CHAPTER 1 – INTRODUCTION

To meet a Vital Few Goal on Environmental Stewardship and Streamlining, the Federal Highway Administration (FHWA) has implemented context sensitive solutions (CSS), a set of principles designed to improve the quality and lessen the environmental impact of transportation projects. In CSS, the word "context" refers to a project's surroundings—its natural environment as well as its historical setting and role in the community (i.e., its use as a public space or thoroughfare). Thus, under the rules of CSS, every project will be planned, designed, and constructed with each of these considerations in mind. In support of this program, the FHWA promotes the development of principles and processes that can be used in all states and within federal lands to improve the quality of transportation decision-making. This includes opportunities to enhance environmental protection and encourage partnerships that promote ecosystem conservation or encourage broader mitigation strategies.

One way to achieve this objective is to incorporate CSS principles in designing rock slopes for transportation facilities—in other words, to design facilities that fit within the project setting and preserve scenic, aesthetic, historic, and environmental resources while maintaining safety and mobility. Many federal agencies served by the Federal Lands Highway Division (FLHD) manage roadways in complex geologic settings, often in steep mountainous terrain, with numerous environmentally sensitive features. Projects constructed in these regions often require rock excavation, slope stabilization, and rockfall mitigation to achieve the desired roadway template and provide a safe public facility.

Rock excavation through mountainous terrain for the construction of travel corridors has been in continuous development for many years. Many of the existing excavation methods use blasting techniques that were originally developed for use by the mining industry and were mainly focused on maximum rock excavation and rapid production with little attention to environmental protection or the aesthetic impacts of the final cut. State DOTs often struggle in designing a safe rock slope that does not appear overly engineered and seems to fit within the project setting.

Over the past several years, rock slope design technologies have been developed for transportation application, but there is no comprehensive document that compares existing and developing technologies or offers selection and implementation guidelines related to context sensitive areas. This document will discuss existing and developing technologies for contact sensitive designs and provide a reference for the selection, evaluation, design, and construction of rock slopes.

Moreover, there is very little published information focusing specifically on the aesthetic concerns of rock slope construction, slope stabilization, and rockfall protection measures. Many of the techniques reviewed in this document are derived from personal experiences, conversations with state DOT construction design personnel, and case histories. Beginning in the early 1990's, engineers Kerry Cook and Craig Dewey have been applying these techniques to several FLHD projects. Examples of some of these projects were presented in the FHWA Special Roadway Aesthetic Treatments Photo Album Workbook. The workbook is intended as a "living document" where examples of innovative aesthetic treatments that have been applied

nationwide on U.S. transportation projects are highlighted. Robert Cummings published one of the first papers that specifically addressed blasting and rock slope alterations that address both safety and aesthetics (Cummings 2002). Cummings' paper discusses aesthetically appealing rock slope design for new construction of travel corridors, but does not consider slope stabilization, rockfall protection, or slope maintenance issues. This paper addresses the most common stabilization, protection, and maintenance techniques used in areas that experience high rockfall hazards, as well as the aesthetic impacts of each.

This paper also addresses the costs associated with various CSS practices. For example, although engineers have developed new mitigation techniques that can control small or discrete rockfall events, we know that large or frequent failures cannot be easily or economically mitigated. The designer must always assess mitigation construction costs versus the impacts and losses caused by rockfall and design the roadway layout and/or mitigation alternatives accordingly.

The objective of this report is to provide design, construction, and maintenance solutions for rock slope excavation, stabilization, and mitigation in context sensitive regions. It addresses state-of-the-art and state-of-practice technologies for the evaluation, design, and construction of context sensitive rock slopes. Key features of the report include the following:

- Advantages and limitations of existing and developing technologies and their acceptability for use on context sensitive projects.
- Relative cost comparisons of design, construction, and maintenance options.
- Design methods and examples for each application.