100 Design Controls and Exceptions

100 Design Controls and Exceptions

100 Introduction

In order to determine the criteria to be used for a project, it is necessary to initially identify some basic information about the facility. This information is known collectively as the design designation and includes: functional classification, traffic data, terrain, locale, design speed and legal speed. ***Figure 100-1*** shows how these design controls relate to many of the design features included in this manual.

101 FUNCTIONAL CLASSIFICATION

101.1 General

Functional classification, the systematic grouping of highways by the character of service they provide, is an important tool that has been used for many years in comprehensive transportation planning. Its adoption by highway designers to categorize basic highway systems serves as an effective transition from the planning process to the design process. Under a functional classification system, standards and level of service vary according to the function of the highway facility. Traffic volumes are used to refine the standards for each class.

101.2 Urban & Rural

Functional classification is initially divided into urban and rural categories. Urban areas are comprised of: (1) places with a population of 5,000 or more, that are incorporated as cities, villages, and towns but excluding the rural portions of extended cities; (2) census designated places with 5,000 or more persons; and (3) other territory, incorporated or unincorporated, included in urbanized areas.

Extended cities are those cities whose boundaries include territory that is essentially rural in character (e.g., uncurbed pavement with open drainage, where a rural typical section would be more consistent with the existing roadway).

Urbanized areas consist of one or more places (central places) and the adjacent densely populated surrounding territory (urban fringe) that together have a minimum population of 50,000. The urban fringe generally consists of contiguous territory having a density of at least 1,000 persons per square mile.

Rural areas are those outside the boundaries of urban areas.

101.3 Classification Used in ODOT Design Criteria

The rural and urban functional classifications are further defined for design purposes as follows:

- Interstate
- Other Freeways and Expressways
- Principal Arterial Roads (rural) and Streets (urban)
- Minor Arterial Roads (rural) and Streets (urban)
- Collector Roads (rural) and Street (urban)
- Local Roads (rural) and Streets (urban)

The functional classifications for streets and highways in Ohio are kept on record in the Office of Systems Planning and Program Management.

102 TRAFFIC DATA

102.1 General

Traffic data is the foundation upon which designs are based; consequently, it is important that adequate traffic data be available early in the development of a project's design. It is equally important that this data be coordinated within various geographic regions of the State to avoid inconsistencies between projects under the same traffic influences.

All forecasted traffic data used shall be developed following state traffic forecasting guidelines provided by Division of Planning, Office of Statewide Planning & Research, Modeling & Forecasting section. Documents containing forecasting guidelines are available on the office internet web page.

102.2 Traffic Data Content

The design criteria tables in this manual require basic traffic data for the design year. The traffic design year is generally considered to be the following:

Project Type	Traffic Design Year (After Opening Day)
New Construction	20 years hence
Reconstruction	20 years hence
Major Pavement Rehab.	20 years hence
Minor Pavement Rehab.	12 years hence
Two-Lane Resurfacing	12 years hence

For most projects, the following data are required:

- Average Daily Traffic (ADT) for opening day (for lighting and signal warrants).
- Average Daily Traffic (ADT) for design year.
- Design Hourly Volume (DHV). AM and PM DHV are required for interchange design.
- The percentage of B and C trucks (T24) during the 24-hour period for the design year.
- The percentage of B and C trucks (TD) during the design hour traffic for the design year (for adjusting capacity analyses).
- Directional Distribution Factor (D) for the design year (used to obtain the Directional Design Hour Volume (DDHV) for the design hour).

Projects on low-volume facilities (current ADT<400) without a design year traffic forecast may use the current ADT for design purposes.

Average Daily Traffic (ADT) volumes should be subdivided into the following classes:

P - Passenger Cars - including station wagons, mini-vans, sport utility vehicles and motorcycles.

A - Commercial - including motorized recreational vehicles, school buses, and light delivery trucks such as panel trucks and pick-up trucks which do not use dual tires.

B - Commercial - including tractors, trucks with semi-trailers and truck-trailer combinations.

C - Commercial - including buses or dual tired trucks having either single or tandem rear axles.

Estimated Design Year ADT may be subdivided into P & A vehicles and B & C trucks if data for each vehicle class is not readily available, since these classes have similar operational characteristics. Current ADTs for various sections of Interstate, United States and State Highways for each county are available in the Traffic Survey Report published by the Office of Technical Services. Counts at specific points in the section may vary from the average and are available upon request from the Office of Technical Services.

103 TERRAIN & LOCALE

103.1 General

Many rural design features are significantly influenced by the topography of the land through which the roadway is constructed. To characterize variations, Ohio topography is categorized into three types of terrain: level, rolling or hilly. Locale is used to describe the type of area and generally refers to the character and extent of development in the vicinity. Urban, rural, residential, and commercial/industrial are characteristics often used to describe locale.

103.2 Terrain Types

Level - Any combination of grades and horizontal and vertical alignment permitting heavy vehicles to maintain approximately the same speed as passenger cars. This generally includes grades of no more than 2 percent for a distance of no more than 2 miles.

Rolling - Any combination of grades and horizontal and vertical alignment causing heavy vehicles to reduce their speeds substantially below those of passenger cars, but not causing heavy vehicles to operate at crawl speeds.

Hilly - Any combination of grades and horizontal and vertical alignment causing heavy vehicles to operate at crawl speeds. Hilly terrain in Ohio conforms to mountainous terrain used in the American Association of State Highway Transportation Officials (AASHTO) publications.

For design purposes a heavy vehicle is defined as a vehicle with a mass/power ratio of approximately 200 lb/hp. This represents a typical semi-truck. Crawl speed is the maximum sustained speed that a heavy vehicle can maintain on an extended upgrade and varies with the weight of the vehicle and the steepness of the grade.

104 DESIGN & LEGAL SPEED

104.1 General

Design speed is defined in the AASHTO publication, "A Policy on Geometric Design of Highways and Streets" (Green Book), as a selected speed used to determine the various geometric design features of the roadway. The assumed design speed should be a logical one with respect to the topography, anticipated operating speed, the adjacent land use and the functional classification of highway.

104.2 Design Speed Values

The minimum design speed for all projects shall be equal to or greater than the legal speed for the facility and the preferred design speed shall be 5 mph higher than the legal speed. Design speeds shall be specified in 5 mph increments. For resurfacing projects the design speed is the legal speed, or alternately, the 85th percentile speed for individual or series of horizontal and vertical curves. Refer to part 1200 of the Traffic Engineering Manual for guidance establishing the 85th percentile speed. Ramp design speeds are included in ***Section 503.2***.

Design speeds of 50 mph and higher are considered high speed and design speeds less than 50 mph are considered low speed.

105 DESIGN EXCEPTIONS

105.1 General

Designers and engineers are faced with many complex tradeoffs when designing highways and streets. A good design balances cost, safety, mobility, social and environmental impacts, and the needs of a wide variety of roadway users.

Highway design criteria that have been established through years of practice and research form the basis by which roadway designers achieve this balance. These criteria are expressed as minimum dimensional values or ranges of values for various elements of the three-dimensional design features of the highway. The criteria are intended to deliver an acceptable, generally cost-effective level of performance (traffic operations, safety, maintainability, and constructability). The criteria are updated and refined as research and experience increase knowledge in the field of highway engineering, traffic operations, and safety.

A design exception is 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. The minimum values or ranges of design criteria, also known as controlling criteria for design, that require design exceptions when they are not met or exceeded are set forth in ***Section 105.2*** and ***Figure 105-1***. The designer should call attention to any design features that require a design exception as soon as possible, but no later than the first stage review submittal as defined in the Location & Design Manual, Volume Three.

Other design values, policies, practices, etc. that are mentioned in this Manual are guidelines intended to promote uniformity and good design. Deviation from these guidelines does not require a formal design exception; however, it may still be necessary to justify or otherwise seek approval from ODOT of the proposed design when deviations are necessary. This should be accomplished through the normal review process.

Ramps do not have continuous design speeds throughout their lengths. However, design exceptions are required for not meeting the lower range for speed related items (see ***Section 503.2*** for directional and loop ramps). In addition, design exceptions for non-speed related items (e.g., lane width, shoulder width, bridge width, and lateral clearance) are required.

A design exception should be reevaluated if the project has not sold within five years of the approved design exception.

Exceptions will not be required for projects that do not change the basic highway cross-section or geometry; e.g. resurfacing, bridge deck overlays, rest areas, lighting, signing, signalization, fencing, guardrail, slide corrections, etc. A change in the basic highway cross section would include any change to the lane width, shoulder width, pavement cross slope or additional earthwork beyond the graded shoulder.

Side roads with more than 600’ of approach work do require design exceptions.

105.2 Design Controlling Criteria that Require a Design Exception

Exceptions must be processed for the following design controlling criteria when they will not be attained:

High Speed Roadways (Interstate highways, other freeways and roadways with a design speed ≥50 mph)

1. Lane Width
2. Shoulder Width
3. Horizontal Curve Radius
4. Maximum Grade
5. Stopping Sight Distance (Horizontal and Crest Vertical Curves)
6. Superelevation Rate
7. Vertical Clearance
8. Pavement Cross Slope
9. Design Loading Structural Capacity

Low Speed Roadways (design speed <50 mph)

1. Design Loading Structural Capacity
2. Lane Width (only if required for the National Network, see ***Section 105.3*** below)

In addition to the above geometric design features, design exceptions are also required when existing non-standard bridge parapets and curb configurations are to be retained. For details on non-standard bridge parapets see ODOT Bridge Design Manual or contact the Office of Structural Engineering.

105.3 National Network (or National Truck Network)

The National Network was established by Congress in 1982 with the Surface Transportation Assistance Act as the network of highways designated for use by large trucks. In Ohio, the National Network consists of all Interstate Routes and the old Federal Aid Primary (FAP) Routes. One of the criteria for the National Network is, "The route consists of lanes designed to be a width of 12 feet or more or is otherwise consistent with highway safety."

In lieu of providing 12' lane widths for all lanes on the National Network, a single 12' lane in each direction can be provided with a design exception for any lane widths that do not meet design criteria. When no 12' lane in each direction can be provided a design exception will be required. The lane width design exception would be required regardless of whether the facility is low or high speed. The emphasis of the lane width design exception should focus on the impacts of the truck traffic such as truck involved crashes (existing and expected), truck off-tracking, etc.

105.4 Local Projects

Locals may design projects in accordance with their own formally written local design standards which have been reviewed and accepted by the ODOT District; otherwise they must use the ODOT Location & Design Manual (L&D) or the appropriate AASHTO publication. On the NHS, projects must conform to ODOT standards unless local standards have been otherwise approved for use by ODOT's Office of Roadway Engineering on behalf of FHWA. Design exceptions for Local-let projects should follow the guidelines in the Local Programs manual on Project Development and Design. Design exceptions for Local ODOT-let projects should follow the L&D Manual. The design exception format for both should follow ***Section 105.5.1***. All Local project (both Local-let and ODOT-let) design exceptions are approved by the District Capital Programs Administrator.

105.5 Design Exception Documentation and Approval Process

105.5.1 Documentation Format

The Design exception document must contain at least the following information:

1. The Design Designation for the project.
2. A Title Sheet Location map and a schematic or plan sheet if needed for clarity.
3. The controlling criteria affected by the proposed design exceptions. (As noted in ***Figure 105-1***, normal design criteria must be used as the basis for all design exceptions.)
4. A description of the project.
5. Proposed mitigation for the deviation (if any).
6. Support for the proposed deviation based upon sound engineering practices, cost comparison/ analysis, impact on the environment, the relationship between any crash patterns and the proposed design exception, etc.
7. The GCAT/CAM Tool must be attached. HSM Analysis may also be required by ORE or CPA based upon the nature of the exception request. Refer to the Safety Analysis Guidelines maintained by the Office of Program Management for information to conduct the analysis.

105.5.2 Processing and Approval Authority

1. All design exception requests shall be prepared or processed by the District using the electronic submission process found on the Office of Roadway Engineering website, http://www.dot.state.oh.us/Divisions/Engineering/Roadway/Pages/default.aspx. Design exceptions must be prepared and sealed by a licensed professional engineer.

2. Design Exceptions for projects in the LPA process will be approved by the District Capital Programs Administrator.

3. Design exceptions for access permit projects are required to be approved by the District Capital Program Administrator.

4. All non-local project Design Exceptions will be approved by Administrator of the Office of Roadway Engineering. The Office of Roadway Engineering will coordinate with FHWA for all projects requiring FHWA approval.

5. The Office of Roadway Engineering will be advised in writing of the action taken by the FHWA on Federal oversight projects. The original of such correspondence will be retained by the Office of Roadway Engineering and copies will be forwarded to the District. The District shall advise all involved LPAs and the Office of Estimating.

6. All exceptions to the 16' vertical clearance standard on rural interstate routes or on a single interstate route through urban areas must be coordinated with the Surface Deployment and Distribution Command Transportation Engineering Agency (SDDCTEA) by the District. For details refer to the FHWA Memorandum of April 15, 2009 (https://www.fhwa.dot.gov/design/090415.cfm).

105.5.3 Amendments to Design Exceptions

A previously approved design exception may be amended to accommodate additional elements (that do not invalidate previously approved items) by submitting an addendum to the design exception. The original may be amended to change previously approved items or remove items that no longer require an exception by submitting a revision to the design exception. In either case, the procedure follows the same formatting and approval process as the original design exception.

106 DATA-DRIVEN SAFETY ANALYSIS

106.1 General

The purpose of the Data-Driven Safety Analysis (DDSA) is to better understand the safety performance of a project and each of the alternatives. Additionally, it can be used to determine if there is a pattern or concentration of crashes within the project limits that can be reasonably and practically addressed through the inclusion of countermeasures in the project.

Factors that can affect countermeasures being “reasonable and practical” include but are not limited to:

1. Cost;
2. Environmental or R/W impacts;
3. Countermeasure work type being compatible with the planned project;
4. Schedule impacts

A minimum safety assessment should be performed in the early phases of project development (i.e. project programming). This will allow schedule, scope, and budget considerations to be accounted for when reasonable and practical countermeasures are to be included in the project. Reference Safety Analysis Guidelines maintained by the Office of Program Management for items included in the minimum safety assessment.

106.2 Applicable Projects

(DDSA) is applicable to ODOT Let projects, except those whose primary purpose are noted below. While Local Let projects are exempt from performing DDSA, the analysis is strongly recommended to understand the impacts of the project on crash frequency and severity.

Typical projects where the DDSA is not applicable:

a) Maintenance projects such as guardrail repair, mowing, striping, signing, RPM’s, etc.;
b) Pavement surface treatment projects as defined by Section 550 of the Pavement Manual;
c) Spot repairs;
d) Slot paving;

106.3 Data-Driven Safety Analysis

(DDSA) is defined as using real data and established methods to analyze crash and roadway data to estimate the safety impacts of highway projects, assess existing safety conditions, and prioritize locations for safety analysis and/or funding. This allows agencies to target investments with greater confidence that will improve safety on the roadway.

Each project is categorized depending on the project size, complexity, and/or potential impact to the environment. Based on the complexity of the project, one of three safety assessment processes should be followed as part of the project development process to qualitatively assess safety. The analysis process is outlined in the Safety Analysis Guidelines maintained by the Office of Program Management.

A minimum assessment for all projects involves reviewing any applicable studies for the project area, reviewing the ODOT Safety integrated Project (SIP) Maps, documenting any other safety priorities in the area (state or local), and reviewing historical crash trends.

Where in the opinion of the district there is a noteworthy location or pattern of crashes, a determination should be made if there is a reasonable and practical countermeasure(s) that can be incorporated into the project and if a safety funding request will be made. For high priority locations, there may be situations when there are reasonable and practical countermeasures, but they can’t be incorporated into the project due to factors such as schedule or work type incompatibility. In these cases, consideration should be given to creating a standalone safety project to address the high priority location.

Projects that have an identified location on the SIP maps or statewide/regional safety priority are eligible for supplemental safety funding up to $500,000 through an abbreviated safety funding application process. Requests exceeding this amount should be submitted through the biannual HSIP Safety Funding Application process.

Refer to the Safety Analysis Guidelines maintained by the Office of Program Management for detailed analysis requirements. The Office of Program Management also maintains the SIP Maps, the Statewide HSIP Priority Location Lists and data related to historical crash trends that can be used to conduct a minimum project assessment. Abbreviated Safety Applications should be coordinated through the District Safety Review Team (DSRT) coordinator.

106.4 Data-Driven Safety Analysis Documentation

While safety should be considered and evaluated for every project, there is no requirement to include safety countermeasures for projects without safety included in the purpose and need. Rather, projects should be evaluated to determine if there is a reasonable and practical countermeasure(s) that can be incorporated into the project without expanding project scope. Decisions should be documented on the appropriate “Data-Driven Safety Analysis Documentation” form. Refer to the Safety Analysis Guidelines maintained by the Office of Program Management for documentation templates.

http://www.dot.state.oh.us/Divisions/Planning/ProgramManagement/HighwaySafety/HSIP/SafetyAnalysisGuidelines/Safety_Analysis_Guidelines.pdf

LIST OF FIGURES

SAMPLES

DESIGN CONTROL/DESIGN FEATURE RELATIONSHIP	100-1
	REFERENCE SECTION 100.1

DESIGN FEATURES	DESIGN CONTROLS				
	Functional Classification	Traffic Data	Terrain	Local	Design Speed
Lane Width (Rural)	X	X	X		X
Lane Width (Urban)	X			X	
Shoulder Width & Type (Rural)	X	X			
Shoulder Width & Type (Urban)	X			X	
Guardrail Offset	X	X			
Degree of Curvature				X	X
Grades	X		X	X	X
Bridge Clearances (Horizontal & Vertical)	X	X			
Stopping Sight Distance					X
Passing & Intersection Sight Distances					X
Decision Sight Distance					X
Superelevation				X	X
Curve Widening					X
Design Speed (Rural)	X	X	X		
Design Speed (Urban)	X			X	
Vertical Alignment	X		X	X	X
Horizontal Alignment				X	X

APPROPRIATE DESIGN CRITERIA GUIDE	105-1
	REFERENCE SECTION 105.1 & 105.5.1

Key Highway Design Features Requiring Design Exceptions	Normal Design Criteria (1)	
	Section	**Figure**
Lane Width	301.1.2 & 303.1	301-2 & -4, 303-1
Shoulder Width	301.2.3 & 303.1	301-3 & -4, 303-1
Design Loading Structural Capacity	302.1	See Bridge Design Manual
Horizontal Curve Radius	202.3	202-2
Maximum Grade	203.2	203-1
Stopping Sight Distance (Horizontal & Crest Vertical Curve)	201.2	201-1, 203-3, -4
Pavement Cross Slope	301.1.5	301-6
Superelevation rate	202.4.1 & .4.3	202-3, -7, thru -10
Vertical Clearance	302.1	302-1, -2, -3

1) Normal design criteria must be used as the basis for all design exceptions.

Figure 107-1 Non-Complex Projects (No Alternative Analysis)

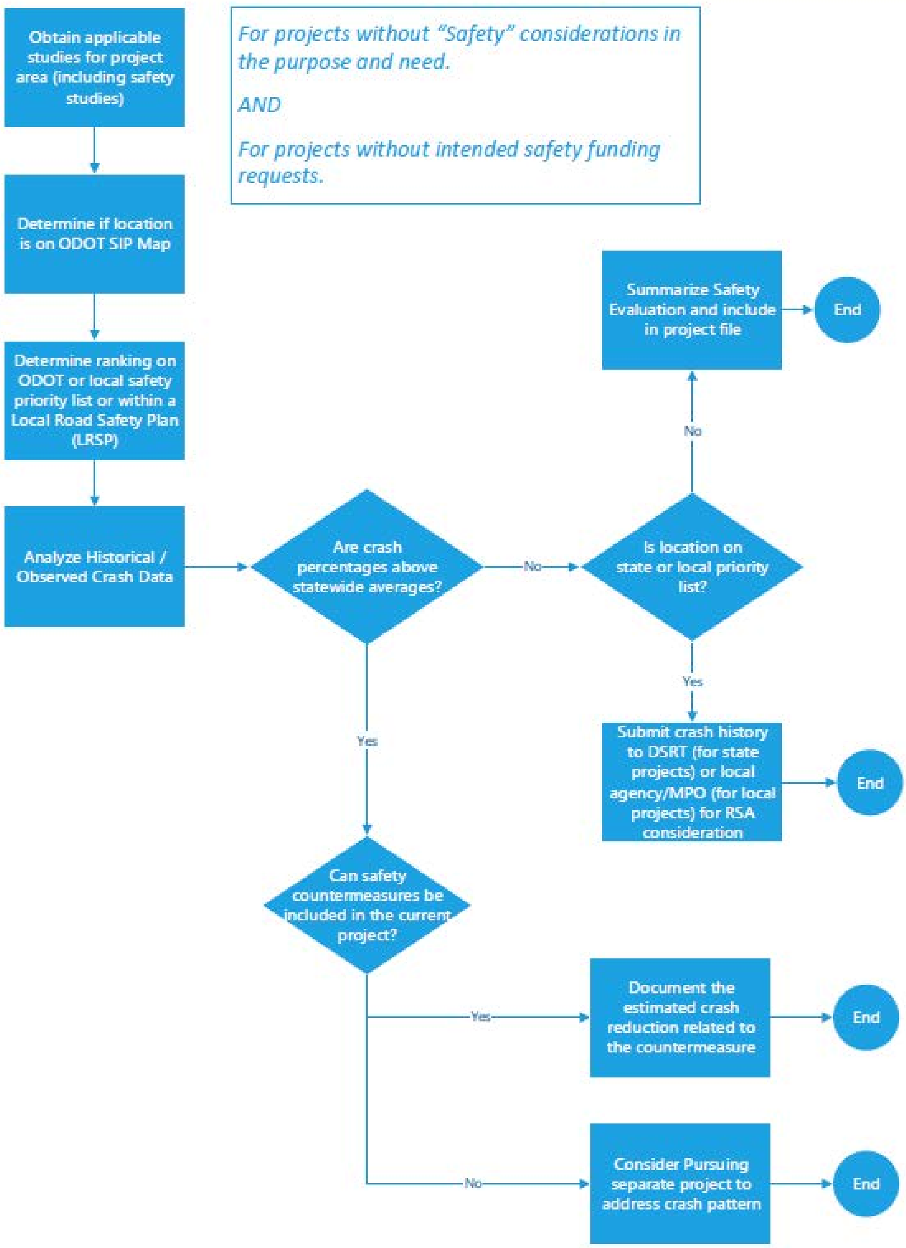
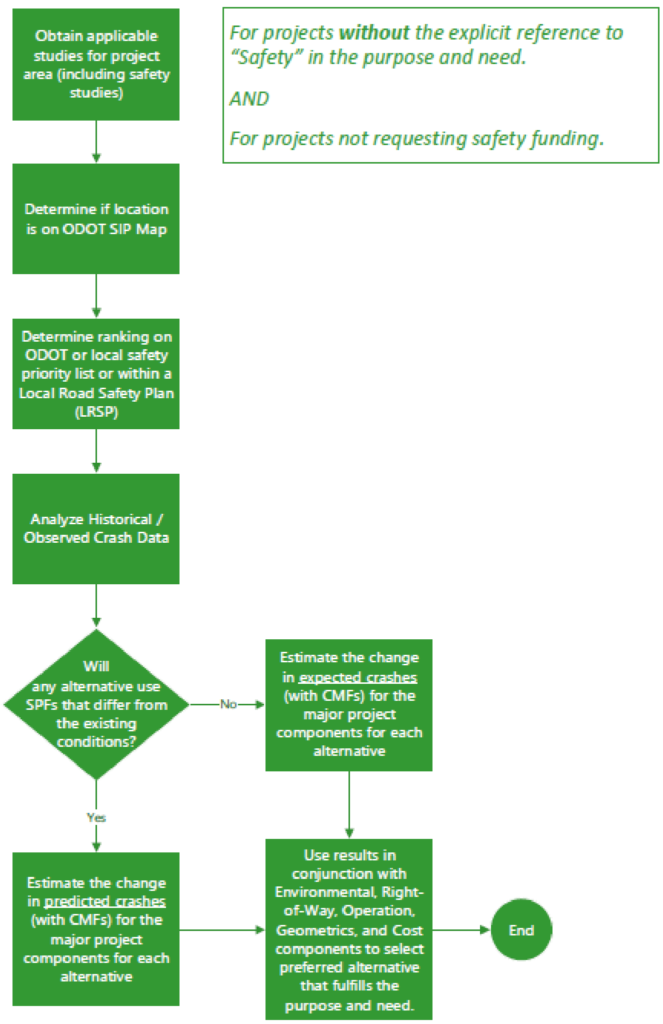


Figure 107-2 Complex Projects Assessment with Alternatives Analysis without "Safety" in the Purpose and Need Statement



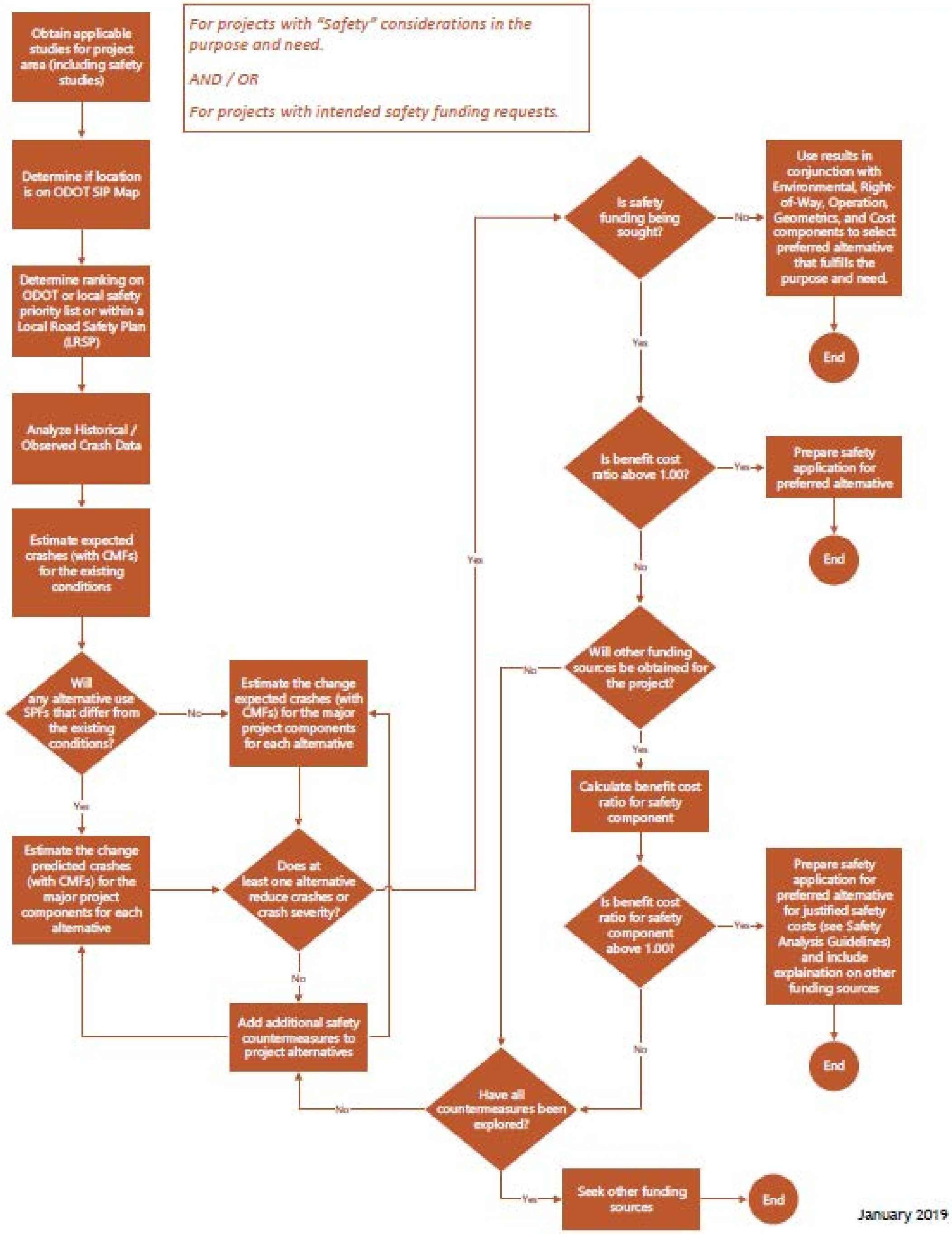
Definitions:

Crash modification factor (CMF): value which quantifies the change in crash frequency at a site as a result of implementing a specific countermeasure or treatment. It can be single value or function and may apply to all crashes or specific crash type(s).

Expected average crash frequency: the estimate of long-term expected crash frequency of a site, facility, or network under a given set of geometric conditions and traffic volumes (AADT) in a given period of years.

Predicted average crash frequency: the estimate of long-term average crash frequency – based on the average number of crashes of a peer group (exact same base conditions) with a given AADT.

Figure 107-3 Complex Projects Assessment with Alternative Analysis and Safety Component



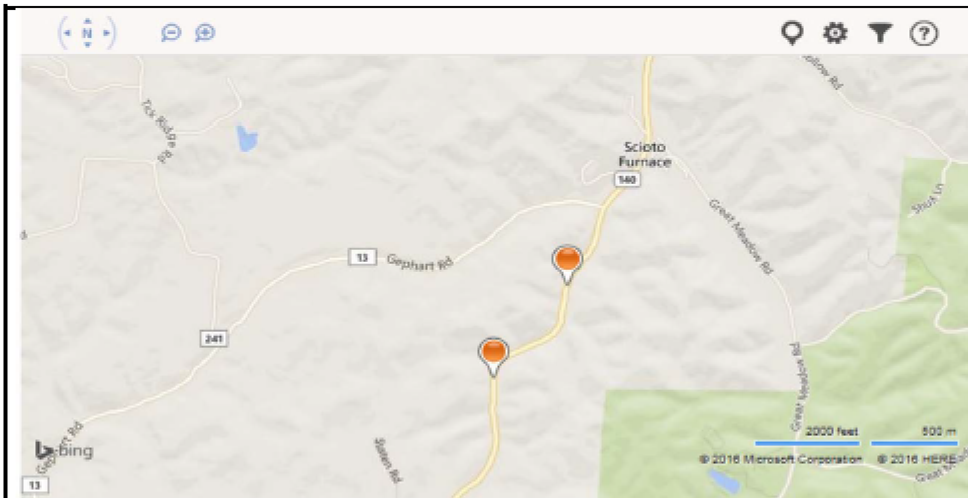
Design Exception Request

SCI-140-7.28

PID: 93794

Letting Type: ODOT-Let

Design Designation				
Current ADT (2016)	4,310		Td	0
Design Year ADT (2035)	4,840		Design Speed	55
Design Hourly Volume (2016)	460		Legal Speed	55
Directional Distribution	0.57		Design Functional Class	5
Trucks (24hr B&C)	0.05		Functional Class Area Type	Urban
			NHS Project	No



Submitted by:

____

(Engineer of Record)

Engineer of Record Seal

Approved by:

____

Design Exception Request

SCI-140-7.28

PID: 93794

	Controlling Criteria Identification		
Controlling Criteria	Standard	Existing (a.)	Proposed
Lane Width			
Shoulder Width			
Horizontal Curve Radius	955'	Curve 1-1300'; Curve 2 - 495'	Curve 1 - 1300'; Curve 2 - 495'
Maximum Grade			
SSD (horizontal & Crest Vertical)	495'	Curve 1 - 367'; Curve 2 - 221'	Curve 1 - 381'; Curve 2 - 345'
Superelevation Rate	Curve 1 - 0.074; Curve 2 - 0.080	Curve 1 - 0.042; Curve 2 - 0.077	Curve 1 - 0.050; Curve 2 - 0.079
Pavement Cross Slope			
Vertical Clearance			
Design Loading Structural Capacity			
"Existing" may be N/A (i.e. New alignment or new ramp)			

Project Description

The proposed project will improve safety by widening the lane and shoulder width and improving the stopping sight distance by increasing the guardrail offset through the reverse horizontal curves.

Proposed Mitigation

Oversized curve warning signs, chevrons and arrow signs were installed in 2011 and will be reinstalled with this project. Flashing beacons will be installed on the two curve signs and the two arrow signs for Curve 2.

Support for Deviation (Benefit-cost, R/W, Environmental, Constructability, Coordination with Other Projects, Relationship between any crash patterns and proposed design exception, etc.):

The lane width is being increased from 11.1' to 12' and the paved shoulders are being increased from 2.8' to 4'. To correct the horizontal alignment, the roadway would need to be relocated through a sizable hill with cuts as deep as 31'.