Design Exceptions and Design Variations

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Quality Assurance & Engineering Support

Design Exceptions & Variations

- Overview
- Identification
- Crash Analysis
- Benefit/Cost Analysis
- Mitigation Strategies
- Justification and Documentation

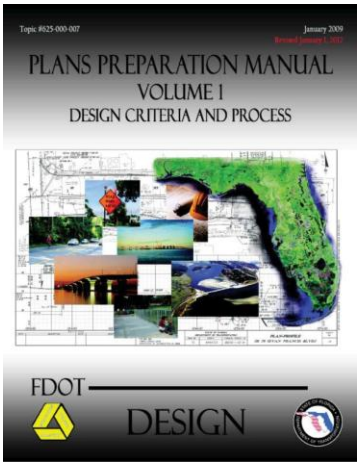
Design Exceptions & Variations

» Overview

Plans Preparation Manual (PPM)

Chapter 23

- Two approval processes:
  - Design Exceptions
  - Design Variations



What are Design Exceptions?

A documented decision to design a highway element or a segment of highway to design criteria that do not meet minimum values or ranges established for that highway or project.

FHWA Mitigation Strategies for Design Exceptions
July 2007

Exceptions

Design Exceptions are required when the proposed design elements are below both the Department's governing criteria and AASHTO's new construction criteria for FHWA's 13 "Controlling" Criteria

- Design Speed
- Lane Width
- Shoulder Width
- Bridge Width
- Structural Capacity
- Vertical Clearance
- Grade
- Cross Slope
- Superelevation
- Horizontal Alignment
- Vertical Alignment
- Stopping Sight Distance
- Horizontal Clearance (lateral offset to obstruction)

Variations

Design Variations are required when proposed design elements are below the Department's criteria and where a Design Exception is not required.

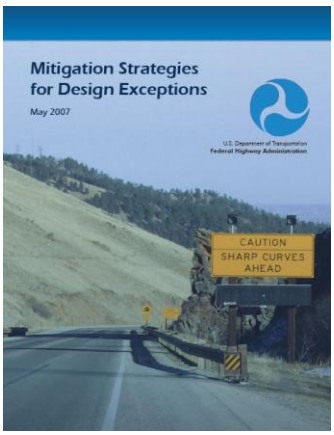
Not all inclusive

- Border Width
- Sidewalk
- Bike Lanes
- Hand Rails
- Front Slope

Common Reasons for Considering an Exception or Variation

- Impacts to the natural environment
- Social or right-of-way impacts
- Preservation of historic or cultural resources
- Sensitivity to context or accommodating community values
- Construction or right-of-way costs

Guidance for Practitioners



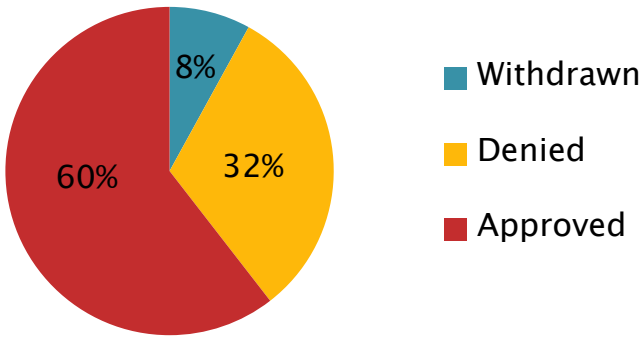
1. Basic Information
2. Design Exception Process
3. Clarifies Criteria
4. Potential Mitigation Strategies
5. Case Studies

http://safety.fhwa.dot.gov/geometric/pubs/mitigationstrategies/index.htm/

Most Common Design Exceptions

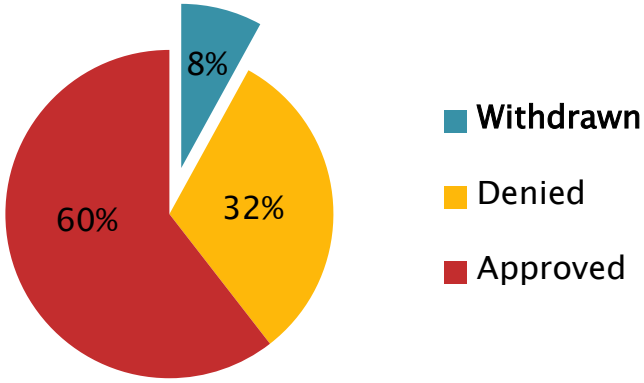
1. Shoulder Width
2. Cross Slope
3. Horizontal Clearance
4. Bridge Width
5. Stopping Sight Distance
6. Vertical Alignment
7. Structural Capacity

Approval Rates for First-Time Submittals



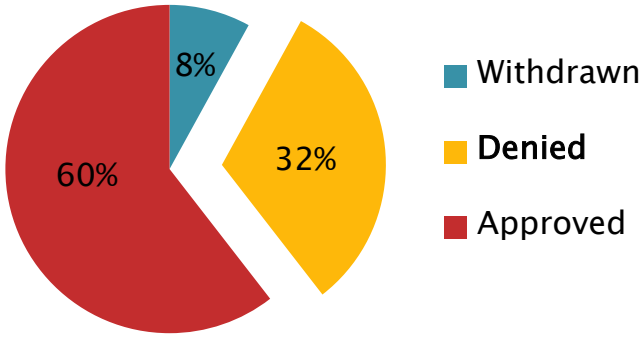
FDOT: 2008 - 2011

Approval Rates for First-Time Submittals



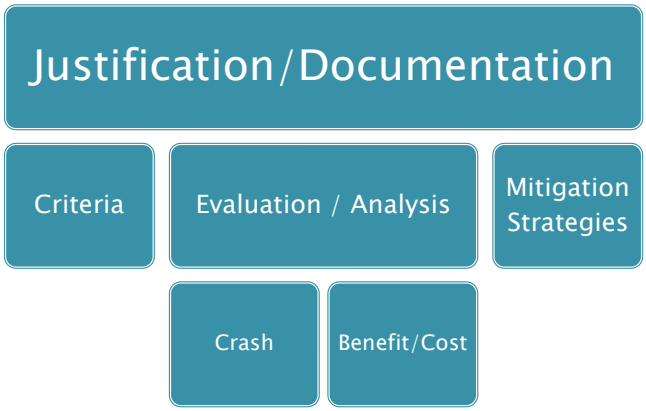
FDOT: 2008 - 2011

Approval Rates for First-Time Submittals



FDOT: 2008 - 2011

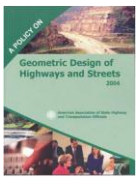
Most Common Reasons for Denial

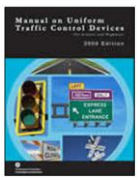


Defining Safety for Road Design

- NOMINAL SAFETY

examined in reference to compliance with standards, warrants, guidelines and sanctioned design procedures





- SUBSTANTIVE SAFETY

actual or expected crash frequency and severity for a highway or roadway segment or intersection

Source: FHWA Resource Center
Developing Strong Justifications for Design Exceptions

Design Exceptions & Variations

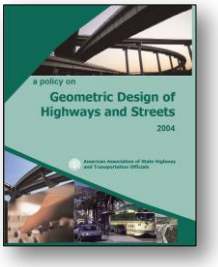
» Identification

Criteria Resources

Department (FDOT)	AASHTO
▪ Plans Preparation Manual (PPM) ▪ Standard Index ▪ Structures Manual	▪ A Policy on Geometric Design of Highways and Streets (Greenbook) ▪ A Policy on Design Standards Interstate Standards ▪ Roadside Design Guide

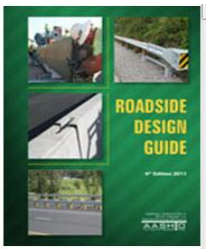
AASHTO Criteria

A Policy on Geometric Design of Highways and Streets (Greenbook)



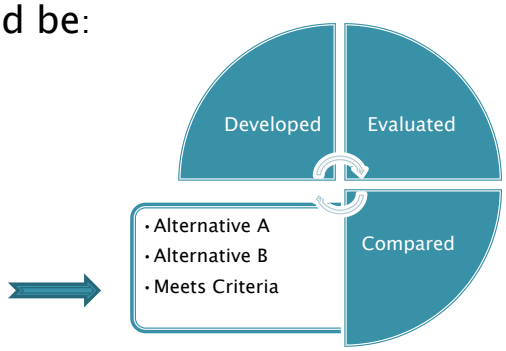
A Policy on Design Standards Interstate System

Roadside Design Guide



Identify Alternatives

- If it appears that meeting criteria may not be feasible at a particular location, alternatives should be:



Design Exceptions & Variations

- Crash Analysis

Crash Reports Provide Clues

Crash Analysis
Highlights

Identify the location(s)

Gather Data

Analyze Crashes

District Three: SR 97 Escambia County

Crash Analysis
Highlights

Identify the location(s)

Gather Data

Analyze Crashes

Establishing Limits

- Project
  - MP 0.615 – 20.070
- Bridge
  - MP 16.087 – 16.101

Crash Analysis
Highlights

- Analysis Period
  - 5 Complete Years
- What Years?
  - 2005 – 2009
  - 2006 – 2010
  - 2007 – 2011

Crash Analysis
Highlights

- Crash Analysis Reporting (C.A.R.) System
  - Detail or Summary Reports
  - Law Enforcement Crash Reports (Long Forms)

Detail Output

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Determine your Project & Design Exception Limits

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 R N     C S    S    I      EN   TR   VAR   E  O  A  O  RALA  L AE I E D RC OC IO O C ET EU EO E OM OA RA ET EU EM E OM OA RA     UI
 A U     O E    E    L      AO   AO   EIA   A  N  Y  U  ATAT  C RV G A   AO AO TC A C HY HS HV H IP NU IG HY HS HO H IP NU IG V K MN
 S M     U C    SC   E      RD   TA   RLF   R  T     R  SESE    ME H T S FN DN EA D   IP IE IM   NA TS VE IP IE IV   NA TS VE E I BJ
 H B     N T    UT   P      EE   ED   AYF      H        H SG  I FN T H U FT  D  T   L CE C  CN D TC RE / CE C  C  D TC RE / H L EU
   E     T I    BI   O      S         G I                  O  N UT I E R IR  T  I S N L  L1 LT I  T I  P1 L  L2 L2 I  T I  P2 C L RR
   R     Y O    O    S      T         E C                  R  V L  N R F CO  N  O D    E1 E  E  R O  B1 E  E2 E  E  R O  B2 E L E  E
           N    N    T                                     Y     1 G    L  S  N  #        1 1 F1    D              2 F2    D S D  D
****************************************************************************************************************************************
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- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
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1
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Caution should be used with eliminating crash reports to review!


```
0
 REPORT...CARPJ13-01                           FLORIDA - DEPARTMENT OF TRANSPORTATION                              PAGE NO:        3
   DATE...04/27/2009                         C A R - CRASH ANALYSIS REPORTING SYSTEM                               USERID:   PL330KB
   TIME...14:03:17                     CRASH DATA DETAIL AND EXTRACT FOR STATE-MAINTAINED ROADS                    I/O....   CARO213

 COMMENT:                                 1 - SORT BY ROADWAY, MILE POINT
   FROM: 01/01/2004 TO 04/27/2009                             RAMPS EXCL
   FROM CO/SEC/SUB: 48 004 000            MP: 008.334          INFL EXCL
   TO   CO/SEC/SUB: 48 004 000            MP: 010.043         CR/OS INCL
(same crash data listing as above)
1
```

Caution should be used with eliminating crash reports to review!

Crash Analysis
Highlights

Identify the location(s)

↓

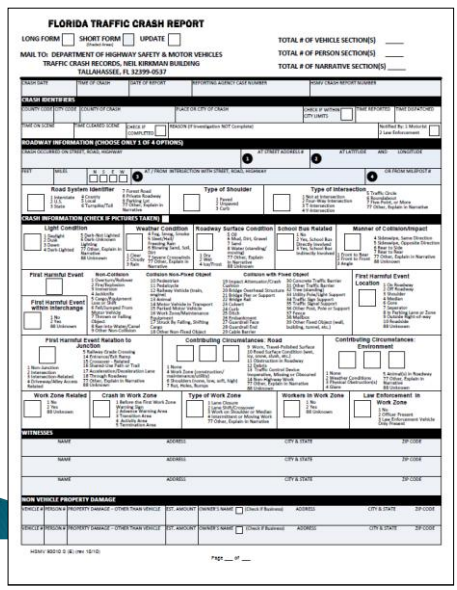
Gather Data

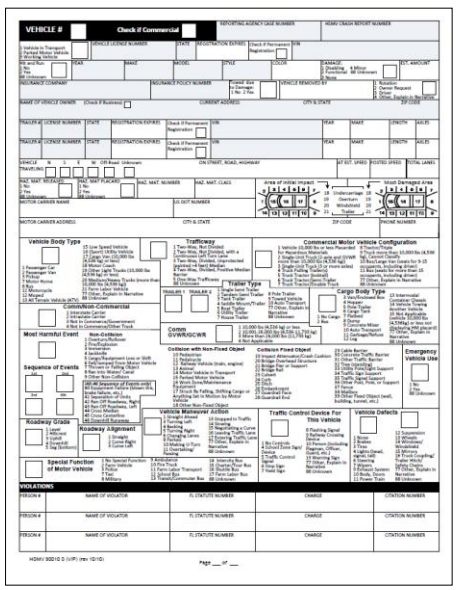
↓

Analyze Crashes

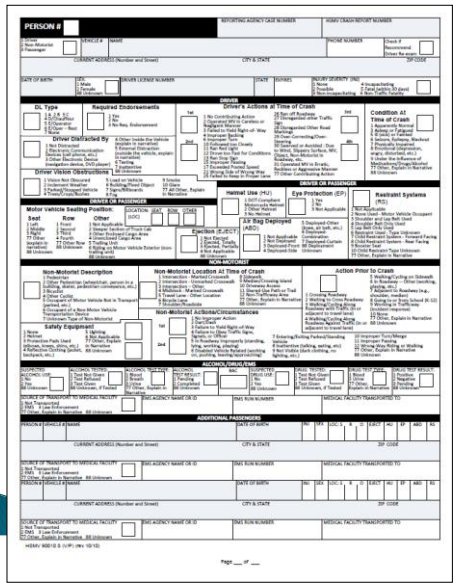
- Crash Analysis Reporting (C.A.R.) System
  - Detail or Summary Reports
  - Law Enforcement Crash Reports (Long Forms)

HSMV 90010 S – New Crash Report





HSMV 90010 S – New Crash Report



ONLY the Crash Reports Tells the Story

Crash Analysis
Highlights

- Contributing Factors
  - Human (Driver behavior)
  - Road Condition (Road design)
  - Vehicle (Vehicle design and maintenance)
  - Environmental (Weather)

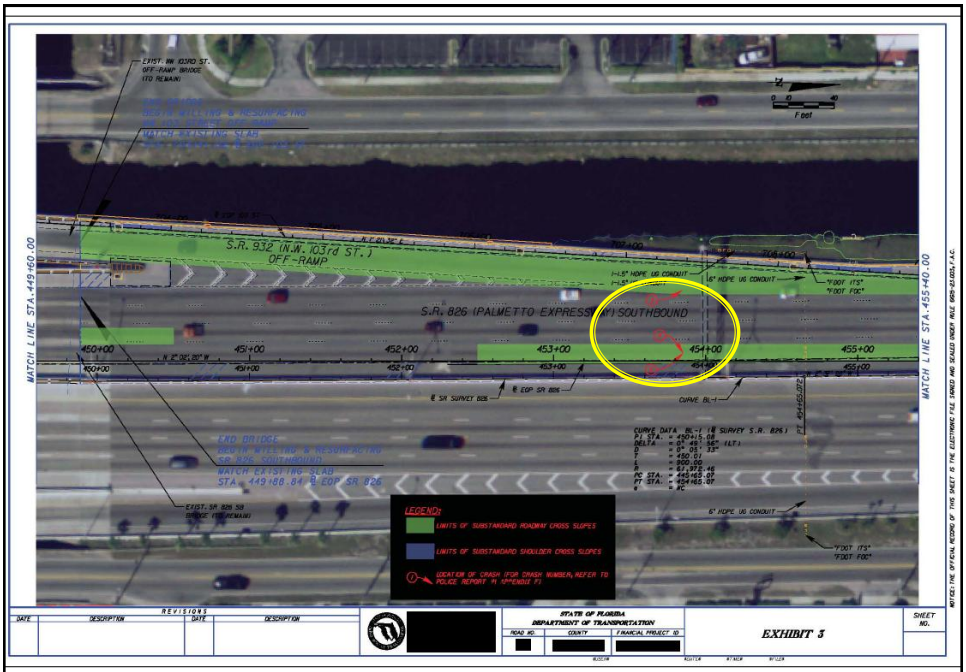
Crash Analysis
Highlights

- Crash Patterns
  - Identify Crash Patterns and Significant Trends.

Document your steps…

A Design Exception Request for Substandard (flat) Cross Slope on a RRR Project:

- 5 years of crash data reveals 434 crashes within the design exception limits.
- 61 occurred under wet pavement conditions.
- Further evaluation of the police reports indicate 8 out of 61 crashes which occurred under wet pavement conditions may have been attributed to substandard cross slope.
- A crash diagram was used for further evaluation.



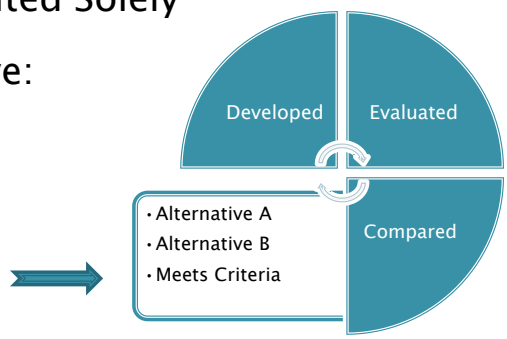
Crash Numbers: 4, 5 & 11

Design Exceptions & Variations

» Benefit/Cost Analysis

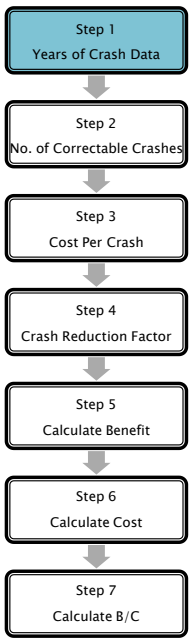
Benefit/Cost Analysis for Alternatives

- The Analysis Should Only Include the Benefits and Costs Attributed Solely to Each Alternative:



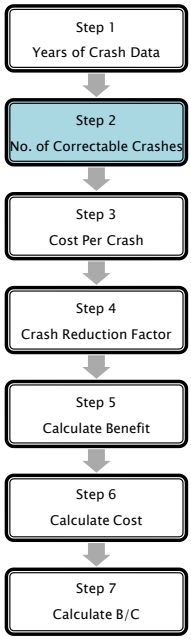
7 Steps to B/C Analysis

Note: If There Isn't a Crash History, a B/C Analysis May Not Be Necessary



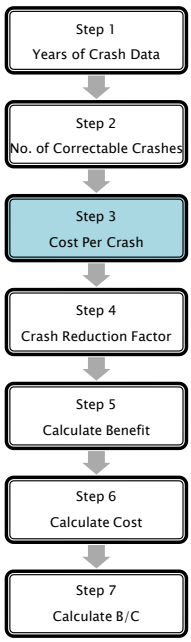
Crash Data

1. Minimum of 5 most recent years of crash data.



Number of Correctable Crashes

2. Number of correctable crashes that were directly related to the deficient roadway element.

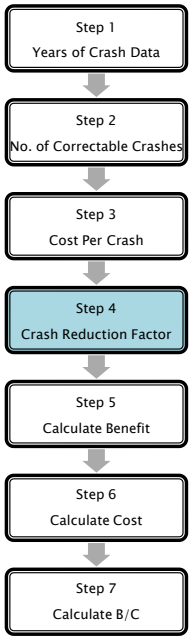


Societal Cost
(Cost Per Crash)

3. Societal Cost provided by the SSO found in the PPM by facility type

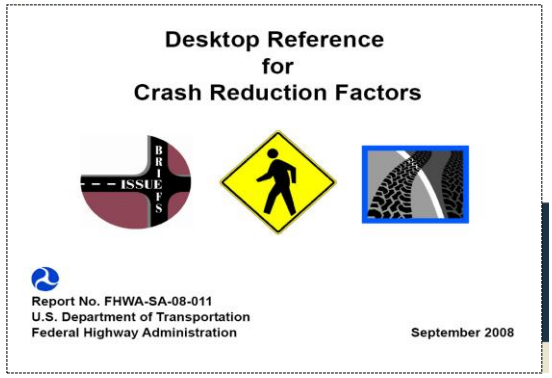
HSIPG Cost/Crash by Facility Type

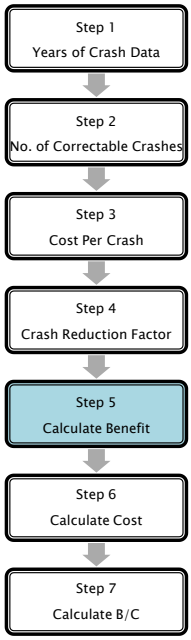
Facility Type	Divided			Undivided		
	Urban	Suburban	Rural	Urban	Suburban	Rural
2-3 Lanes	$85,851	$151,015	$260,531	$92,847	$228,613	$402,003
4-5 Lanes	$83,359	$181,265	$366,422	$83,359	$193,774	$94,171
6+ Lanes	$107,658	$130,385	$478,263	n/a	n/a	n/a
Interstate	$141,197	n/a	$295,810	n/a	n/a	n/a
Turnpike	$124,459	n/a	$215,507	n/a	n/a	n/a



Crash Reduction Factor

4. Found In Order of Preference
   - State Safety Office
   - FHWA CMF Clearinghouse
   - FHWA Desktop Reference

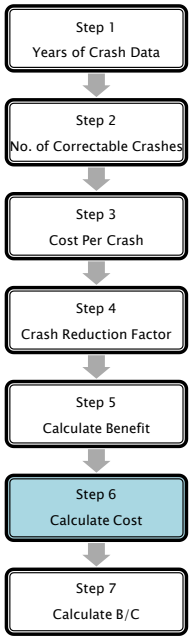




Calculate the Benefit

5. The Benefit is the anticipated total annual crash cost saving.

$$\text{Annual Benefit} = \frac{\text{No. Correctable Crashes X Cost per Crash X CRF}}{\text{No. Years of Crash Data}}$$



Calculate Cost

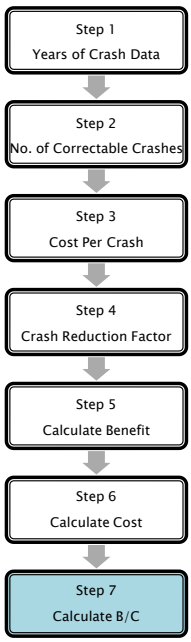
6. Cost from the Long Range Estimate (LRE)

   Capital Recovery Factor

   Service Life

   Discount Rate (4%)

$$\text{Annual Cost} = \Sigma \text{ Construction Cost per Feature X (Capital Recovery Factor)}$$



Calculate B/C

7. The B/C is the Annual Benefit divided by the Annual Cost

$$\frac{B}{C} = \frac{\text{Annual Benefit}}{\text{Annual Cost}}$$

Design Exceptions & Variations

» Mitigation Strategies

Mitigation Strategies

In many cases some form of mitigation can be accomplished to lessen any adverse impacts that may result from the lower design criteria.

Mitigation Strategies for Design Exceptions (July 2007) is a resource for evaluating and implementing.

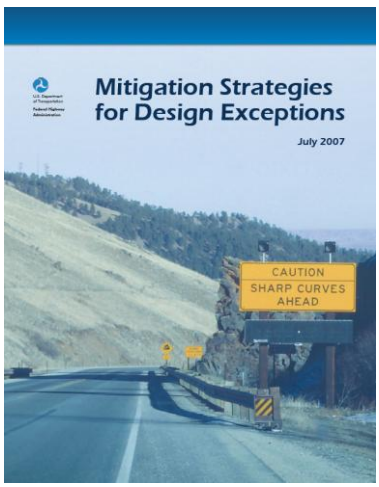


TABLE 22
Potential Mitigation Strategies

Mitigation Strategies

Design Element	Objective	Potential Mitigation Strategies
1. Design Speed	Reduce operating speeds to the design speed.	Cross-sectional elements to manage speed.
2. Lane Width & 3. Shoulder Width	Optimize safety and operations by distributing available cross-sectional width.	Select optimal combination of lane and shoulder width based on site characteristics.
	Provide advance warning of lane width reduction.	Signing.
	Improve ability to stay within the lane.	Wide pavement markings.
		Recessed pavement markings.
		Raised pavement markings.
		Delineators.
		Lighting.
		Centerline rumble strips.
		Shoulder rumble strips.
		Painted edgeline rumble strips.
	Improve ability to recover if driver leaves the lane.	Paved or partially-paved shoulders.
		Safety edge.

Mitigation Strategies

- Include a Section In Your Report that Discusses all Mitigation Strategies:
  - Existing
  - Considered
  - Proposed

Design Exceptions & Variations

» Justification and Documentation

Justification

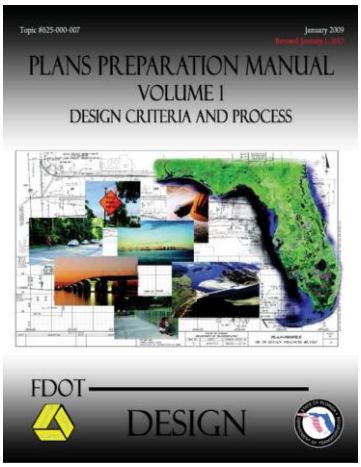
- A Strong Case for an Exception Can Be Made If:
  - The Required Criteria Are Not Applicable to the Site Specific Conditions.
  - The Project Can be as Safe by Not Following the Criteria
  - The Environmental or Community Needs Prohibit Meeting Criteria

Justification

- A Case Should Not Be Made Based Solely On the Basis That:
  - The Department can save money.
  - The Department can save time.
  - The proposed design is similar to other designs.

Documentation

- Plans Preparation Manual <u>Chapter 23</u>
  - Don't Forget to Include the Applicable "A"–"Y" Requirements in the PPM.

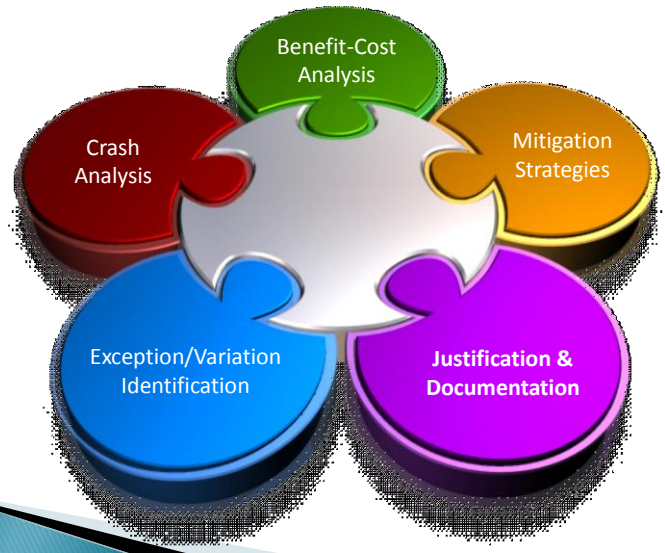


Documentation

- Use Engineering Judgment
- Length of Documentation is Not Important.
- The Key is to Provide Clarity and Completeness To Someone Not Familiar With the Project or the Design.

Note: Provide Enough Time for Central Office and for FHWA Review

Putting it all together!



Central Office Contacts

Exceptions and Variations

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Questions?