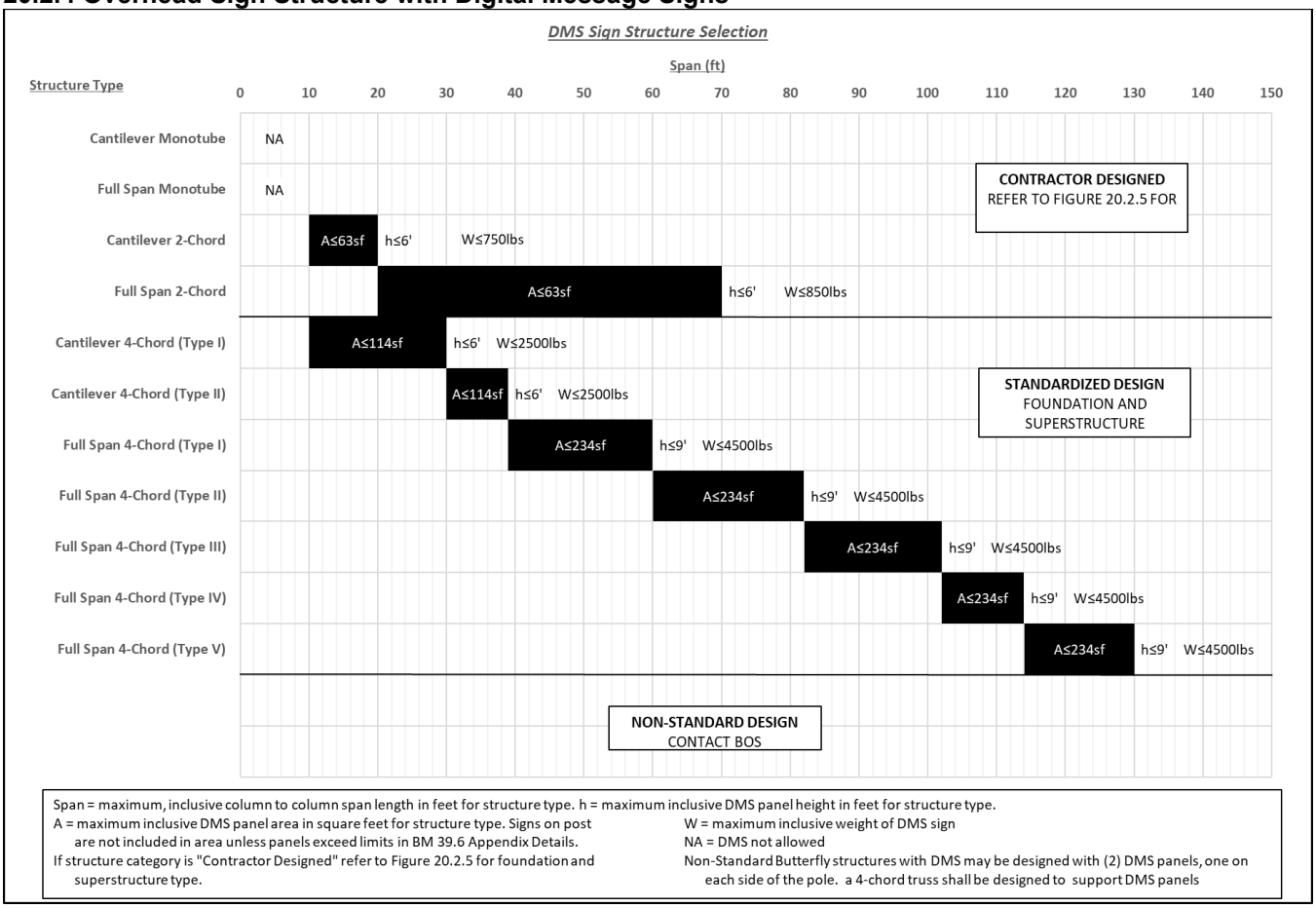

Figure 20.2.4
OSS Type Selection for DMS

Notes:

1. The selection of structure types follows the same process as the example in Attachment 20.2 with the added criteria of the DMS panel weight that must also be checked.
2. Only 2 and 4 chord trusses may be used with DMS panels. If a 2-chord structure is chosen, use figure 20.2.5 to determine the structure type, appropriate types will have “DMS” following the sign heights.
3. If a structure has a combination of static and DMS panels, contact the Bureau of Structures Design Section.

20.2.5 Overhead Sign Structure for Contractor Designed OSS

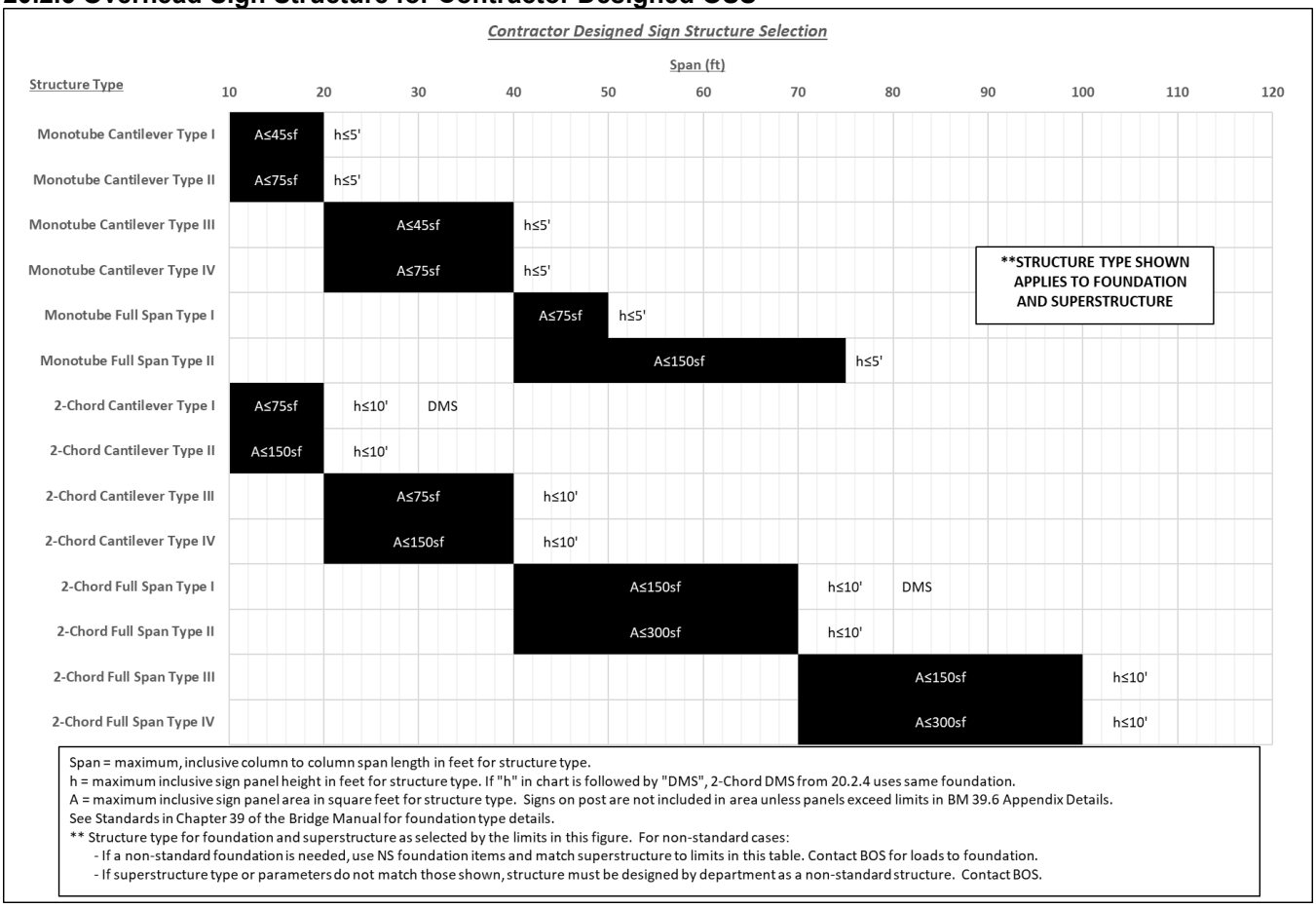

Figure 20.2.5
OSS Type Selection for Contractor Designed OSS

Notes:

1. An example for sign structure selection using this figure is provided in Attachment 20.2.
2. The progression of foundations within each type provide additional capacity to match increased signage demands. Only a single foundation option for each 2-chord OSS type is available for OSS carrying a DMS.

Type (structure)(span)-(design) *Example: a monotube cantilever type III is coded as a Type MC-III*					
STRUCTURE		SPAN		DESIGN	
M	Monotube	C	Cantilever	I	Standard WisDOT designs
T	Two-chord truss	F	Full span	II	
F	Four-chord truss	B	Butterfly	III	
				IV	
				V	
				NS	Non-standard

Figure 20.2.6
Standard Structure and Foundation Type Encoding

20.3 OSS Design and Plan Submittal Process

Identification of the need for a sign structure occurs at the preliminary design phase in conjunction with development of the initial signing plan. Based on the sign requirements for the project, the Region traffic engineer selects the type of sign structure needed, considering the appropriate subsections of 20.2. As most

sign structure types come with standard foundations, the Regional soil engineer should be consulted to verify foundation constructability (see section 20.5 for more information). Regional or consultant staff initiate the design process by requesting a structure number from the Region Ancillary Project Manager, then completing a Grade Separation Structure Survey Report (DT1694), checking "sign structure" on the form, and submitting to the Bureau of Structures via the structure e-submit process.

When submitting the SSR, indicate the type of sign structure in the "preference for structure type" field (e.g. Cantilever Monotube). For those *Contractor Designed* or *Standard Design* OSS types, no supporting documents or additional information is required with the SSR submittal. For non-standard designs, DMS butterfly, bridge mounted type, or for reasons listed in 20.4.3, submit the supporting information (plan and profile, layout, etc.) with the SSR.

The design and plan submittal process depend on the sign structure design type (Contractor, Standard or Non-standard). For Contractor Designed or Standard Design OSS types, without special or unique requirements, the Region or their consultant may prepare final contract plans, utilizing available BOS Standard Design Drawings. Care must be taken to ensure that there are no soil, utility or other conflicts that arise with the placement and foundation type of the given structures. A flow chart illustrating the different processes is shown in Attachment 20.3. Additional information is provided in Section 20.4.

All OSS contract plans are included in the series 8 structure section. Standard Design Drawings and templates for the lead sheets are available on the BOS website. The lead sheets shall provide the following information:

- The assigned structure number (S-XX-XXX).
- The sign sizes and location on the structure as well as their relation to the traffic lanes below.
- The high point of roadway elevation and the top of concrete foundation elevation or the relative difference in elevation between the two.
- The required lower minimum vertical clearance from the high point of the roadway to the low point on the sign/structure. Refer to WisDOT Bridge Manual 39.4.2.3 and FDM 11-35 Attachment 1.8 for more details on lower minimum vertical clearance requirements. Show signs centered vertically on the horizontal arm.
- Horizontal dimensions of the roadway typical section, including cross slopes.
- The location of the structure by station and offset and, if applicable, by highway and crossroad.
- The detail views should depict the correct OSS superstructure type and match the associated OSS pay item.
- For DMS, show the length x width x thickness and weight.

20.4 OSS Design Types

20.4.1 Contractor Designed OSS

These smaller sign structures carry type II directional signs, limited amounts of type I signs and small dynamic message signs (DMS).

Using figures 20.2.3 and 20.2.4, to determine if a sign is to be contractor designed the type is identified using figure 20.2.5 during the design phase. Selection is based on the required sign structure configuration and length, maximum design sign height, and total design sign area to be supported by the structure. Beginning with monotube and moving to 2-chord planar truss OSS, the designer identifies the smallest sign structure type suitable for the intended use. If the range of applicability for any design parameter (cantilever arm or full-span length, maximum sign size, total sign area) is exceeded for the sign structure type under consideration, the designer must check the next larger type with design ranges of applicability that meet or exceed the required values for the intended use.

Things to keep in mind while selecting a structure type in addition to the structure limits are:

- Check the available room at the installation site for the structure foundation. For example, check the proposed foundation diameter against the available room between a curb section and a sidewalk.
- Consider future inspection or maintenance access to the structure, foundation and anchor rods. Will the structure need special equipment or traffic control be needed to inspect or maintain?
- If possible, do not leave large portions of horizontal span "unsigned" with signs only at the ends.
- See FDM 11-35-1 and Chapter 39 of the WisDOT Bridge Manual for design considerations and requirements for vertical clearance.

Bid items for monotube and 2-chord planar truss OSS include structural design and detailing of the anchor rods and superstructures in addition to supplying and erecting these sign structures within the construction contract. Design is typically done by the contractor's sign fabricator / supplier or another party on behalf of the fabricator or supplier. The type of structure is matched to a standard foundation.

The foundation design is **not** the responsibility of the contractor, the contractor only designs the anchor rods and steel structure. See Chapter 39 of the WisDOT Bridge Manual for information regarding the use of standard detail drawings in contract plans.

20.4.2 Standard Designed OSS

Butterfly and 4-chord truss OSS are larger sign structures that are generally used to carry Type I signs with large total sign areas or large DMS and are capable of spanning over multi-lane highways and interstate routes.

Using figures 20.2.3 and 20.2.4, the appropriate standard design OSS is identified during the design phase based on the required sign structure configuration and length, maximum design sign height, and total design sign area to be supported by the structure.

With Standard Design OSS types both the structure and foundation are pre-designed and detailed. See Chapter 39 of the WisDOT Bridge Manual for information regarding the use of standard detail drawings in contract plans.

20.4.3 Non-Standard Designed OSS

A unique design must be provided by Bureau of Structures or by a structural design consultant for all non-standard designs. The following circumstances warrant a non-standard design:

1. The OSS type is Butterfly carrying DMS or Bridge Mounted.
2. The OSS type falls outside the limits of type, span length, sign area, DMS weight, or sign height in figures 20.2.3 and 20.2.4.
3. Region soil engineer advises that subsurface conditions at the site are expected to negatively differ from assumed soil profile and design parameters of standard foundations (e.g. soft soil or shallow bedrock).
4. Unique site constraints (e.g. column or foundation behind MSE wall) or requires the use of concrete column (designed for impact load). Please note that it is possible to use a standard structure on a non-standard foundation. Contact BOS if you have questions regarding these situations.

Contractor Designed OSS superstructures are rarely non-standard if the selection parameters are maintained. There could be a case where a unique foundation is needed (e.g. to reduce the steel column height, site specific soil conditions, structure attached to a bridge pier). In this case, the superstructure would match the respective type shown in figure 20.2.5 and would be designed by the contractor, and the foundation would be non-standard and would be provided by the Bureau of Structures or by a structural design consultant. If the span of a contractor design OSS needs to exceed the standard lengths shown in figure 20.2.5, contact BOS.

When space or other constraints prohibit the use of an overhead sign structure and no practical alternatives exist, signs may be mounted on the side of grade separation bridges crossing over another roadway. These are considered non-standard designs that require individually designed structural mounting brackets to attach the sign to the side of the grade separation bridge. Bridge mounted sign support brackets are assigned a sign structure number and inventoried in the WisDOT HSI system. Refer to Chapter 39 of the WisDOT Bridge Manual for further guidance.

20.5 Subsurface Investigation and Information

Standard foundation designs are available for use with *Contractor Designed* and *Standard Design* OSS types within the OSS Standard Design Drawings. The standard foundation designs are based on conservatively assumed subsurface soil parameters that are intended to underestimate the actual subsurface soil strength at most sites across the state of Wisconsin. No subsurface investigation/information is necessary for any of the sign structures that meet the limitations for allowing the use of WisDOT standard foundations. When weaker soil strength or other conditions such as the presence of near surface bedrock is known, or suspected, appropriate subsurface information is necessary to confirm that soils strength parameters meet or exceed the assumed soil parameters used for the standard foundation designs. If weaker subsurface soil parameters or shallow bedrock are confirmed, an individually designed and detailed foundation is required. The foundation design and plan submittal process would proceed as a non-standard design. Refer to Chapter 39 of the WisDOT Bridge Manual for further guidance on the use of standard OSS foundations, assumed soil parameters, and the individual design of non-standard OSS foundations.

20.6 Roadside Design Guidelines

Provide shielding (e.g. crash cushion or barrier, transitions, end terminals, grading…) for an OSS installation

when the design or off-peak operating speed is 45 mph or greater. Shielding is required even if the sign structure is placed outside the clear zone of the roadway because the consequences of a crash (not only for the individuals in the errant vehicle, but other users of the roadway network and pedestrians) are severe.

If the design or off-peak operating speed are less than 45 mph but are greater than or equal to 35 mph it is optional to provide shielding for sign structures installed outside the clear zone. However, individual site analysis is required. If the design or off-peak operating speed are less than 45 mph but are greater than or equal to 35 mph and the sign structure is within the clear zone, provide shielding unless individual site analysis indicates otherwise.

For design or operation speeds that are less than 35 mph, shielding is not typically required, unless an individual site analysis indicates otherwise. Designers are required to perform an individual site analysis for speeds less than 35 mph.

Individual site analysis includes:

- Review of existing crash data
- Review of the alignment and cross-sectional elements near installation
- Traffic volumes
- Character of traffic
- Impact of installing barrier systems, (e.g. grading required, purchase of R/W, drainage needs…)
- Consequences of not installing barrier system, (e.g. Could the sign fall onto the road or pedestrians, if sign does not fall but is taken out of service, what is the impact to the road network?)

Some examples that would tend to lead designers to install barrier would be:

- Segment of roadway has run-off-road (ROR) flag in metamanager.
- Less than lower minimum alignment or cross-sectional elements exist near the proposed installation.
- Installation is near or in a weave, merge or diverge section of roadway.
- Roadway violates driver expectation (e.g. hidden curves, entrance/exit ramps on left side of roadway).
- Installation is in areas where ROR crashes are more likely to occur (e.g. tapers, outside of curves…).
- High AADT in area of installation (i.e. High AADT increases the probability of a vehicle leaving the roadway).
- Majority of traffic is unfamiliar with the roadway.
- Impact to roadway and users if the overhead sign support was damaged or destroyed.

Some examples that would lead a designer to not install barrier are:

- Not possible to install barrier according to design criteria (e.g. LON would cause the closure of side streets)
- Accident history does not indicate a problem with ROR accidents.
- No less than lower minimum features are present
- Installation is on tangent section.
- Low AADT

Document decisions to provide or not to provide barrier or crash cushions at a given location. Provide barrier systems with appropriate Length of Need (LON), adequate deflection distance from barrier to front face of sign bridge support, appropriate end terminals and grading. Document why it is not possible to provide adequate LON, deflection distance, end terminals, and grading. Documentation is to include what other alternatives were reviewed, and why a particular alternative was selected.

See FDM 11-15-1 and FDM 11-20-1 for guidance on clear zones. See FDM 11-45 for guidance on barrier systems. FDM 15-1 Attachment 5.14, page 1 shows a sample permanent signing plan sheet for freeways and ramps. See Chapter 39 of the WisDOT Bridge Manual contains design examples for foundation cap and drilled shaft interface and concrete column for vehicle impacts.

LIST OF ATTACHMENTS

Attachment 20.1	WisDOT Overhead Sign Structure Types
Attachment 20.2	Overhead Sign Structure Selection Examples
Attachment 20.3	Overhead Sign Structure Design Process Flow Chart

FDM 11-55-25 Ramp Gates

February 15, 2023

25.1 Background

To enable the physical closure of freeway on-ramps, the Wisconsin Department of Transportation (WisDOT) has installed ramp gates at numerous Interstate interchanges and on-ramps for selected highways around the state. Ramp gates utilize a mechanical gate arm that are manually lowered to provide a physical barrier prohibiting motorists from accessing the Interstate and highways. The gates are used as a safety feature to help mitigate severe congestion caused by incidents or severe weather. The gates restrict access to the roadway and allow first responders to work in a safer environment while clearing an incident. This also provides for the quicker clearance of an incident and reduces the possibility of secondary incidents.

The ramp gate design and the details were originally developed by the State of Wyoming. This gate can be installed within the clear zone because the base is designed as a breakaway component and the above ground components are designed to rotate over the vehicle during an impact.

25.2 Deployment and General Considerations

The situations in which closure methods are to be applied are summarized below:

- *Barricades* - Type III barricades are recommended for deployment on entrance ramps along interstate corridors with an average annual daily traffic (AADT) along the mainline of less than 45,000. These barricades are to be safely stored within the freeway interchange when practical. Ramp closure barricade rack(s) (refer to STSP 662-015) shall be included for storing the barricades.
- *Ramp Gates* - are recommended for deployment on freeway entrance ramps along interstate corridors with the mainline AADT of more than 35,000 and criteria of the 'Other Deciding Factors' section. These gates are manually operated.

The overlap in AADT ranges is intended to allow for flexibility in selecting which closure method to implement at a location. Deployment recommendations are based on AADT, crash history and Law Enforcement input; however, other factors should be evaluated before prescribing the gate treatment.

Other Deciding Factors:

- *Site-Specific Conditions* - Site-specific conditions need to be considered when selecting a closure method. Some issues to consider include availability of a safe barricade storage location, expected personnel availability during a road closure event, crash frequency in the area, geometric deficiencies, sight distance and expected frequency of use. Also, some locations may require a combination of gates and barricades. For example, at signalized intersections a gate may be used to close the entrance of the ramp and barricades may be used to close left turn lanes that approach the ramp. In addition, closure devices must be placed in locations that do not trap vehicles. Engineering judgment must be exercised when selecting a closure method.
- *Corridor Consistency* - In some locations the AADT guidelines may not be followed to select a closure method that maintains consistency within a corridor.
- *Barricade Storage* - Barricades should be pre-positioned on-site when practical. Consideration must be given to placement outside of the clear zone, right of way availability, site topography, snow storage needs, and locations that do not obstruct sight lines. Steps should also be taken to limit weathering of the barricades' reflective sheeting.
- *Maintenance* - A maintenance plan must be followed to inspect barricades and ramp gates to ensure proper functionality. Barricades should be inspected a minimum of once per year, prior to the winter driving season. Special attention should be given to the condition of barricade stands and retroreflective barricade/sign sheeting. Ramp closure gates and associated signing should be inspected a minimum of twice per year, prior to and after the winter driving season. Maintenance should follow the procedures outlined in the *Wisconsin Ramp Gates Maintenance and Inspection* graphic (refer to Attachment 25.1). A maintenance log for ramp gates should be reported to the regional maintenance coordinator (Attachment 25.2).
- *Stakeholders* – Consider input and feedback from the stakeholders in the location, including law enforcement, fire service personnel, and other state/county/local responders, who are involved in WisDOT's Traffic Incident Management Enhancement (TIME) Program.

Additional Considerations:

- *System to System Interchanges* - System to system interchanges should be closed with multiple

devices brought to the site in accordance with procedures outlined in the MUTCD. Drop down gates and stored on-site barricades are generally not feasible to close system to system interchanges because of the higher vehicle speeds and resulting roadway geometries, both of which require greater closure visibility than a gate or small number of barricades can provide.

- *Roundabouts* - Roundabouts are generally amenable to closure with gates or barricades.
- *Signage* - Properly placed signs are an important tool in notifying the public of closures. Flip down signs should be installed in conjunction with drop down gates. For especially high-volume areas, these signs could be augmented with active warning flashers to be made more effective.

25.3 Guideline Compliance Documentation

If it is not feasible to follow the gate placement guidelines, document why a location was selected, what alternatives were reviewed and why an alternative was selected.

25.3.1 Gate Placement

Placing gates is a complex design process that must consider many, often competing, factors. These factors are listed below in relative order of importance and are discussed in more detail in the remainder of this section.

- Grading
- Curb and Gutter
- Gate Knockdowns
- Vehicle Trapping
- Single vs. Multiple Gates
- Adjacent Roadway Features
- Pedestrians
- Sightlines and Driver Reaction Time
- Control Boxes and Power Supplies

25.3.2 Grading

Breakaway designs require the vehicle to properly engage the pole assembly. Proper engagement is dependent on the vehicle's bumper being close to its normal position during impact, and the mounting hardware/base being properly traversable. Place gates in locations that adhere to the following guidance:

Approach Grading:

Provide grading that is 10:1 or flatter within the approach grading area (refer to Figure 25.1).

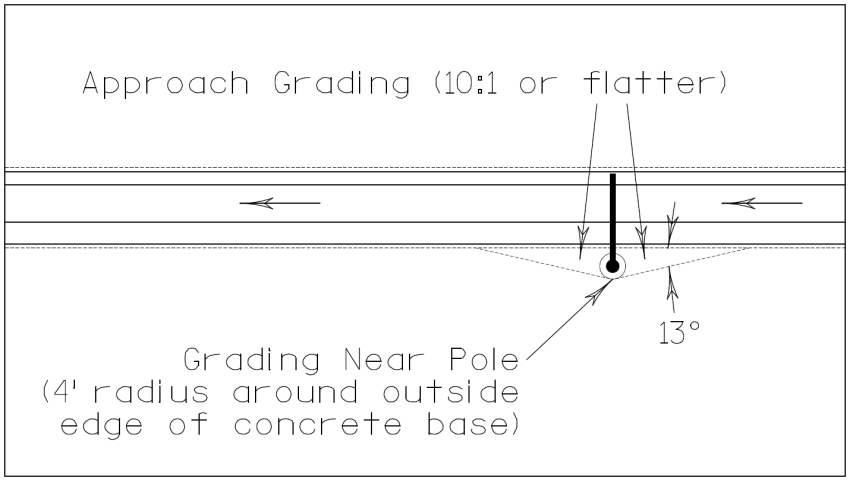

***Figure 25.1* Horizontal Grading at Ramp Gate**

Grading less than 10:1 may not allow for proper activation of the breakaway features of the pole or may cause the pole to contact the roof of the vehicle after initial impact. Figure 25.2 shows failure to properly break away when a vehicle did not engage a pole at the correct height.

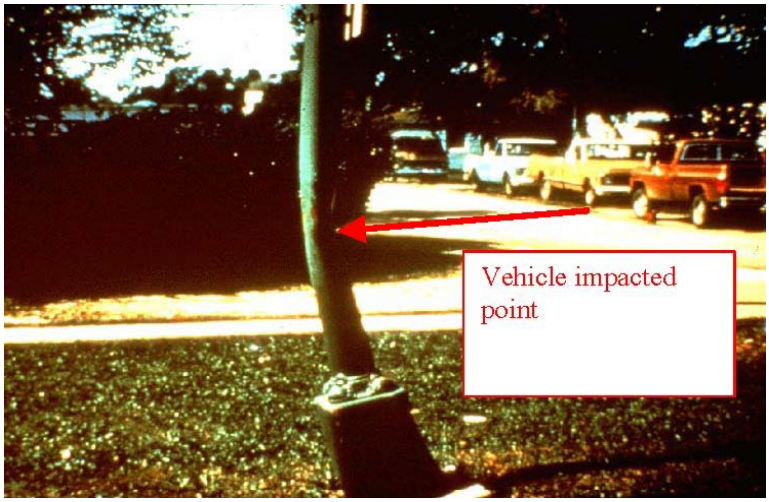

***Figure 25.2** Improper Grading Causing Pole Not Breakaway* [1]

Vertical Grading at Pole:

For a vehicle to effectively traverse the pole mounting hardware or concrete footing, the stub height of the gate's breakaway support is required to be less than 4" on a 5-foot chord (see Figure 25.3). If the stub height is greater than 4" on a 5-foot chord, a vehicle may decelerate too rapidly or be tripped by the stub. Provide 10:1 or flatter grades near the pole to make sure the vehicle does not snag on the stub or concrete footing.

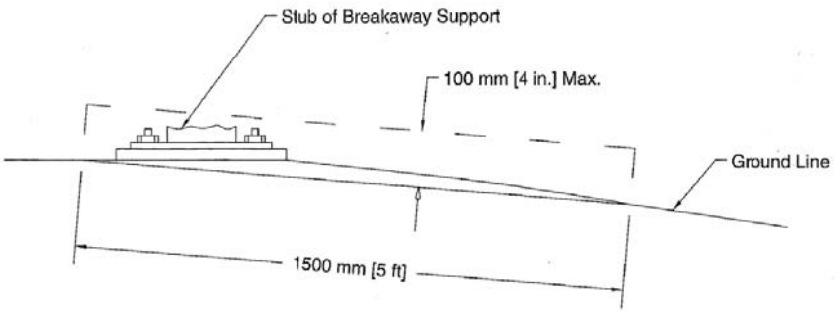

***Figure 25.3** Grading Profile* [2]

Figure 25.4 shows an installation where the concrete footings for a breakaway road sign are too far out of the ground, resulting in a roadside hazard even though the sign has breakaway hardware.

[1] NHI Roadside Design Presentation, 2009

[2] AASHTO Roadside Design Guide, 2006

***Figure 25.4** Improperly Installed Concrete Footing* [3]

25.3.3 Curb and Gutter

After impact with a 6” high barrier curb, it is difficult to predict the vertical trajectory of a vehicle’s bumper. Thus, impact with a curb increases the probability that a vehicle will not engage a ramp closure gate correctly. Crash testing has indicated that a distance of 8’ is needed from the flow line of a curb and gutter to the face of rail so that a vehicle properly engages beam guard [4]. This crash testing serves as a basis for gate placement guidance in the presence of curb and gutter. In the area of approach grading shown in Figure 25.1, ensure the following conditions are met:

- For operating speeds ≥ 35 MPH - three options are recommended:
- Place gate 8’ from the flow line of the ramp curb and gutter (see Figure 25.5)
- Remove curb and replace with mountable curb less than 2” high (driveway entrance curb, per SDD 8d1, less than 2” high is exempt from the 8’ requirement)
- Provide shielding per FDM 11-45
- For operating speeds < 35 MPH - there are no restrictions on the use of curb.

[3] NHI Roadside Design Presentation, 2009

[4] Zhu, L., Reid, J.D., R.K., Lechtenberg, K.A., Brenner, C.D. and Bielenberg, R.W., "Draft Performance Limits for 152-mm (6-inch) High Curb Placed in Advance of the MGS using MASH 08 Vehicles - Part 1: Vehicle-Curb Testing and LS-DYNA Analysis", TRP-03-205-08

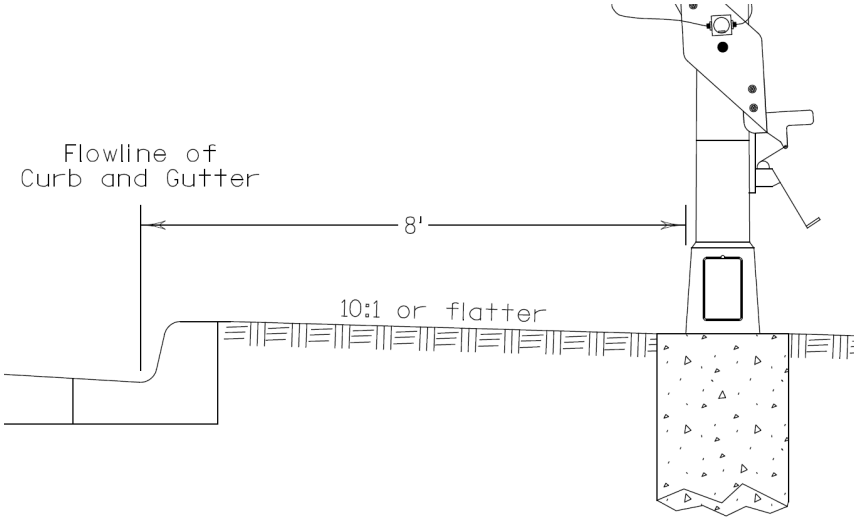

***Figure 25.5* Footing**

25.3.4 Gate Knockdowns

Special considerations should be made regarding the potential for gate knockdowns from errant mainline vehicles and oversize vehicles, especially when the mainline roadway is a designated long truck route. To lessen the chance of a knockdown from an errant mainline vehicle, gates should be located outside the mainline roadway's clear zone. Locating gates at the edge of or outside mainline clear zones will also lessen the chance of an errant mainline vehicle spearing a deployed gate arm.

As previously indicated, place gates 8' from the flow line of a ramp curb and gutter (see Figure 25.5). In locations without curb and gutter, place gates 6' from the edge of ramp pavement (see Figure 25.6). Analysis of long truck turning movements indicates that gates located within the infield of a typical diamond interchange are less likely to be struck by a trailer than gates placed to the outside of the interchange. Thus, consider placing gates within the infield of a typical diamond interchange (see Figure 25.7). Make similar considerations for other types of interchanges.

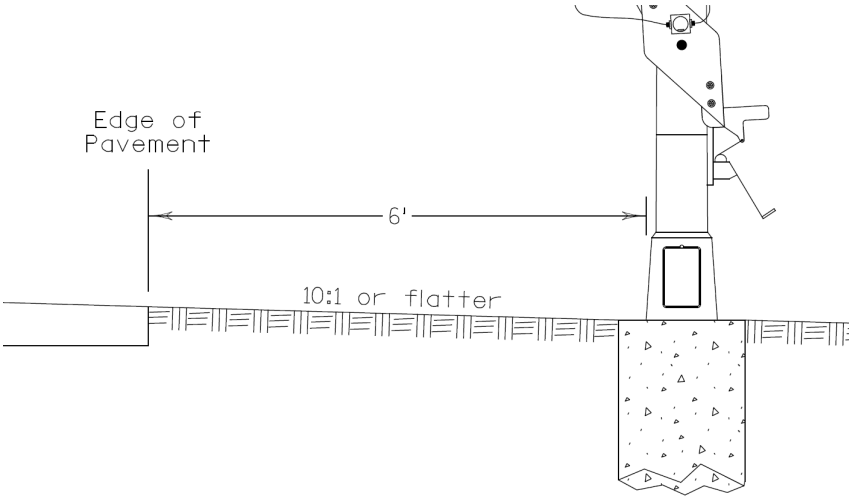

***Figure 25.6* Footing**

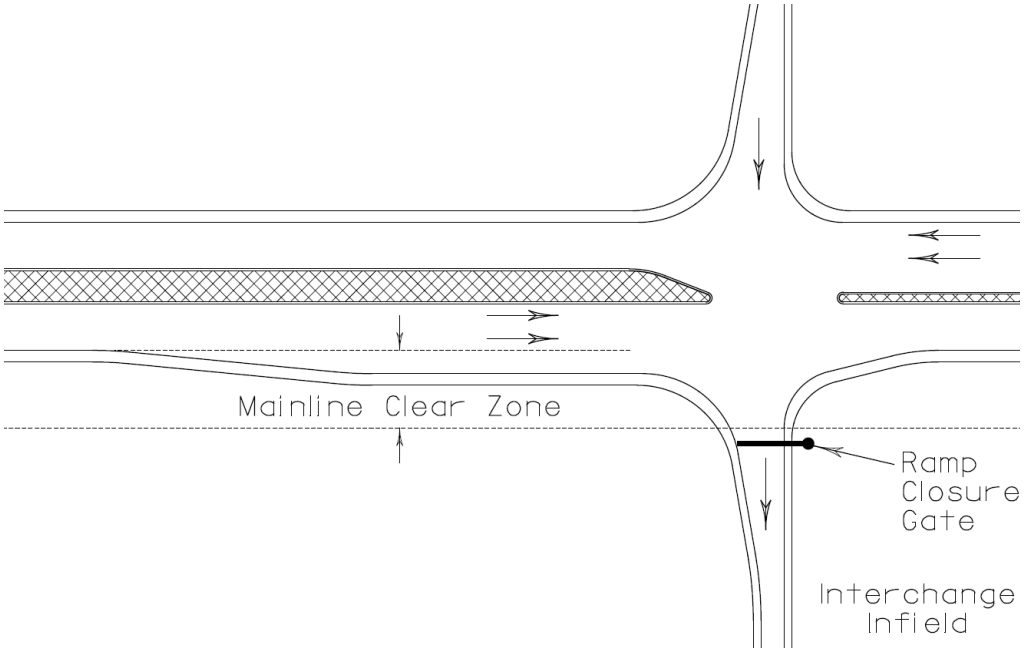

Figure 25.7 Ramp Gate Placement at Diamond Interchange (Typical)

25.3.5 Vehicle Trapping

If possible, gates should be located outside the mainline roadway's clear zone. However, gates should be placed close enough to the intersection to prevent "trapping" vehicles between the gate and the intersection. Gates located near the downstream ramp curb return (or a similar edge of pavement return for ramps without curb and gutter) will often put a gate outside the mainline roadway's clear zone while keeping the possibility of trapping vehicles to a minimum (refer to Figure 25.8).

25.3.6 Single vs. Multiple Gates

Using a single gate to close a ramp is highly desirable, as installation costs, maintenance costs and the possibility of a gate being struck all increase with the placement of multiple gates. Choose a gate arm length to cover at least the distance between the mounting pole and a point three feet from either the opposite side curb face or opposite side edge of shoulder to prevent drivers from maneuvering around the gate structure (refer to Figure 25.8). The lower minimum gate arm length is 24' while the maximum gate arm length is 40' (gate arm lengths are measured beginning at a point offset approximately 1.33' from the center of the mounting pole).

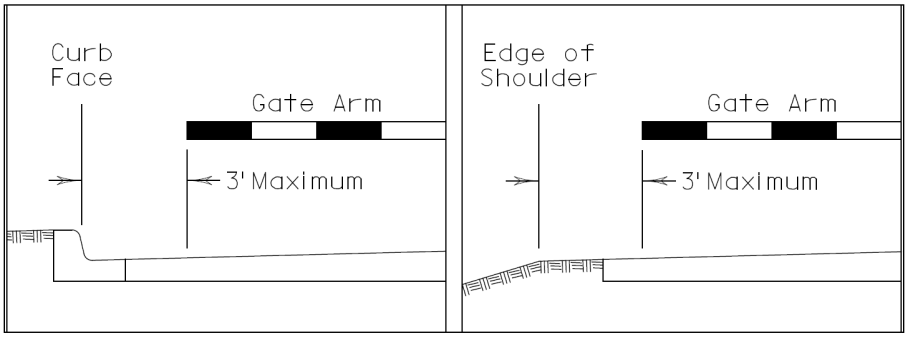

Figure 25.8 Ramp Gate Arm Lengths

If closing a ramp is not feasible with a single gate while adhering to gate placement guidelines, consider positioning the gate slightly downstream to take advantage of the ramp tapering to a narrower width. In positioning the gate slightly downstream, be careful not to create a situation in which vehicles can become trapped as described in the previous section. Depending on ramp geometry, closing a ramp with only a single gate may not be feasible. If more than one gate is needed to span the ramp, locate gates to minimize the likelihood of an impact on one gate striking the other.

25.3.7 Adjacent Roadway Features

If gates adhering to the above gate placement guidelines conflict with utilities, traffic signals, lighting, beam guard or other adjacent roadway features, shifting the gate location may be required. Increasing the offset from the ramp and moving a gate slightly downstream or to the opposite side of the ramp are the simplest measures for reducing conflicts with adjacent roadway features.

Always ensure that gates are not in conflict with the indications on traffic signal heads. Placing a gate along a ramp downstream from an adjacent traffic signal standard and mast arm should avoid such conflicts.

On a ramp lined with beam guard, place gates 6’ behind the face of the beam guard to allow for deflection (refer to Figure 25.9).

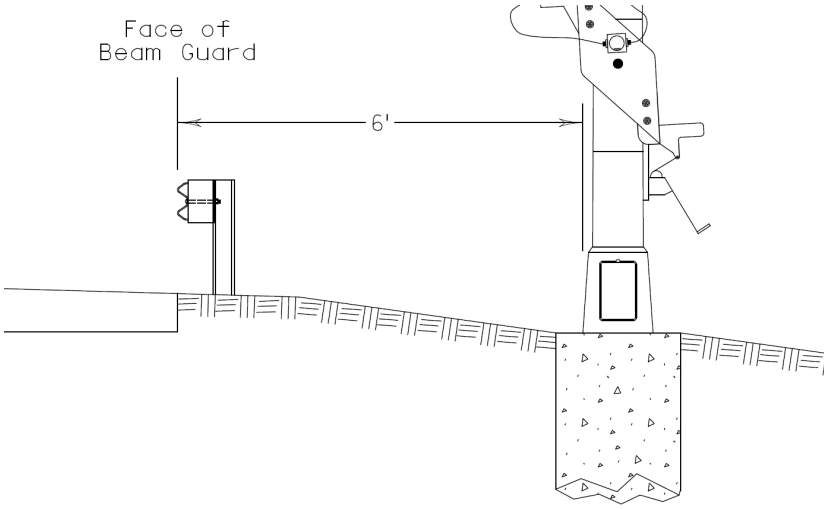

***Figure 25.9** Ramp Gate Offset behind Conflict*

Ensure the gate pivot assembly is installed at a proper height on the mounting pole to allow for free gate arm movement above the beam guard (see Figure 25.10).

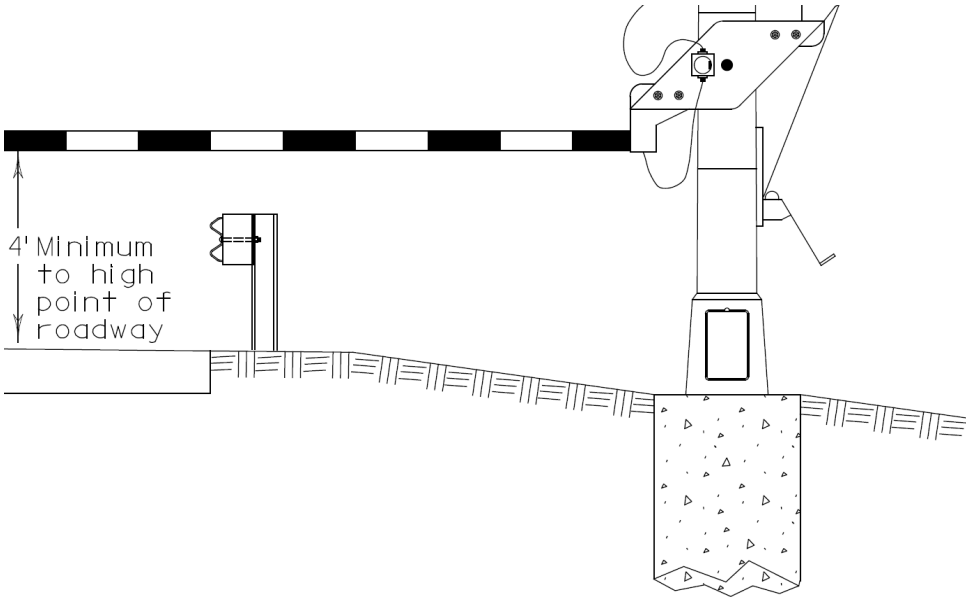

***Figure 25.10** Ramp Gate Height behind Conflict*

25.3.8 Pedestrian

Place gates to not block a pedestrian sidewalk or crosswalk when the gate arm is deployed.

If gates must be placed in areas of significant pedestrian traffic, the potential exists for pedestrian injuries due to a knockdown. Several options should be considered for mitigation:

- If possible, place the gate in an area where there is less pedestrian exposure
- Place the gate in an area where knockdowns are less likely
- As a last resort, provide beam guard shielding to prevent a vehicle from hitting the gate

If beam guard is needed to shield a gate, it is required that the barrier is of sufficient length to protect the gate (i.e. length of need), has appropriate end terminals and appropriate grading is provided for the barrier and end terminals.

25.3.9 Sightlines and Driver Reaction

Consider sightlines and driver reaction time when locating gates. Ideally, drivers would be able to observe a deployed gate arm far enough in advance to avoid entering a closed ramp and becoming trapped.

25.4 Other Design Considerations

25.4.1 Operating Speeds

Operating speeds on the ramp near a gate may be lower than the design speed used for the mainline roadway due to vehicles turning onto the ramp. Use acceleration tables from *2018 GDHS* to calculate operating speeds near a gate as this will influence run out length for barrier (if needed due to pedestrian concerns), clear zones and potentially grading leading up to a gate base.

25.4.2 Signing

The designer should supplement the visual cues of the ramp gate arm and attached flashers by installing WisDOT Standard Sign R11-54F (Folding “RAMP CLOSED USE ALT ROUTE”) on or near each approach to the ramp to be closed by the gate to reinforce a closure. Include these details on the signing plan and in the signing quantities.

Guidance for the R11-54F sign installation:

- For two-lane rural crossroads, the folding R11-54F sign shall be placed at the ramp gate or barricade rack. If possible, a folding R11-54F sign should be placed in advance for traffic turning onto the ramp (see Attachment 25.3).
- For multi-lane crossroads, the folding R11-54F sign shall be placed at the ramp gate or barricade rack. Advance folding R11-54F signs should be considered at roundabout bypass lanes and look ahead left turn lanes, left turn lanes and right turn lanes (see Attachment 25.3).

25.5 Identification Plaques

Ensure proper installation of structure identification plaques per SDD 12a4.

25.6 Barricades in Conjunction with Ramp Closure Gates

Where slotted turn lanes create the potential for a vehicle virtual trap, and ramp closure gate deployment is not feasible, type III barricades should be deployed (see Figure 25.11).

Refer to the “Deployment and General Considerations” section for additional barricade guidance.

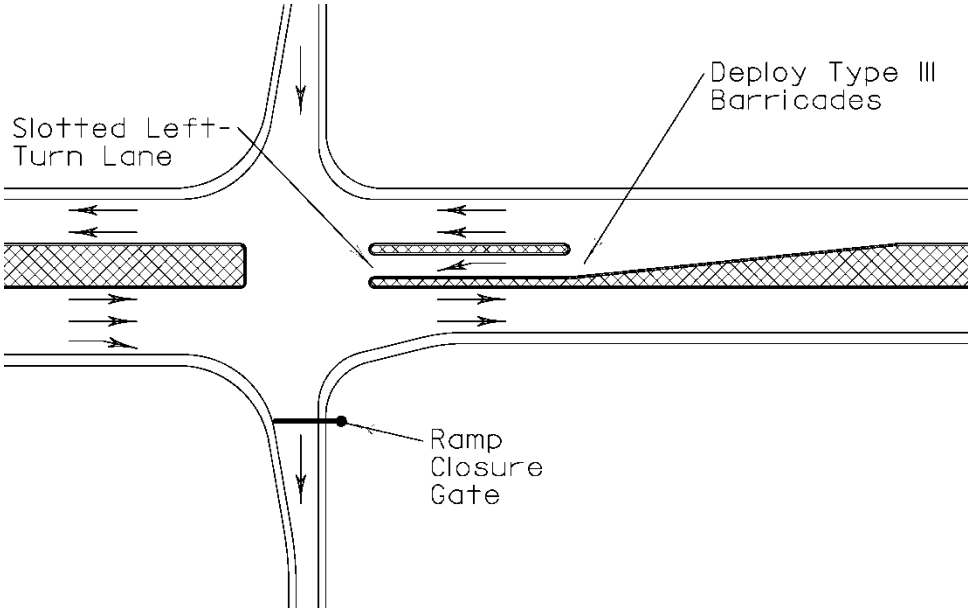

***Figure 25.11* Barricades in Conjunction with Ramp Closure Gates**

25.7 Additional Information

In 2018, WisDOT suspended installation and maintenance of the electrical components on ramp gates, new and existing. Designers should refer to standard detail drawings (SDD 12a4, 15d35 (a-c)) and standardized special provisions (refer to http://wisconsindot.gov/Pages/doing-bus/eng-consultants/cnsltrsrces/tools/stsp.aspx) ramp gates and barricade racks.

LIST OF ATTACHMENTS

Attachment 25.1	Wisconsin Ramp Gate Maintenance and Inspection Guideline
Attachment 25.2	Inspection Form for Manual Ramp Gates
Attachment 25.3	Example Ramp Closed Use Alternative Route (R11-54F) Sign Details

FDM 11-55-30 Crash Investigation Sites *May 17, 2021*

30.1 Existing Conditions

Crash Investigation Sites (CIS) are designated places, such as interchange exit ramps for vehicles to relocate to after being involved in a minor crash or where vehicles have become disabled. A CIS provides a much safer place for motorists and emergency responders to make emergency repairs or exchange insurance information, compared to the shoulder of a high speed, high volume freeway.

Existing CISs are currently located in any number of publicly owned facilities throughout the state including interchange exit ramps, park-and-ride lots, truck weigh stations, tourism information centers, or sheriff offices. No matter what the location, CISs tend to have a few similar features which include:

- Proper signage (see Figure 30.1)
- Close proximity to a freeway interchange
- Paved surface
- Enough space to accommodate multiple vehicles including semi-trucks (150 feet by 22 feet)
- Lighting

On many of the CISs located on exit ramps, there is also a raised median to increase safety and clearly distinguish the exit ramp travel lane from the CIS.

Locations are determined by WisDOT staff at the regional level. In general, they have been placed along freeways that demonstrate one or more of the following attributes: urban areas, tight geometrics, high volumes, congestion, narrow shoulders, or high crash locations.

CIS locations adjacent to exit ramps can also be used as incident staging areas, strategic drop sites, or safe places for law enforcement to pull a vehicle over for a routine traffic violation or vehicle inspection.

Locations that are currently used include many of the formal locations identified above that shall include the proper signage (e.g. park and ride lots, etc.)

***Figure 30.1** Example of a CIS in Green Bay*

30.2 CIS Recommendations

30.2.1 Location Guidance

CISs at interchanges where a medium or high level of incident management is proposed. These areas are generally along freeways in suburban or urban areas. There should be additional analysis to confirm CIS location decisions prior to construction.

It is recommended that CISs be located on freeways only, since volumes and speeds tend to be higher. Also, because of the design of a freeway, there are limited interchanges and no at-grade accesses for vehicles to access a side street.

CISs should be considered on freeways with an Annual Average Daily Traffic (AADT) greater than 20,000 vehicles. As shown in Table 30.1, as traffic volumes increase, so does the recommended need for a CIS in the corridor. Traffic volumes greater than 60,000 vehicles per day are recommended to have the highest need. These higher volumes are in the Wisconsin's major urban areas where there tends to be recurring congestion.

Freeway Traffic Volumes (AADT)		
20,000 - 40,000	**40,000 - 60,000**	**60,000+**
Low Need	Medium Need	High Need

Table 30.1 Guidelines for Crash Investigation Site Need

Other variables also should be considered when determining the need for a CIS. These include:

- **Crash Density:** Freeway segments with a high number of crashes per mile increase the need for CISs. More specifically, congested freeway segments with high crash rates may experience more minor crashes and have a higher need for CISs.

- **Shoulder Width:** Urban sections of roadway with narrow shoulders increase the need for a CIS. Shoulder widths of six feet or less make it difficult and unsafe for a motorist to pull over because the width of the vehicle is greater than the width of the shoulder. Conversely, roadway segments with substantial shoulder widths (e.g., 8 feet, 10 feet, or more) may reduce the need for a CIS. Wider shoulders allow the entire vehicle to be stationary on a level, paved surface outside of traffic. A wide shoulder should allow enough space for a driver to exit the vehicle and assess any damage to it. While a wider shoulder is more convenient for drivers because it is immediately adjacent to the travel lanes, it is not as safe as a crash investigation site because of the high mainline speeds and possibility for secondary crashes. Vehicles on the shoulder can also negatively affect traffic operations on the travel lanes.
- **Speed/Congestion/Level-of-Service (LOS):** Urban freeway segments with an average speed of approximately 45 mph increase the need for a CIS. This level of speed often occurs in segments approaching or leaving congested areas where speed differentials are high, increasing the likelihood of a crash. Also, segments with recurring congestion or poor LOS increase the need for CISs.
- **Interchange Design:** Interchange design also affects the usefulness of a CIS placed on an, exit ramp. CISs placed on loop ramps create sight line issues and are less user-friendly than standard diamond interchanges. System-to-system interchanges are also not recommended locations for CISs because of the higher speeds associated with them. Finally, CISs should not be placed on a half diamond interchange, because it does not allow the motorist to get back onto the freeway after using the CIS.
- **Number of Lanes:** As more of a roadway's capacity is occupied and safety problems increase, so does the need for a CIS. In a six-lane section of roadway, it is easier for motorists to change lanes as they approach a stalled vehicle on the shoulder compared to a four-lane section, potentially decreasing the need for a CIS.
- **Spacing:** The spacing of CISs depends on the setting (urban vs. rural areas). In urban areas where there is a need for CISs, they should be spaced one to three miles apart. In some places in the State, spacing toward the lower end of this range is appropriate (e.g., within the Milwaukee urban area, interchanges on either side of major bridges such as the US 41 Lake Butte des Morts Bridge in Oshkosh or the WIS 172 Bridge over the Fox River in Green Bay). In rural areas where there is a need for CISs, they can be spaced every five to 15 miles. These recommendations also consider interchange spacing, which is reduced in urban areas compared to rural areas.
- **Signing and Pavement Marking:** Before considering a new location, coordinate with the Region's Signing Engineer to evaluate the requirements of the spacing requirements along the freeway for Type I Signs. Reference the Wisconsin Manual on Uniform Traffic Control Devices.
- **ITS:** The use of existing cameras at interchanges allow the monitoring of activities at the CISs and increase the effectiveness of the response.
- **Maintenance:** There are maintenance considerations when determining the type of CISs to construct. Coordinate with County Highway Departments that will be impacted. For CISs on exit ramps, snowplowing is more difficult when there is a raised paved median. CISs with medians were sometimes damaged by snowplows during the winter season. The lights will also require periodic maintenance.

LIST OF ATTACHMENTS

Attachment 30.1	CIS Rural Design Example
Attachment 30.2	CIS Urban Design Example
Attachment 30.3	CIS Park and Ride Design Example
Attachment 30.4	CIS Signing and Pavement Marking Example

FDM 11-55-35 Law Enforcement Pads

May 17, 2021

35.1 Existing Conditions

A Law Enforcement Pad (LEP) is a designated place, where law enforcement vehicles can safely monitor traffic operations and vehicular speeds. These locations are designed to allow law enforcement to safely pull out and

accelerate to freeway speeds. LEPs provide a high safety benefit for a low cost. In addition, a LEP does not require substantial maintenance other than plowing during the winter season. As traffic volumes continue to increase on many freeways throughout the state, the need to provide law enforcement with safe areas to monitor traffic increases.

In some parts of the state, LEPs are placed within the gore area between the entrance ramp and the mainline. In many cases though, maintenance turnarounds are used as LEPs, even though these median areas are not specifically designed for this purpose.

Existing LEPs in Wisconsin are generally located on freeway facilities. Identified features of LEPs include:

- Either protected by a barrier wall or out of the mainline clear zone
- Immediately adjacent to the travel lanes
- Gravel or paved pad large enough for a law enforcement vehicle
- Good sight lines to monitor traffic
- Ability to safely accelerate to mainline speeds

Locating LEPs at the entrance ramp gore provides safety, especially if a barrier wall is present. In addition, when leaving the LEP, there should be enough space for law enforcement to safely merge with traffic. Low volume entrance ramps with a wider interchange provide even greater safety benefits when merging onto the entrance ramp.

The primary factors that influence the location decision for LEPs include safety, interchange design, entrance ramp volumes, and the ability to monitor traffic. The cross-section and available space also are major determinants in where to locate LEPs. A lack of right-of-way was cited as a major challenge in locating LEPs. Other issues identified by stakeholders include dealing with drainage and fencing.

Locate LEPs in suburban or urban areas where a concrete median separates the travel lanes and median crossovers are not available. Due to safety concerns with the maintenance turnarounds, LEPs placed in rural sections of freeways such as the I-94 North-South Corridor should consist of two LEPs placed per county per direction (four per county). Appropriate spacing of LEPs should be a major factor in determining locations.

35.2 LEP Recommendations

35.2.1 Location Guidance

It is recommended that LEPs be placed on freeways only (see Attachment 35.1). Volumes and speeds tend to be higher on freeways, increasing the need for a safely situated LEP. It is not recommended that thresholds involving volumes or LOS be used exclusively to pinpoint a location for a future LEP. Instead, it is recommended that LEP placement should be a cooperative effort between law enforcement and WisDOT Region staff.

Variables to consider when determining the need for a LEP include:

- **Law Enforcement Safety:** LEP locations should be at the end of a barrier wall to protect law enforcement vehicles.
- **Entrance Ramps and Mainline Volumes:** Entrance ramps with lower volumes generally provide more gaps allowing law enforcement to merge with entrance ramp traffic as they approach the mainline. However, higher mainline volumes may increase the need for a LEP and the monitoring of traffic conditions.
- **Speed and Crash Density/Severity:** Segments of roadway where motorists typically exceed the posted speed limit would also be good locations for LEPs. Segments with high crash densities and/or high amounts of severe crashes also lend themselves to LEP construction, so that law enforcement will be in a good position to quickly respond to an incident.

- **Geometrics:** Urban sections of roadway with concrete medians (lack of maintenance turnarounds) increase the need for a LEP. While LEPs could be placed on nearly any type of interchange design; if there is enough right-of-way and proper site characteristics, diamond interchanges with long entrance ramps provide the best option.

- **Law Enforcement Visibility:** The topography of the site and height of adjacent barrier walls must be low enough for law enforcement to monitor traffic. Also, of importance, is the angle to monitor vehicular speed with radar. The angle is important because law enforcement need to bounce the radar off the lower portion of a vehicle to record its speed.

- **Spacing:** The recommended spacing of LEPs depends on the setting (urban vs. rural areas) and the interchange spacing for that segment of freeway. In urban areas where interchanges are spaced closer together, LEPs could be placed at more frequent intervals than in rural areas. A specific range for either urban or rural spacing is not recommended because specific site characteristics play such a critical role in the viability of a site.

- **Stakeholders:** Consider input and feedback from the stakeholders in the location, including law enforcement, fire service personnel, and other state/county/local responders, who are involved in WisDOT's Traffic Incident Management Enhancement (TIME) Program.

LIST OF ATTACHMENTS

Attachment 35.1 LEP Design Example

FDM 11-55-40 Roadside Facilities Coordination *May 17, 2021*

40.1 Background and Roadside Facilities Coordination

As outlined in WisDOT's Program Management Manual (PMM 3-15-1), funding for select improvements at roadside facilities (rest areas and safety and weight enforcement facilities (SWEFs)) adjacent to the Backbone roadway network can be included in the highway project. The Backbone roadway network is identified on map 5-1 on page 5-14 in the Connections 2030 Long-Range Multimodal Transportation Plan.

Therefore, projects on the Backbone roadway network that have adjacent roadside facilities within the project limits need to contact and coordinate with the Bureau of Highway Maintenance Roadside Facilities Unit to evaluate roadway related needs at the roadside facilities and include them in the project's PS&E documents.

The Backbone funding for roadside facilities work is limited to perpetuation and rehabilitation improvement activities that are typically associated with state highway perpetuation and rehabilitation projects (pavements, curb and gutter, sidewalks, site lighting, signing and pavement markings, safety and security items, ITS items, drainage improvements).

In general, the cost of the roadside facility improvements should not exceed 10% of the associated Backbone roadway network project cost. Approval from BSHP is needed if costs are above 10% of the associated backbone highway network project.

Refer to PMM 3-15-1, available to WisDOT staff at https://iisgtwyp.wi.gov/ffm/pmm/03/03-15-01e.pdf for addition guidance. Rest area and SWEF locations can be found on WisDOT web pages https://wisconsindot.gov/Pages/travel/road/rest-areas/locations.aspx and https://wisconsindot.gov/Pages/dmv/com-drv-vehs/mtr-car-trkr/mc-safety/scale-locations.aspx.