Facilities Development Manual

ORIGINATOR Director, Bureau of Highway Development		PROCEDURE 11-3-5
CHAPTER 11	Design	
SECTION 3	Community Sensitive Design	
SUBJECT 5	Decision Making Guidance	

Introduction

As described in Procedure 11-3-1, an important aspect of Community Sensitive Design **(CSD)** is to deliver transportation projects that not only provide safety and mobility, but are also in harmony with communities and the environment. This requires balancing design, construction and safety standards with impacts to the natural, social, economic and cultural environment.

This procedure provides guidance for making the appropriate design choices. Figures 1 through 14 consist of decision-making matrices showing the following:

- Steps to follow,
- Project information and data to collect,
- Types of analyses to be completed, and
- Things to consider when applying flexibility in design, construction and safety standards.

Consult AASHTO's GDHS, FHWA's "Flexibility in Highway Design" and the AASHTO Bridging Document for additional guidance.

Decision Making Steps

The appropriate decision making steps are as follows:

1. Use desirable FDM design criteria for initial preliminary designs and design alternative alignments. Layout the horizontal and vertical alignments to best fit the "lay of the land," and to reduce or soften impacts to community and environmentally sensitive areas. The design must meet the safety and mobility needs of the project at a financially feasible cost.
2. Consider using less-than-desirable, but at least minimum FDM design criteria only if further flexibility in design criteria is needed to reduce impacts and to develop the best overall design. The use of less-than-desirable design criteria values shall be justified, documented and approved in the Design Study Report. This documentation shall include a description of the impacts that are being avoided or reduced, and a description of the crash history and other analyses completed to address safety concerns.

3. Consider using less-than-minimum FDM design criteria only for unique situations where even minimum FDM design criteria will cause excessive impacts to community or environmentally sensitive areas, and where it can be proven from the crash history that safety problems do not exist. For controlling criteria, the use of less-than-minimum design criteria requires an approved exception to standards. See Procedure 11-1-2 for information on preparing Exceptions to Standards Reports, and Procedure 11-1-4 for information on Programmatic Exception to Standards (PES) for 3R projects. For non-controlling criteria the use of less-than-minimum design criteria shall be justified, documented and approved in the Design Study Report. This documentation shall include a description of the impacts that are being avoided or reduced, and a description of the crash history and other analyses completed to address safety concerns.

Use of values outside of FDM and AASHTO standards requires great care to ensure that the safety operational characteristics of the new roadway design are compatible with the operational characteristics of the original roadway. These operational characteristics consist of such things as meeting driver expectations and maintaining existing vehicle operating speeds and consistency of operating speeds throughout the project. Appropriate mitigation measures must be used to warn drivers and to maintain consistent operating characteristics. Examples of mitigation measures for various design features are listed in Figures 1 through 13.

Project Information, Data Collection and Analyses

To ensure that design criteria are used appropriately, the following project information and data are collected and analyzed:

Project Information

Type of construction: Choose the type of construction (new construction, reconstruction or 3R) that best reflects the purpose and need of the project. Design criteria flexibility is generally greater for 3R projects than for new construction and reconstruction projects.

Roadway Functional Classification: Flexibility in design criteria increases as the functional classification of roadways decreases. Based on functional classifications the following philosophies in applying design criteria are followed:

Arterials

Interstates, Other Freeways, and Expressways. There is very little design criteria flexibility for these facilities. CSD is applied only to the extent that the safety and mobility needs and desirable design criteria allow. CSD is achieved on these projects through roadway location selection, horizontal and vertical alignments that follow the “lay of the land,” aesthetic features that soften roadway impacts, and by using roadside and median safety barriers to reduce roadway widths. Both FDM and AASHTO guidance requires the use of the highest design criteria. Exceptions to design standards are rarely justified, and then only under the most unique circumstances.

Corridors 2020 Multilane and Two-lane Roadways. Follow the same philosophy as the Interstate, Freeways and Expressways; but include urban roadway design criteria in addition to rural roadway design criteria. Exceptions to design standards may be submitted for unique circumstances on a limited basis. Design criteria flexibility for these facilities are limited to some minimum widths for median shoulders on rural projects, some minimum median and outside shoulder/curb offset widths on transitional/high speed urban roadways and some minimum travel and parking lane and median widths on low speed urban roadways.

Non-Corridors 2020 Principal and Minor Arterials. The CSD philosophy is applied by making careful choices between the safety and mobility needs of the roadway with the social and environmental needs. Crash history is analyzed on these projects to determine where safety improvements are required. Crash history and other data, such as vehicle operating speeds, should also be used to make careful choices between geometric upgrades and social and environmental impacts.

Less-than-desirable design criteria should not be used if safety will be degraded as an outcome or if driver expectations will be violated. For example, upgrading lane and shoulder widths on a highway without upgrading the horizontal or vertical features may give drivers the impression that the entire roadway has been upgraded. This may encourage them to drive faster than the horizontal and vertical features can handle and thereby potentially increasing crash rates.

Design criteria flexibility for rural roadways includes minimum shoulder widths and, in rolling terrain conditions, minimum lane widths on roadways with lower volumes or lower design speeds. Design criteria flexibility for urban roadways includes minimum median and outside shoulder/curb offset widths and narrower lane widths on lower volume transitional/high speed urban roadways and minimum travel and parking lane and median widths on low speed urban roadways.

Increased levels of congestion, above AASHTO guidance, are allowed in FDM Procedure 11-5-3. Exceptions to design standards may be submitted for approval when needed to avoid or reduce impacts in socially or environmentally sensitive areas.

Collectors, Locals and Town Roadways. Apply the same CSD Philosophy to collectors, locals and town roads as described above for the Non-Corridors 2020 principal and minor arterials. The difference is that collectors, locals and town roads have additional flexibility in design criteria, and are allowed to operate at even higher congestion levels. Exceptions to design standards may be submitted as needed to avoid or reduce impacts to socially or environmentally sensitive areas.

Type of Terrain: The AASHTO policy for level, rolling, and mountainous terrain conditions reflects design practices related to cost and operational efficiency. Steep upward grades reduce vehicle operating speeds at the approach to crest vertical curves. The lower design speeds provided in the rolling terrain tables reflect these lower operating speeds and the economical constraints that are imposed in the construction of roadways under these conditions. Exercise caution in the design of sag vertical or sharp horizontal curves at the bottom of steep down grades, because vehicle operating speeds at these locations tend to increase. This can create difficulties, especially for large trucks, affecting their ability to decelerate safely. Level terrain is the predominant terrain in Wisconsin, but there are areas in the state that have rolling terrain.

Project Design Speed: Horizontal, vertical and cross sectional design features are all affected by the project design speed. Lower design speeds allow increased flexibility in the ranges of design criteria. The selection of design speed must be compatible with the operating characteristics, functional classification and predominant use (e.g., high mobility, local access, "Scenic Byway," etc.) of the highway. See Procedure 11-10-1 for guidance on the selection of design speed.

Data Collection

Existing and Projected Traffic Volumes: Traffic volumes affect the flexibility available in cross sectional design criteria. As traffic volumes increase the potential number of conflicts between vehicles and between vehicles and objects increases. This, in turn, increases the potential for a crash. Wider lane and shoulder widths are needed to provide additional lateral separation between vehicles and vehicles and roadside objects. This provides drivers with more room to perform avoidance and deceleration maneuvers. Carefully review projected traffic volumes to be sure that they adequately reflect future development plans.

Operating Speeds: These indicate how a highway is being driven and whether individual geometric elements meet driver expectations. Use this data when selecting project design speeds, and when considering the use of less than desirable design criteria. Consult with district traffic sections when collecting and analyzing operating speed data.

Crash History: This indicates the types of safety improvements that need to be considered in the design of a project. It also indicates the relative safety performance of various geometric elements or roadside safety features. Crash history information and analysis must be documented in all Exceptions to Standards reports, and in Design Study Reports when the use of less than desirable design criteria is proposed.

Roadside Conditions: Field reviews and photo log observations of roadside conditions can help to identify and evaluate potential safety impacts of existing geometric elements or roadside features. Such things as vehicle tracks and skid marks and damage to roadside barriers or other roadside objects may indicate potential safety hazards that may not show up in the crash history data.

Pavement Friction: An assessment of existing or proposed pavement surface friction can help to evaluate the safety impacts associated with the use of minimum or less-than-desirable curve radii or superelevation. If a decision is made to retain or use a minimum or less-than-minimum radius curve based on a thorough analysis of crash history, operating speeds and roadside conditions, construction of a pavement surface with an increased coefficient of friction in combination with the use of maximum superelevation is a good mitigation measure.

Analyses

Operating Speed Analysis

Close inspection of vehicle operating speeds is important in evaluating how the existing roadway is being driven and as to how well existing geometrics are meeting driver expectations. An ideal analysis would include the measurement of existing operating speeds at various locations throughout the project with special measurements made at locations where geometric features are of most concern. On projects with a complex or controversial decision-making process, actual measurements of operating speeds may be needed to generate or defend a final decision. In many cases however, the time and effort required to collect this data may not be cost effective. In those cases the designer can get a feel for the effects of existing geometric features on vehicle operating speeds by:

- Driving the roadway or soliciting comments from other staff who have driven the roadway,
- Making field observations of vehicle operating speeds on various sections of the project or at individual geometric features that are of particular concern,
- Soliciting comments from law enforcement officials, other local officials or public citizens that drive or live near the highway,
- Calculating the average running speed from driving the project and comparing it to the posted speed limit and design speed,
- Reviewing crash history reports for those crashes in which excessive operating speeds were cited as a cause of the crash.

Crash History Analysis

Close inspection of crash history data is required to evaluate the overall safety improvements needed on a project and when considering the use of less-than-desirable design criteria. The analysis shall go beyond the customary project crash rate comparisons to statewide averages to include a performance based crash analysis. Performance based crash analyses consist of looking at individual crash types at concentrated locations and levels of severity. For instance, when evaluating the decision to use a less-than-desirable curve radius, review the crash history at the curve location being analyzed to see if a crash history exists and to determine what specifically caused the crashes. Documentation for exceptions to standards, or for the use of less-than-desirable design criteria in the Design Study Report, shall include an analysis of crash history as one of the justifications for approval.

The safety screening analysis performed for 3R projects (see Procedure 11-1-4) could be useful in this effort.

Traffic Capacity and Level of Service Analysis

An analysis of a highways capacity and level of service is needed to determine a highways ability to handle current and future traffic volumes. As a highway nears its capacity and the level of service decreases, the safety and mobility of a highway can become compromised. Use accepted traffic analysis formulas and models, such as the Highway Capacity Manual, to determine the incremental improvements or level of capacity expansion needed to meet the traffic needs for the project. See Procedure 11-5-3 for more guidance on traffic analyses and recommended traffic analysis models and software

Things to Consider When Making Decisions on Design Criteria

Design Elements Involved

Under Community Sensitive Design, designers make geometric and other design elements conform to the “lay of the land” in order to minimize community and environmental impacts. These design elements are listed below.

<table>
<tr><td>Highway Capacity and Traffic Control</td><td colspan="2">Level of service (LOS) requirements, intersection traffic control warrants, signing and marking criteria and requirements</td></tr>
<tr><td>Horizontal</td><td colspan="2">Tangents, curves, superelevation and transition, sight distances</td></tr>
<tr><td>Vertical</td><td colspan="2">Grades, vertical curves, vertical clearance, sight distances</td></tr>
<tr><td>Sight Distance</td><td colspan="2">Stopping sight distance (SSD), intersection sight distance (ISD), passing sight distance (PSD), decision sight distance (DSD), approach sight distance (ASD), driveway sight distance (DWSD)</td></tr>
<tr><td rowspan="3"><u>Cross Section</u></td><td>Lanes and Shoulders</td><td>Number of lanes, lane widths, shoulder widths, cross slopes, superelevation, lateral clearance, curb and gutter, auxiliary lanes, passing and climbing lanes, horizontal clearance, shy distance, clear roadway width of bridges, pavement structure, truck route requirements</td></tr>
<tr><td>Medians</td><td>Type (raised, flush, or ditched), width, slopes, lateral clearance, barrier requirements and criteria</td></tr>
<tr><td>Roadside</td><td>Side slopes, clear zones, sidewalk width, sidewalk cross slope, driveway side slopes, driveway culverts, terrace slopes, side ditches, culvert end treatments, retaining wall requirements, barrier requirements and criteria, fencing requirements and criteria</td></tr>
<tr><td>Intersections, RR Crossings, Interchanges, and Driveways</td><td colspan="2">Location, intersection angles, turning radii, horizontal and vertical roadway alignments, left/right turn lanes and tapers, median openings, channelization, approach grades, traffic control, approach sight distance, intersection sight distance, vision triangle, design vehicle, parking, frontage road offsets</td></tr>
<tr><td>Clearances</td><td colspan="2">Clear roadway width of bridges, clear zone, lateral clearance, horizontal clearance, vertical clearance, shy distance</td></tr>
<tr><td>Drainage and Erosion Control</td><td colspan="2">Design storm, drainage basin size and characteristics, hydrology, hydraulic characteristics and requirements (ditches, gutters, culverts, storm sewer pipes and inlets)</td></tr>
<tr><td>Access Control</td><td colspan="2">Controls (Ch. 84.09, 82.25, 84.295 stats, Trans 233, driveway permits, state access management system plan), access spacing, intersections, driveway location, driveway use, driveway design vehicle</td></tr>
<tr><td>Bicycle accommodations</td><td colspan="2">Location, width, cross slope, longitudinal slope, pavement structure, sight distances, vertical clearance, road crossing, driveway crossing, grates, median refuge</td></tr>
</table>

Pedestrian and Handicap Accommodations	ADA requirements, location, width, cross slope, longitudinal slope, landings, handicap accessibility, pedestrian characteristics, curb zone, planter/furniture zone, pedestrian zone, frontage zone, surface texture, ramp design, road crossing, driveway crossing, grates, median refuge	
Bridge	Clear Roadway Width of Bridges, cross slopes, superelevation, Horizontal Clearance, Vertical Clearance, Structural Capacity, freeboard, Hydraulic Capacity, Railings and Barriers.	
Other	Trail crossings	Trail use, hourly exposure factor
	Cattle passes	Number of cattle, size of opening, longitudinal grade, length of structure
	Construction traffic control	Speed, detour routes, requirements of traffic control devices: size, spacing and placement, delays, traffic control zone components: advance warning area, transition area, activity area (longitudinal and lateral buffer spaces, work space, traffic space), termination area, all applicable previously discussed design elements

A decision to use design criteria outside the FDM desirable design criteria must be made very cautiously, and be based on a thorough consideration of many factors. The type of factors that could be considered for all of the various geometric features involved on a project can be numerous, and not always readily apparent. To help guide designers through this decision-making process, Figures 1 through 14 provide a checklist of factors, titled “Things To Be Considered.” These are a list of factors to consider when making these design criteria decisions. ★

Horizontal Alignment (Tangents, Curves, & Superelevation)

Factors Affecting Design

- Construction type (New, Recon, 3R)
- Roadway functional classification
- Type of terrain (level or rolling)
- Existing/projected traffic volumes
- Selection of design speed
- Operating speeds
- Crash history at curves
- Roadside conditions in curve vicinity – particularly on the outside of curves
- Available pavement friction

Things To Consider When Making Decisions on Design Criteria

Before deciding to apply minimum or less-than-minimum curve design criteria consider the following:

- **Exception to Standards –** Horizontal alignment, superelevation, and stopping sight distance are controlling criteria. Design values that are less than the FDM minimum or greater than the FDM maximum require an exception to standards, and will be approved in only very rare instances.
- **DSR documentation –** Document any recommendation to use less-than-desirable design criteria in the DSR.
- **Traffic volumes -** The risk is lower for lower volume highways and higher for higher volume highways.
- **Number of unfamiliar drivers** - The risk is higher on roads with a higher percentage of unfamiliar drivers (such as on long distance traveler and tourist route highways) .
- **Vehicle operating speeds** - The risk may generally be acceptable if the effective or nominal speed on the proposed curve is within 5 to 10 mph of the project design speed.
- **Amount of truck traffic -** The risk increases as truck volumes increase due to trucks' propensity to overturn on curves (stay within 5 mph of project design speed when truck traffic is a factor).
- **Length of curve** - The longer the curve the higher the risk (short, flat curves are the most desirable).
- **Vehicle entry speeds at curves -** The risk varies as a function of the approach speed distribution.
- **Cross section** - The risk is reduced when wider lanes, shoulders and clear zone are provided along curves.
- **Sight distance -** The risk is reduced when sight distance is increased along curves.
- **Presence of intersections and driveways -** The risk increases when intersections and driveways are present on curves.
- **Number of geometric elements -** The overall risk of a sharp horizontal curve increases when the combination of other geometric elements in the vicinity of the curve is at or below minimum design criteria values.
- **Use full range of curvature to establish the best alignment -** Rigid adherence to minimum radius curvature is not recommended, instead use the full range of curvature to fit terrain, land use constraints and desired operating speeds.
- **Mitigation measures -** Use these when less then minimum radius values are used to mitigate potential safety impacts.

- **Reductions to vehicle speeds -** Use transition curves to "step down" operating speeds prior to sharp curves.
- **Provide adequate justification for lesser design criteria -** Thoroughly document why FDM and AASHTO criteria are not being met and what analysis of crash history was performed to minimize safety concerns.

Possible Mitigation Measures If Less-Than-Minimum Design Criteria Are Used

- Widening the lanes and/or shoulders along curves
- Improving the roadside (clear zone/side slopes) on curves
- Relocating or closing intersections or driveways on curves
- Spot pavement resurfacing or "wedging" to increase friction
- Advanced warning signing prior to curves
- Delineation (signing and/or pavement marking) on curves
- Use of spiral curve transitions
- Increased super-elevation (up to a maximum) on curves
- Shoulder paving along curves

Vertical Alignment (Grades, Crest Vertical Curves & Sag Vertical Curves)

Factors Affecting Design

- Construction type (New, Recon., 3R)
- Roadway functional classification
- Type of terrain (level or rolling)
- Existing/projected traffic volumes
- Selection of design speed
- Operating speeds
- Crash history on grades & curves
- Truck percentage data
- Roadside conditions in grade vicinity
- Drainage analysis

Things To Consider When Making Decisions on Design Criteria

Before deciding to apply maximum or greater than maximum grade design criteria consider the following:

- **Exception to Standards** – Vertical alignment, grades, vertical clearance, and stopping sight distance are controlling criteria. Design values that are less than the FDM minimum or greater than the FDM maximum require an exceptions to standards, and will be approved in only very rare instances.
- **DSR documentation** - Document, justify, and solicit approval for less than desirable design criteria in the DSR.
- **Drainage needs** - Flat grades may require steeper cross-slopes and other special drainage considerations in order to avoid "ponding" of water.
- **Traffic volumes and percentage of trucks** - The risk is reduced on roadways having lower traffic volumes, especially lower truck volumes.
- **Length of grade** - Longer, steeper grades affect vehicle deceleration and acceleration operations, especially trucks, whereas shorter steeper grades have very little effect.
- **Type of terrain** - Select the appropriate type of terrain for the project to determine the appropriate grade criteria to apply. See Procedures 11-10-5 and 11-15-1.
- **Truck climbing lanes** - Consider when the truck percentage is significant and grades are long and steep
- **Shoulders and clear zones** - Consider using wider shoulders and clear zones at the bottom of steep grades to provide additional safety measures to compensate for higher vehicle operating speeds.
- **Curves at the bottom of steep grades** - Use higher curve radii and increase super-elevation to compensate for higher vehicle operating speeds.
- **Provide adequate justification for lesser design criteria** - Thoroughly document why FDM and AASHTO criteria are not being met and what analysis of crash history was performed to minimize safety concerns.

Before deciding to apply minimum or less-than-minimum grade design criteria consider the following:

- **Use of less-than-minimum grades** - consider drainage needs. Steeper cross-slopes and other special drainage considerations may be needed to avoid "ponding" of water.
- **Provide adequate justification for lesser design criteria** - See above

Possible Mitigation Measures If Less-Than-Minimum Design Criteria Are Used

- Wider shoulders or climbing lanes
- Design of truck escape ramps
- Increased shoulder and clear zones at the bottom of grades
- Increase curve super-elevation at the bottom of grades
- Use greater-than-minimum horizontal curves at the bottom of grades

When using grades less than minimum, consider the following mitigation measures:

- Increased cross slope and other special drainage designs
- Careful design of pavement edges at superelevation transitions

Sight Distance (Stopping Sight Distance (SSD)

Factors Affecting Design

- Construction type (New, Recon., 3R)
- Roadway functional classification
- Type of terrain (level or rolling)
- Existing/projected traffic volumes
- Selection of design speed
- Operating speeds
- Crash history at vertical curves
- Roadside conditions in vicinity of vertical curves (intersections, driveways, etc.)

Things To Consider When Making Decisions on SSD Design Criteria

Before deciding to apply minimum or less than minimum SSD design criteria consider the following:

- **Exception to Standards** –Stopping sight distance is a controlling criterion. Design values that are less than the FDM minimum require an exception to standards and will be approved in only very rare instances.
- **DSR documentation** - Document, justify, and solicit approval for less-than-desirable design criteria in the DSR.
- **Traffic volumes** - The risk of a sight restriction is related to the traffic volume exposed to it.
- **Features within sight restrictions** - The risk is greater where other features such as intersections, narrow bridges, high-volume driveways or sharp curvature occur within the sight restriction.
- **No high-risk features in sight restriction** - Nominal deficiencies as great as 5 to 10 mph may not create undue risk of increased crashes in sight restricted areas without high-risk features.
- **Eye heights** - Greater eye-heights associated with trucks, recreational vehicles and other similar vehicles provide a greater margin of safety for vertical sight restrictions.
- **Horizontal sight restrictions** - Horizontal sight restrictions such as large buildings, signs, tree lines, etc. affect all vehicle types equally.
- **Shorter sag vertical curves** - When faced with a choice, use shorter sag vertical curves in favor of providing the longest crest vertical curve possible.
- **Reconstruction of existing highways** - Study known crash history of the highway and the locations to determine the extent of actual safety risk.
- **Provide adequate justification for lesser design criteria** - Thoroughly document why FDM and AASHTO criteria are not being met and what analysis of crash history was performed to minimize safety concerns.

Possible Mitigation Measures If Less Then Minimum Design Criteria Are Used

- Relocate or remove features within sight-restriction
- Spot widening to increase room for collision avoidance
- Appropriate signing, lighting and delineation treatments

Sight Distance (Intersection Sight Distance (ISD)

Factors Affecting Design

- Construction type (New, Recon., 3R)
- Roadway functional classification
- Existing/projected traffic volumes
- Selection of design speed
- Intersection approach operating speeds
- Intersection crash history
- Roadside conditions at intersection
- Intersection design vehicle
- Intersection traffic control (signal, all-stop, etc.)

Things To Consider When Making Decisions on Design Criteria

Before deciding to apply minimum or less-than-minimum ISD design criteria consider the following:

- **Design speed** - Higher approach design speeds require more sight distance than approaches with lower design speeds.
- **DSR documentation** – ISD is not a controlling criterion and does not require an Exception to Standards if it is not provided. However, If ISD is needed, but cannot be provided, this must be documented, justified, and approved in the DSR. ISD is extremely important, and deficient ISD will not be approved unless there is sufficient justification and adequate mitigation.
- **Vehicle type** - ISD computations should be based on the appropriate design vehicle type.
- **Intersection control** - Certain types of intersection control (I.e. signal, all stop) require less stringent sight lines.
- **Sight restrictions** - Strive to eliminate sight restrictions such as trees, vegetation, signs and movable obstacles.
- **Vertical geometry sight restrictions** – Removing sight restrictions may include alignment reconstruction, but also may include relocation of the intersection away from the sight restriction, closure of intersection, or turn restrictions that eliminate higher risk movements.
- **Urban roadway sight restrictions** - Viable solutions may include creative use of turn restrictions or focusing traffic on safer (perhaps signal-controlled) intersections.
- **Advance signing** – advance signing can be used on the unstopped approach to warn of the intersection.
- **Traffic signal control** - Where volumes are high, sight restrictions significant, and a pattern of crashes related to the sight restriction is evident, traffic signal control may be a solution.
- Provide documentation in the DSR when ISD should be provided, but can not be provided

Possible Mitigation Measures If Less-Than-Minimum Design Criteria Are Used.

- Remove objects to eliminate sight restrictions
- Relocate or close the intersection
- Impose turn restrictions to eliminate higher risk movements
- Place advance signing on the unstopped approach to the intersection
- Install traffic signal control at high volume intersections

Sight Distance (Passing Sight Distance (PSD)

Factors Affecting Design

- Construction type (New, Recon., 3R)
- Roadway functional classification
- Existing/projected traffic volumes
- Selection of design speed
- Operating speeds
- Crash history due to lack of PSD
- Existing % passing/no passing

Things To Consider When Making Decisions on Design Criteria

Before deciding to apply PSD design criteria consider the following:

- **DSR documentation** – PSD is not a controlling criterion, and does not require an Exception to Standards if it is not provided. However, if PSD is needed but cannot be provided, this must be documented, justified, and approved in the DSR.
- **PSD is not a requirement in the FDM or AASHTO**
- **Effects of Insufficient PSD**– Insufficient PSD can degrade operations and increase risk taking by drivers. The effects of insufficient PSD may not be evident except where traffic volumes approach the capacity of a two-lane highway, or where the volume of heavy vehicles is usually great.
- **DSR documentation** - If PSD is needed, but cannot be provided, document why in the DSR.

If PSD cannot be provided consider the following:

- Construction of passing lanes
- Construction of truck auxiliary lanes on long upgrades
- Construction of intermittent turn-outs for slower vehicles

Sight Distance (Decision Sight Distance (DSD)

Things To Consider When Making Decisions on Design Criteria

Before deciding to use DSD design criteria consider the following:

- **DSR documentation** – DSD is not a controlling criterion and does not require an Exception to Standards if it is not provided. However, if DSD is needed, but cannot be provided, this must be documented, justified, and approved in the DSR
- **DSD is not a requirement of the FDM or AASHTO**
- **Location and circumstances** - Provide DSD where complex or instantaneous decision-making and unusual maneuvers are required, such as complex intersections, exit ramps, lane drops, etc.
- **Three dimensional design** - Strive to provide three dimensional alignments that produce DSD as part of location planning and studies for new alignment and in considering proposals to add new intersections and interchanges to existing highways.

Where DSD should be available and is needed but cannot be provided consider the following:

- Traffic control devices
- Advance warning signs

Cross Section (Lane)

Factors Affecting Design

- Construction type (New, Recon., 3R)
- Roadway functional classification
- Type of terrain (level or rolling)
- Existing/projected traffic volumes
- Selection of design speed
- Operating speeds
- Crash history due to lane width
- Roadside conditions

Things To Consider When Making Decisions on Design Criteria

Before deciding to apply minimum lane widths consider the following:

- **Exception to Standards** – Lane width, pavement cross slope, and superelevation are controlling criteria. Any lane widths that are less than the FDM minimum lane width criteria or greater than the FDM maximum require an exception to standards and will be approved in only very rare instances.
- **DSR documentation** - Document, justify, and solicit approval for less-than-desirable design criteria in the DSR.
- **Design speed** - Wider lanes widths are associated with higher speed roadways such as freeways, suburban arterials and two-lane arterial and collector highways.
- **Traffic volumes** - Wider lanes are desirable to accommodate variations in the lateral placement of vehicles within lanes.
- **Vehicle type** - Wider lanes better accommodate wider vehicles.
- **Drainage** – Flat cross slopes, particularly in conjunction with flat grades, may lead to ponding of water.
- **Driveway Operation** – Steep pavement cross slopes can contribute to vehicles “bottoming out” when entering and leaving driveways.
- **Capacity** - Wider lanes marginally increase the capacity of the roadway
- **Horizontal curves** - Adequate lane width is very important for vehicle "off-tracking" on horizontal curves.
- **Vehicle separation** - Narrow lanes reduce vehicle separation and separation from bicyclists.
- **Urban cross section** - Total cross section that considers left turning vehicles, medians and pedestrian and bicyclist needs should be considered,
- **Narrow lane widths on urban streets** - Lessen pedestrian crossing distances, enable provision for on-street parking and transit stops, enable development of left turn lanes for safety and tends to encourage lower operating speeds.

Possible Mitigation Measures If Less-Than-Minimum Design Criteria Are Used

- Wider shoulders
- Improved roadside (slopes & clear zones)
- Lane widening through sharp horizontal curves
- Special centerline and edge line delineation (pavement marking)
- Use of shoulder rumble strips
- Improved stopping sight distance
- Flush or raised medians on 4 or 6 lane urban roadways

Cross Section (Shoulder)

Factors Affecting Design

- Construction type (New, Recon., 3R)
- Roadway functional classification
- Type of terrain (level or rolling)
- Existing/projected traffic volumes
- Selection of design speed
- Operating speeds
- Crash history due to shoulder width
- Roadside conditions

Things To Consider When Making Decisions on Design Criteria

Before deciding to apply minimum shoulder widths consider the following:

- **Exception to Standards** – Shoulder width is a controlling criterion. Shoulder widths less than the FDM minimum shoulder width criteria require an Exception To Standards **and will be approved in only very rare instances.**
- **DSR documentation** - Document, justify, and solicit approval for less than desirable design criteria in the DSR.
- **Design Speed** - Wider shoulder widths are associated with higher speed roadways such as freeways, suburban arterials and two-lane arterial and collector highways.
- **Traffic Volumes and Vehicle Type** - Wider shoulders are desirable to enable collision avoidance maneuvers and store disabled vehicles.
- **Shoulder Side Slope** - Side slopes that are steeper than 4:1 reduce the effective width of finished shoulder.
- **Capacity** - Wider shoulders marginally increase the capacity of the roadway
- **Horizontal Curves** - Adequate shoulder width is important for vehicle off-tracking on horizontal curves.
- **Drainage** - Wider, paved shoulders increase drainage runoff.
- **Bicycles and Pedestrians** – Consider wider, paved shoulders for bicycle and pedestrian accommodations.

Possible Mitigation Measures If Less-Than-Minimum Design Criteria Are Used

- Provide a wider clear slope or roadside
- Use traversable ditch designs
- Provide adequate shy distance at safety barriers

Cross Section (Medians)

Factors Affecting Design

- Construction type (New, Recon., 3R)
- Roadway functional classification
- Existing/projected traffic volumes
- Selection of design speed
- Operating speeds
- Posted speed
- Rural versus urban categories
- Crash history due to median or lack of
- Roadside conditions
- Alignment consistency
- Truck type and %
- Left turn movements
- Intersection traffic controls

Things To Consider When Making Decisions on Design Criteria

Before deciding to apply minimum or lesser median widths or no median at all, consider the following:

- **Exceptions To Standards** - For rural and transitional/high speed urban roadways, an exception to standards is required for median widths less than the FDM design criteria.
- **DSR documentation** - For low speed urban roadways, provide documentation and solicit approval in the DSR when minimum median width criteria cannot be provided.
- **Tradeoffs** - Balance median widths with other elements of the total roadway cross section. Wider medians require more right-of-way and may result in greater environmental effects or increased construction costs.
- **Intersection operation** - Care should be taken in selecting a median width that provides for safe intersection operations. Special consideration should be given to whether room for truck storage in the median is needed.
- **Safety benefits** - Research strongly supports the safety benefits of four-lane divided urban streets versus undivided urban streets with no median.

Possible Mitigation Measures If Less-Than-Minimum Design Criteria Are Used

- Use of median safety barriers
- Where medians do not exist or cannot be provided:
- Consider left-turn restrictions
- Consider access controls
- Where narrow medians exist in urban areas
- Consider re-allocation of cross section width
- Consider use of turn-arounds or jug-handles

Cross Section (Roadside)

Factors Affecting Design

- Construction type (New, Recon., 3R)
- Roadway functional classification
- Existing/projected traffic volumes
- Selection of design speed
- Operating speeds
- Crash history due to clear zone
- Roadside conditions
- Roadside slopes
- Horizontal alignment

Things To Consider When Making Decisions on Design Criteria

Before deciding to apply minimum or lesser clear zones consider the following:

- **Exception to Standards** – Horizontal clearance is a controlling criterion. Design values that are less than the FDM minimum require an exception to standards and will be approved in only very rare instances.
- **DSR documentation** – Clear zone is not a controlling criterion and does not require an exception to standards if it is not provided. However, if clear zone is needed, but cannot be provided, this must be documented, justified, and approved in the DSR.
- **Design Speed** - High design speeds require larger clear zones, however avoid setting artificial design speeds.
- **Traffic Volumes** - The higher the traffic volume the greater the probability of a vehicle leaving the roadway and thus the greater the clear zone needed.
- **Roadside Slope and Ditch Designs** - The design of recoverable and traversable slopes and ditches reduces the size of the clear zone needed.
- **Consistency** - Apply a consistent roadside treatment approach for any project.
- **Flexibility** - Avoid the establishment of a uniform clear zone. Width does not necessarily need to be uniform. Adjust clear zone to match roadway needs.
- **Removal Or Relocation** - Encourage the removal or relocation of objects in the clear zone to improve safety and aesthetics.
- **Extreme hazard areas** - Provide extra protection when the obstacle is a cliff, a deep body of water, a flammable liquids tank, or some other similar feature that is equally dangerous regardless of the travel speed.
- **Grading** - Modify objects by flattening embankment slopes, re-grading the surrounding ground to safely redirect an errant vehicle over or around a feature or back onto the road, or redesigning the feature to be traversable or re-directive.
- **Barriers** - Barriers should be crashworthy for speeds at which they will likely be struck, regardless of the project's overall design speed, since operating speeds may vary along a highway.
- **Landscaping** - Encourage safe landscaping, paying special attention to trees placed within the clear zone, sight triangles at intersections, and bushes or other treatments in medians.

Possible Mitigation Measures If Less-Than-Minimum Design Criteria Are Used

- Removal or relocation of severe hazards and as many other hazards as possible
- Modification of objects such as:
- Flattening slopes
- Re-grading to safely redirect errant vehicles
- Redesigning features to be traversable or re-directive

If clear zone cannot be provided, then the following treatments should be considered for hazardous objects

- Removing objects
- Relocating objects
- Making objects break-away
- Shielding objects with safety barriers

Intersections

Factors Affecting Design

- Construction type (New, Recon., 3R)
- Roadway functional classification
- Existing/projected traffic volumes
- Selection of design speed
- Operating speeds
- Crash history due to median or lack of
- Roadside conditions
- Design vehicle(s)
- Alignment consistency
- Truck type and %
- Turning movements
- Traffic control

Things To Consider When Making Decisions on Design Criteria

Before deciding on Intersection design criteria consider the following:

- **DSR documentation** - Document, justify, and solicit approval for less than desirable design criteria in the DSR.
- **Sight Distance** - Provide sufficient sight distance in advance of the intersection and on all approaches to the intersection.
- **Traffic Control** - Use appropriate traffic control.
- **Skew angle** – Skew angles that are greater than 15 degrees off of 90 degrees may inhibit the ability of drivers on a side road to see traffic approaching on the mainline. This is particularly true for older drivers.
- **Left Turns** - Provide safe and efficient handling of left turning vehicles.
- **Alignments** - Avoid unusual or confounding alignments near intersections. Intersections located within a mainline horizontal curve appear to be more crash prone than intersections located on a tangent.
- **Capacity** - Provide sufficient capacity at intersections to reduce adverse operational effects on the adjacent street system.
- **Design Vehicles** - Select the appropriate design vehicle.
- **Traffic Control Devices** – The Manual on Uniform Traffic Control Devices specifies practice regarding the design and placement of traffic control devices, including traffic signals, stop and other regulatory signs and warning signs.

Possible Mitigation Measures If Less-Than-Minimum Design Criteria Are Used

- Placement of roadside objects farther from pavement edge
- Use of mountable or painted end treatments on raised barriers
- Use of different traffic control schemes where turn lanes can not be provided:
  - Turn prohibitions
  - Special signal phasing
  - Rumble strips
  - Other measures

Access Control

Factors Affecting Design

- Construction type (New, Recon., 3R)
- Roadway type & functional class.
- Existing and projected traffic volumes
- Selected design speed
- Operating speeds

Things To Consider When Making Decisions on Design Criteria

Access management is the key to a highway's two primary functions: 1) mobility and 2) access to adjacent lands.

Before deciding on access control criteria consider the following:

- **WisDOT policy and guidance** - Follow WisDOT policy and guidance for access control - see FDM Chapter 7.
- **Existing and Proposed Controls** – Consult with the District Access Administrator and review records, plans, plats, and the State Access Management System Plan for existing and proposed access controls such as: §83.027 - County Administrative Access Control, §84.09 – Purchased Access Control, §84.25 - Administrative Access Control, §84.295 – Freeway or Expressway Designation, TRANS 233 – Land Division Review, driveway permits.
- **Local requirements** - Work with communities when deciding on the appropriate access control measures to provide. Work with communities to develop a highway system in which access needs are provided within the context of each road's function.
- **Limit the number of conflict points -** This includes using non-traversable medians to manage left-turn and crossover movements. Judicious use of median treatments, driveway permits and driveway geometry can improve the operation of the road without undue burden on landowners accessing their property.
- **Separate conflict points** - This includes preserving the functional area of intersections and interchanges.
- Separate turning movements from through movements.
- **Locate traffic control signals to facilitate traffic movement.**
- **Maintain a hierarchy of roadways by current and planned function -** An important part of this is to provide an adequate supporting street and circulation system.
- **Limit access to state highways** and other major roads when there is an opportunity for alternative access to lower-functioning roads.
- **DSR documentation** - If access control should be provided is needed (based on crash history etc.), but can not be provided, document why in the DSR
- Access control is among the most useful tools available to maintain safe and efficient operations

Pedestrian/Bicycle Accommodations

Factors Affecting Design

- Construction type (New, Recon., 3R)
- Roadway type & functional class.
- Existing and projected traffic volumes
- Bicycle and pedestrian counts
- Selected design speed
- Operating speeds
- Bicycle/pedestrian related crash history
- Drainage grate types

Things To Consider When Making Decisions on Design Criteria

Before deciding on pedestrian and bicycle design criteria consider the following:

- **DSR documentation** - Provide Pedestrian or bicycle accommodations except where prohibited (i.e. freeways), or where it isn't feasible. Document in the DSR whenever they cannot be provided.
- **Location** – Ideally, construct pedestrian and bicycle facilities outside the clear zone of high speed, high-volume highways.
- **Curbing** - Curbing has little, if any, re-directive capacity at medium and high speeds and consequently affords little, if any, protection for pedestrians.
- Designated routes
- Pedestrian/Bicycle volumes
- Shared and vs. exclusive facilities
- Existence of parking
- Regular versus integral curb and gutter
- Accommodations on bridges

Bridges

Factors Affecting Design

- Construction type (New, Recon., 3R)
- Roadway functional classification
- Existing/projected traffic volumes
- Selection of design speed
- Operating speeds
- Bridge crash history
- Roadside conditions
- Bicycle/pedestrian accommodations

Things To Consider When Making Decisions on Design Criteria

Before deciding to apply minimum or less-than-minimum SSD design criteria consider the following:

- **Exception to Standards** – Bridge Width, Horizontal Clearance, Vertical Clearance, and Structural Capacity are controlling criteria. Design values that are less than the FDM minimum or greater than the FDM maximum require an exception to standards, and will be approved in only very rare instances.
- **DSR documentation** - Document, justify, and solicit approval for less than desirable design criteria in the DSR.
- **Historic or very low volume bridges** - Replacement or retention of bridges having historic or aesthetic value or design of bridges on very low volume roads may justify widths less than the indicated minimum AASHTO values (although this may still require an exception to standards).
- Pedestrian and bicycle needs.