CHAPTER 1
INTRODUCTION

1.1 OBJECTIVES OF THIS GUIDE

This guide is intended to provide assistance in the warranting, selection and design of roadside barriers. This document is not intended to be a design standard. Rather it is a tool for Federal Lands design engineers and owner agency representatives. Since it is impossible to foresee all possible conditions and situations, these guidelines should not be used as a substitute for good engineering judgment. The guide is prepared specifically for warranting, selecting and designing barriers on Federal Lands projects that are low volume and/or low speed facilities. Finally, the guidelines present practical and useful guidance for common conditions and situations encountered in the design of roadside barriers for Federal Lands projects.

1.2 CHALLENGES OF FEDERAL LANDS PROJECTS

The Federal Lands Highway Divisions of the Federal Highway Administration partner with the National Park Service, the Forest Service, the Fish and Wildlife Service and other federal, state and local agencies to plan, design and build roads into and within federally owned lands. These roads are frequently low volume and low speed facilities. The character of Federal Lands projects frequently raises roadside safety concerns. Mountainous terrain, forests, boulders and water hazards are examples of common roadside features that may be considered serious hazards. These safety concerns are somewhat mitigated because these roads frequently have low nighttime traffic, may be closed during the winter and many have restrictions on commercial truck usage.

It is common for environmental, wildlife and aesthetic concerns to be in conflict with roadside safety concerns on Federal Lands projects. It is the responsibility of the Federal Lands Highway Division design engineer, in cooperation with the land management and road owner agency representatives, to find the proper balance of public values related to environmental, aesthetic, safety, mobility and sustainability concerns.

Context Sensitive Solutions (CSS) encourages flexibility in the application of design standards and guidelines to accommodate local concerns about issues such as community needs, environment and aesthetics. Federal Lands engineers have been practicing CSS for decades. Section 9 of the Project Development and Design Manual discusses the application of CSS on Federal Lands projects. This guide recognizes that the full clear zones and barrier warrants recommended in the AASHTO Roadside Design Guide may be impractical to achieve on rural low volume, low speed roads and offers guidelines to identify the most serious roadside hazards. In light of CSS, the best decision will not always be to implement a recommendation from this guide. Although it is legitimate to exercise flexibility in the application of design standards and guidelines, it is also important to have a clear understanding of the safety consequences of context sensitive decisions so that an appropriate balance can be achieved.

1.3 THE ROADSIDE SAFETY PROBLEM

There are many reasons why vehicles leave the pavement and encroach onto the roadside, including:

- Driver fatigue or inattention
- Excessive speed
- Driving under the influence of drugs or alcohol
- Crash avoidance
- Rebound off an initial crash within the roadway
- Environmental conditions such as ice, rain or poor visibility
- Vehicle component failure

Regardless of the reason, an encroachment into the roadside environment can lead to a serious crash. Roadside crashes represent approximately 20 percent of all motor vehicle fatal crashes, typically accounting for over 9,000 fatalities annually. These events involve a vehicle leaving the roadway, for whatever reason, and hitting a fixed object alongside the road. Of these crashes, 60 percent occur on rural roads. Forty-one percent of all roadside fatalities occur on horizontal curves.

Trees are by far the most commonly struck object type, accounting for almost half of all fixed object crashes. Table 1.1 lists the roadside objects most commonly struck in roadside fatal crashes, in descending order of frequency:

Table 1.1: Objects Most Commonly Struck in Fatal Crashes

1. Tree
2. Utility Pole
3. Boulder
4. Drainage Device
5. Embankment
6. Guardrail

Although roadside fatalities occur more frequently at higher speeds, they can, in fact, occur at any speed, as shown below:

Table 1.2: Deaths in Roadside Crashes, 2003

Speed Limit	Percent
50 km/h or less (30 mph or less)	12%
55 – 60 km/h (35 – 40 mph)	19%
70 – 80 km/h (45 – 50 mph)	17%
90 km/h or greater (55 mph or greater)	48%
No Limit or Unknown	4%
Total	100%

All of the crash statistics discussed in this section are from analysis of data from the *Fatality Analysis Reporting System* by the Insurance Institute for Highway Safety.

1.4 LOW VOLUME ROAD ISSUES

For purposes of this guide, low volume roads are defined as those with an annual average daily traffic (ADT) of under 2,000 vehicles per day (vpd). These roads present many challenges to highway engineers. The roadside crash fatality rate for rural minor roads is estimated to be three times the average roadside fatal crash rate for all roads in the United States. These types of roads typically have very restricted rights-of-way, little or no clear zones and substandard design features. Because there is less traffic, drivers are more likely to become inattentive and fatigued. Low volume roads have a fairly high bridge density, averaging approximately nine bridges every 100-centerline kilometers (14 bridges every 100-centerline miles). Because of restricted conditions and rigid rails, bridges always present roadside safety issues.

Specific design features that relate directly to increased roadside crashes include narrow lanes, little or no shoulders, curvilinear alignment, poor delineation and poor pavement conditions. Design inconsistencies can result in increased roadside crashes, such as exceptionally sharp curves on a fairly straight road, abrupt narrowing of lanes and varying shoulder widths and pavement conditions. All of these features, common on low volume roads, contribute to increased roadside crashes.

The American Association of State Highway and Transportation Officials (AASHTO) *Roadside Design Guide* (RDG) contains some guidance on low volume conditions, but there is very little detail. The AASHTO *Guidelines for Geometric Design of Very Low Volume Local Roads* (ADT < 400) also offers very little guidance for roadside design issues.

Roadside crashes can and do occur on low volume roads, but corrective actions can be difficult to justify economically. Although the probability of roadside crashes may be fairly high, the actual numbers can be very low, making the expenditure of funds difficult to justify.

1.5 LOW SPEED ROAD ISSUES

Low speed conditions, defined as 70 km/h (45 mph) or less, are not commonly associated with roadside crashes. In fact, the risk of death or serious injury in roadside crashes drops significantly as vehicle speeds are reduced. The probability of serious crashes can be estimated by the energy expended in a crash. The energy expended in a crash is an exponential relationship to velocity or speed. Significantly less energy is expended in low speed crashes compared to high speed crashes. Also, drivers in low speed situations are more likely to regain control of their vehicle and avoid a roadside crash than in a high speed situation. This is not to say, however, that serious roadside crashes cannot occur in low speed conditions, as shown in Table 1.2.

The *RDG* provides very little guidance for low speed roads. Generally, criteria are provided down to about 60 km/h (40 mph) with very little information for slower speeds. The *National Cooperative Highway Research Program* (NCHRP) *Report 350* provides for low speed testing of roadside barriers and other safety devices, at 50 km/h (30 mph) (Test Level 1) and 70 km/h (45 mph) (Test Level 2). Because of concern about high speed conditions, Test Level 3, tested at 100 km/h (62 mph), devices are considered standard by many highway agencies. A number of Test Level 3 barriers have been tested and accepted. Test Level 3 devices work for Test Level 1 and 2 conditions as well as for high speed conditions. Some barriers have been tested and accepted only at Test Level 2 and Test Level 1.

1.6 APPLICATIONS OF THIS GUIDE

The recommendations in this document are not the result of crash testing or macro-analysis of crash data. The recommendations contained in this document were arrived at by review of literature, information and comments received from Federal Lands Highway Division engineers, logical extensions of published design criteria, engineering judgment and economic analysis. The recommendations are reasonable applications of good engineering practice to conditions commonly encountered on Federal Lands projects. However, it is impossible to anticipate every condition and situation. Engineers should use this guide as a tool, along with their experience, engineering judgment, other appropriate guides and standards and the needs and desires of owner agencies and the public. Frequently there will be good reasons for a designer to arrive at a solution that is not in conformance with the recommendations contained in this document.

The primary guideline for roadside barrier warranting, selection and design is the RDG. This Barrier Guide should be used as a supplement to that document for Federal Lands projects with existing traffic volumes below 2,000 and/or speeds 70 km/h (45 mph) or lower. *The Project Development and Design Manual*, Standard Drawings and the contract documents all tae precedence over this document.