EROSION PREDICTION PROCEDURE MANUAL

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Glossary of Terms

Best Management Practice (BMP): A practice that eliminates or reduces the discharge pollutants from construction sites to waters of the state.

Caltrans Revised Universal Soil Loss Equation 2 (Caltrans RUSLE2): The Revised Universal Soil Loss Equation 2 software program modified for Caltrans use.

Cover Management/C: Represents how soil, vegetation, and residue affect soil loss.

Construction: The period when project construction activities occur, including major site preparation, grading, excavation, structures and roadway construction, drainage, landscaping, sound walls, and other construction activities.

Cover/C: Cover management "C factor" (see above)

Erosion Prediction Procedure: A procedure to accurately predict erosion rates in the three project phases, pre-construction, construction, and post-construction.

Fiber Rolls: Used on the toe and face of slopes to intercept runoff, reduce flow velocity, release the runoff as sheet flow, and provide removal of sediment from the runoff. Fiber rolls consist of wood, rice, wheat straw, or coconut fibers rolled or bound into a tubular roll.

Groundcover: Material in contact with the soil that both intercepts raindrops and slows runoff. Groundcover is provided by live vegetation, plant litter, crop residue, and applied materials.

Isohyetal Map: Isohyetal maps are rainfall intensity contours generated by rainfall data from rainfall recording stations in the area. The map considers microclimatic aspects on different topographic conditions.

Management Practices: BMPs including operations and vegetation choices for erosion and sediment control.

Maximum Allowable Erosion Rate (MAER): The performance goal for determining the maximum amount of erosion on a hillslope based on best available technologies (BAT), receiving water condition, and cost effectiveness to obtain maximum extent practicable (MEP) treatment.

Method Demonstration Form (MDF): The MDF is a one-page summary capturing RUSLE2 model results for inclusion in Notice of Termination filing package to support achievement of final stabilization.

Post-construction: A defined period of 5 to 15 years after the project construction work has been accepted by Caltrans as complete.

Pre-Construction: The period prior to any significant ground-disturbing activity at the project site.

Practice/P: Practices are used to control soil loss. One type is cultural practice, like planting, vegetative cover, crop rotations, conservation tillage, and applying mulch. Another type is using supporting practices such as contouring, strip cropping, and terraces.

Predicted Soil Loss/A: An output result of the erosion control procedure.

Profile (RUSLE2): A computational component that computes erosion along an overland flow path on a hillslope and contains computed soil-loss and sediment-yield estimates.

Rainfall Erosivity/R: The product of storm energy multiplied by the maximum 30-minute rainfall intensity.

Rainfall Intensity: The rate of precipitation.

Reference Site: The sample site considered for completing the erosion prediction procedure as a comparison for the project site. Ideally, the site should contain disturbed but revegetated soil with similar slope length, steepness, and slope aspect as those proposed for the project.

Revised Universal Soil Loss Equation 2: The Revised Universal Soil Loss Equation 2 (RUSLE2) is an empirically derived model, widely used to estimate rill and inter-rill erosion that occurs on overland flow areas.

Rock Cover: A groundcover that reduces erosion similar to plant litter, crop residue, and applied mulch, except the rock does not decompose and add organic matter to the soil. Rock fragments are sufficiently large to not be moved by runoff and the diameter is generally larger than 10 mm.

Rotation: A list of operation descriptions in cover management descriptions that are repeated in a cycle. The length of cycle is rotation duration.

RUSLE2 Worksheet: A template used to summarizes basic project site information, RUSLE2 input data that will be used in the Caltrans RUSLE2 model runs, and model run results (predicted erosion rates) to allow comparison of BMP combinations.

Sediment Basin: A basin that collects storm water discharge from a construction site. Discharge is usually passed through a perforated riser that completely drains the basin in 24 hours.

Sediment Delivery: A quantity of detached soil discharged offsite from a construction site.

Slope Length/L: Horizontal slope distance along overland flow path.

Slope Percent/S: Gradient of slope, as a percentage, along overland flow path.

Soil Detachment: Separation of soil particles from soil mass by raindrops, water drops falling from vegetation, and surface runoff.

Soil Erodibility/K: A factor value empirically determined from erosion on reference plots that represents soil susceptibility to erosion.

Soil Surface Roughness: A random roughness caused by soil peaks and depressions that pond runoff, which are created by a soil-disturbing operation.

Topographical factor/LS: Factor determined from the length and gradient of the slope; it is not equal to the slope length (L) multiplied by the slope percent (S).

Vegetative Cover: Live cover above ground biomass and live canopy cover.

Worksheet: Computational component that compares erosion control alternatives and contains computed soil-loss and sediment-yield estimates.

Acronyms and Abbreviations

ac	acre
ARS	Agricultural Research Service
BAT	best available technology
BMP	best management practice
C	cover factor
Caltrans	California Department of Transportation
Caltrans RUSLE2	Revised Universal Soil Loss Equation Version 2, modified for Caltrans
CASQA	California Stormwater Quality Association
CGP	Construction General Permit
EPP	Erosion Prediction Procedure
FOTG	Field Office Technical Guide
K	soil erodibility factor
KP	kilopost
LS	topographical factor
MAER	maximum allowable erosion rate
MDF	Method Demonstration Form
MEP	maximum extent practicable
NOT	Notice of Termination
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
P	practices
PM	postmile
R	erosivity factor
RECP	rolled erosion control products
RUSLE	Revised Universal Soil Loss Equation
SWDR	Storm Water Data Report
t	ton
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USLE	Universal Soil Loss Equation
yr	year

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Section 1

Introduction

1.1 Overview

This Erosion Prediction Procedure (EPP) Manual provides guidance on how to predict expected erosion rates at California Department of Transportation (Caltrans) construction sites. Caltrans adapted the Revised Universal Soil Loss Equation Version 2 (RUSLE2) computer model to predict erosion and sediment delivery on their sites using project site characteristics and proposed erosion and sediment control measures. The Caltrans RUSLE2 model predicts anticipated erosion rates for the following project phases:

- **Pre-construction:** The period prior to any significant ground-disturbing activity at the project site.
- **Construction:** The period when soil disturbance and project construction activities occur, including site preparation, grading, excavation, structure work, and roadway construction.
- **Post-construction:** The period after project construction work has been completed and before permanent erosion control and vegetation are fully established. The period needed to establish vegetation may require 5 to 15 years.

The general procedure for soil erosion prediction using Caltrans RUSLE2 is as follows:

1. Obtain site data and determine the pre-construction erosion rate.
2. Establish a Maximum Allowable Erosion Rate (MAER) for the construction phase of the project.
3. Establish a post-construction phase erosion rate goal to achieve final stabilization.
4. Select construction and post-construction soil stabilization and sediment control Best Management Practices (BMPs) and revegetation techniques to limit erosion and achieve the established erosion rate limit for each phase.
5. Compare Caltrans RUSLE2 model findings and document the selected BMP combination in a Method Demonstration Form (MDF).

The RUSLE2 model was adapted to meet the specific requirements of Caltrans and to facilitate the execution of steps 1 through 5. The benefits of using Caltrans RUSLE2 include:

- The ability to predict erosion rates in all three project phases with reproducible accuracy.
- The ability to use a quantitative process to select an appropriate combination of permanent and temporary BMPs for soil stabilization and sediment control during the construction and post-construction project phases.
- The ability to use erosion control reports supported by RUSLE2 outputs and the MDF to communicate design approaches, BMP selection, and erosion control plans and findings. This can be helpful for communicating the project plan to agencies such as the Regional Water Quality Control Board, U.S. Environmental Protection Agency (USEPA), U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, and California Department of Fish and Game.
- The improved ability to address public concerns related to water quality issues by incorporating detailed erosion control plans into the project construction and post-construction phases.

- The ability to prepare detailed studies that specifically address management of erosion and sediment transport during the construction and post-construction project phases.
- The improved ability of Caltrans and its contractors to better compare, understand, and improve the effectiveness of individual, and combinations of, BMPs used during the construction and post-construction project phases.

1.2 Purpose

The purpose of this EPP is to communicate methods established and approved by the Office of Storm Water Management Design for the prediction of erosion rates before, during, and after construction of Caltrans projects to meet the final stabilization conditions for filing a Notice of Termination (NOT). The NOT requirements are described in the National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities (Order No. 2009-0009-DWQ), otherwise known as the Construction General Permit (CGP).

1.3 EPP Objectives

The objectives of this EPP are:

1. To identify resources for collecting project-specific information needed as inputs to Caltrans RUSLE2.
2. To provide consistency with existing Caltrans manuals, procedures, policies, and practices for assessing project site conditions. The EPP identifies potential appropriate sources of project and site information, including existing geotechnical studies, design plans, environmental studies, and other data sources.
3. To demonstrate how RUSLE2 can be used to demonstrate final stabilization for the NOT process as defined in the CGP.
4. To identify a method for estimating the amount and type of existing vegetative cover on a project site.
5. To identify methods to establish the construction MAER and post-construction erosion limit for a project site. The effectiveness of project BMPs in reducing erosion during the construction and post-construction project phases can be assessed against the erosion limits using Caltrans RUSLE2. This allows performance goals to be applied to erosion control and revegetation design.
6. To consider the diverse soil, topographical and climatic conditions across California and identify how the appropriate data for each project site should be selected. Simulations to determine soil erosion are completed by entering project-specific information into Caltrans RUSLE2 for the pre-construction, construction, or post-construction phases.
7. To assess the effectiveness of vegetation growth and establishment during the post-construction phase and the ability of vegetation to control erosion and reduce runoff and sedimentation from the project site. A sufficient time period (years) is considered to assess the effectiveness of the vegetation growth and maturation and if and when the vegetation needs to be replaced or modified. The EPP includes guidelines for comparing the performance of the project site during the post-construction phase with a reference site to ensure that the vegetation at the project site is properly maturing and that it is achieving the desired erosion control goals.

8. To describe the Caltrans RUSLE2 model process, which allows users to compare BMP options and to select effective temporary and permanent BMPs for highway projects.
9. To provide a worksheet that allows users to record the data inputs used in the Caltrans RUSLE2 erosion prediction tool and to compare the predicted results of different BMP combinations. It also allows effective and consistent reporting of BMP selections for state projects.
10. To provide an overview of the RUSLE2 resources available to users. Reference guides, training materials, and many other resources are available from Caltrans and other sources.

1.4 EPP Manual Organization

The EPP is intended to be used in conjunction with the desktop computer-based Caltrans RUSLE2 model on Caltrans transportation projects. The EPP is organized as follows:

Section 1 (Introduction): This section provides a description of the EPP, the purpose of the EPP, and how to use the EPP.

Section 2 (Procedure): This section presents the EPP step-by-step process, including selecting a reference site, establishing erosion rate limits, and reporting findings.

Section 3 (Site Characterization): This section provides guidance to the user on the collection of site data for input into Caltrans RUSLE2 and on the use of a standardized RUSLE2 Worksheet and MDF.

Section 4 (Erosion Prediction Using Caltrans RUSLE2): This section describes the Caltrans RUSLE2 model and provides an overview of how this model can be used to predict erosion for Caltrans highway projects, including how to select and input data into the model.

Section 5 (References): This section lists the technical references researched during the preparation of this EPP.

Appendix A (Reference Guide – Caltrans Construction BMPs in RUSLE2): This appendix is a reference guide for BMP selection. BMPs available in Caltrans RUSLE2 are listed with its equivalent designations in the Caltrans Construction Site BMP Manual and the California Stormwater Quality Association (CASQA) Stormwater BMP Handbook: Construction.

Appendix B (Caltrans RUSLE2 Resource Materials): Supporting guidance for using the RUSLE2 program is available from two sources: the Caltrans RUSLE2 training course and the RUSLE2 webpage. This appendix provides a brief description of each and lists the materials available.

Appendix C (Soil File Creation): This appendix has soil testing guidance for erosion control projects.

Appendix D (Caltrans RUSLE2 Program Improvements): The 2007 version of the Caltrans RUSLE2 software was upgraded in 2011. This appendix provides a list of the program improvements made in the 2011 version.

Appendix E (RUSLE2 Program Components and Organization): This appendix describes the organizational structure of the RUSLE2 program and outlines how the data and choices are grouped. Descriptions of the operations of each data category are also included.

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Section 2

Procedure

This section describes the overall process for predicting and managing erosion on highway construction projects. The process includes the following steps: site characterization, identifying appropriate reference sites, predicting erosion rates and identifying maximum limits, selecting appropriate BMPs, and preparing an erosion control report. Each of these steps is described in the following subsections.

2.1 Site Characterization

The first step in predicting erosion rates is to gather information about the site. This information includes a project description, soils information, climate data, topographic maps, and design plans. The data are entered into the RUSLE2 Worksheet (see Section 3.3.7). It is important that the information be as accurate as possible so that realistic erosion rate predictions can be obtained. The user should select enough locations to represent the overall project area. This may require the analysis of several representative slopes. Each site should have a minimum of three data collection areas. The project's Storm Water Data Report (SWDR) may already include most of this information.

2.2 Erosion Rate Limits

Two essential steps in erosion prediction are establishing the construction MAER and post-construction erosion rate limit for the project site. Construction MAER was developed by Caltrans and is the performance goal to be used in determining the maximum amount of erosion on a slope based on best available technologies (BAT) and cost effectiveness to obtain maximum extent practicable (MEP) treatment.

The post-construction erosion rate limit is the maximum erosion allowed as determined by the final stabilization requirement in the CGP. To achieve final stabilization, the project site must not pose any additional sediment discharge risk than it did prior to beginning construction (CGP, Provision II.D). In order to conclude coverage under the CGP, a NOT must be filed that demonstrates attainment of final stabilization. Three options are provided in the CGP for demonstrating final stabilization; one of which is the RUSLE or RUSLE2 method with accompanying computational proof.

The methods for determining appropriate erosion rate limits for each project phase are discussed below.

2.2.1 Construction MAER

Erosion should be reduced on the proposed cut and fill slopes by 80 percent through the design and deployment of BMPs. For instance, if the erosion rate (calculated using Caltrans RUSLE2) for a proposed cut slope without the use of any BMPs is 10 tons/acre/year (t/ac/yr), this value would need to be reduced by 80 percent, to 2 t/ac/yr or less, through the incorporation of applicable BMPs. The construction MAER for this slope would be 2 t/ac/yr. Some NPDES-delegated authorities have used this 80 percent benchmark as a method for establishing BMP utilization to the MEP (Wisconsin Department of Commerce 2007; City of Sheboygan 2007; Wisconsin DNR 2007; USEPA 2005).

In areas draining to sensitive receiving waters, more restrictive erosion rates may be imposed by permitting agencies. Collaboration with the NPDES coordinator at each respective construction site's District office will be needed to facilitate compliance with local conditions. The corresponding limits would then need to be translated into a construction MAER.

2.2.2 Post-construction Erosion Limit

To demonstrate final stabilization, erosion during post-construction must be reduced to less than or equal to the pre-construction erosion rate. In other words, the maximum allowable post-construction erosion rate is the pre-construction erosion rate. Erosion rates during both pre-construction and post-construction project phases would be calculated using Caltrans RUSLE2. For example, if the calculated erosion rate for the project was 5 t/ac/yr prior to the start of construction activities, applicable permanent BMPs would need to be incorporated until the calculated post-construction value was 5 t/ac/yr or less at the site.

2.3 Erosion Prediction

Once site characterization, erosion limit determination, and reference site selection if needed (see Section 2.5), are complete, erosion rates are computed for each of the three project phases: pre-construction, construction, and post-construction. Different storm water management schemes (i.e., BMPs) are evaluated in an iterative process using Caltrans RUSLE2 until a specific scheme is found that meets the established erosion goal. The types of BMPs included in the RUSLE2 program are:

- **Construction BMPs:** track walking, ripping/ridging, hydroseeding, straw mulch, hydraulic mulch, bonded fiber matrix, straw blankets, compost blankets, jute netting, pine needles, and curled wood fibers.
- **Post-construction BMPs:** pine needles, compost blankets, hydroseeding, grasses and forbs, coconut/coir netting, hydraulic mulch, straw/coir RECP, jute netting, straw blankets, and straw mulch.
- **Permeable Barriers:** silt fence, fiber rolls, straw bale barriers, compost socks, and gravel or sand bag berms.

A detailed description of the step-by-step process for calculating the erosion rates with Caltrans RUSLE2 is presented in Section 4.

2.4 BMP Selection

An integral part of the process to meet the erosion limits during construction and post-construction is the selection of appropriate BMPs to control soil loss and erosion. For the construction phase, temporary BMPs are evaluated though an iterative process until the erosion rate is reduced to the construction MAER or less. For the post-construction phase, permanent BMPs with and without vegetative cover are evaluated until the predicted erosion rate is reduced to at or below the pre-construction erosion level. The Caltrans RUSLE2 software includes many of the BMPs commonly used at Caltrans construction sites. To assist users in picking their intended BMP, a reference guide is included in this EPP Manual that lists the BMPs in RUSLE2 with their corresponding Caltrans and CASQA designations (see Appendix A). The abbreviations come from the Caltrans Construction Site BMP Manual (Caltrans, 2003) and the CASQA Stormwater BMP Handbook: Construction (CASQA, 2009).

In addition to selecting BMPs based on performance and BAT, the user must also consider the economic feasibility of the proposed BMP plan. The user should consider typical installed costs of different options and look for comparable performance between BMPs to facilitate cost-effective solutions that can meet MEP treatment goals within the project budget. Tables of installed BMP costs are available through supplemental sources, such as the Caltrans RUSLE2 training course materials (see Appendix B for how to obtain copies).

2.5 Reference Site

At times, it can be difficult to select appropriate BMPs for a specific project, especially when the post-construction conditions are different than the pre-construction conditions. In these cases, knowing how certain BMPs may have behaved in a similar environment can be beneficial. Reference sites provide this information. The concept of a reference site is to use a previously constructed site as a comparison for the project site. The reference site should be chosen to assist in selecting the appropriate erosion control measures for a proposed project. When post-construction conditions of the project site (slope steepness, slope length, disturbed soil characteristics, etc.) match pre-construction conditions, then a reference site is not required.

Proper selection of the reference site is a useful tool for predicting how the project's permanent slopes and selected BMPs will perform. This is especially helpful when using RUSLE2, as the vegetative component can be difficult to predict. An appropriate reference site should consist of disturbed but revegetated soil with similar slope length and steepness and similar slope aspect (e.g., North-facing direction) as those proposed for the project. The site should be well established and less than 5 years old, and should be selected based on the proximity, soil type, and vegetation used. The reference site should be studied to gauge the effectiveness of the vegetation used and how well established it is.

The reference site should be in close proximity to the project site so that the climate characteristics are similar. Sites with mature vegetation on well-developed soil should be avoided as these will not resemble project slopes. The age of the reference site is helpful in determining the length of time needed for the permanent erosion control and vegetation to establish and stabilize the project slopes. The types and species of vegetation on the reference site are helpful in selecting the vegetation likely to succeed on the project slopes. Soil samples can be obtained from the reference site if soil from the project site is unattainable (i.e., soil disturbance has already occurred).

Examples of good reference sites include: (1) a completed vegetated widening project near the proposed widening project, provided the soil and proposed slopes are similar, and (2) a naturally vegetated landslide near a proposed slipout repair project. Selecting the reference site for a proposed project can be challenging as it may be difficult to find a site where all the parameters correspond to the parameters at the project site.

2.6 Documentation

After Caltrans RUSLE2 has been applied to predict erosion rates and the appropriate construction and post-construction BMPs have been selected, the final step is to document the findings. The MDF is the preferred method for documenting the findings and should be incorporated into the project's SWDR and NOT filing package. The MDF captures the NOT final stabilization information by the using RUSLE2 model results to demonstrate that the post-construction phase generates no more erosion than the pre-construction phase. A more developed erosion control report beyond the one-page MDF may be required for some projects to document pre-construction and post-construction conditions. Supplemental guidance for developing erosion control reports, SWDRs, or NOT filing packages are available from Caltrans.

The RUSLE2 Worksheet can be used to facilitate recordkeeping and comparison of different BMP combinations. The worksheet is useful in developing the information needed to complete the MDF. The site characteristics and corresponding RUSLE2 inputs are recorded in the worksheet along with the RUSLE2 outputs for the different project phases and BMP iterations. Editable MS Word files of the MDF and RUSLE2 Worksheet can be found in the supplemental resources (see Appendix B). The RUSLE2 Worksheet is discussed in more detail in Section 3.3.7 and an example is provided.

Section 3
Site Characterization

The effectiveness of the erosion control techniques used during and after construction is dependent on the specific characteristics of the project site (i.e., the same BMPs at different sites will produce different results), so an accurate site characterization greatly improves the ability to select appropriate BMPs. This section presents guidelines and procedures for site characterization.

3.1 Site Background

Prior to visiting the project site, the following information for the proposed project should be obtained:

- Caltrans district and county in which the project is located
- Route number
- Post miles (PM) or kiloposts (KP) for the beginning and the end of the project segment
- Longitude and latitude of the project
- Site map
- Topographic map
- Aerial photography for the project site and immediately surrounding areas
- Project summary:
  - Project map, preliminary engineering drawings, and project description
  - Project geotechnical reports
  - Time frame and schedule
  - Type of construction

The project's SWDR, Project Reports, or Project Summary Reports can provide much of the above information. The existing condition of the site should be documented through a site visit prior to any site disturbance associated with the proposed project. Digital photographs of the site should include views of both vegetative and non-vegetative (e.g., rock, mulch) cover, canopy, and exposed soil. Any areas of existing erosion or concentrated flows should be noted along with project site run-on or runoff conditions. Ground slopes should be verified against the project and topographic mapping.

The intent of this data collection effort is to provide the following information in the RUSLE2 Worksheet for use during the Caltrans RUSLE2 modeling steps:

1. **Location Information:** Note the county, route number, PMs and latitude/longitude values for the beginning, end, and midpoints of the project where RUSLE2 simulations will be done. For small projects, the PM or nearest street address to the project should also be noted to assist others in locating the site physically or on documents such as the isohyetal mapping.

2. **Construction:** The proposed construction activities and schedule should be identified. The anticipated depth of cut or fill, area, and amount of earth-moving activities should be noted. The construction schedule should define the duration of active soil disturbance, ending when the disturbed soil area is covered or seeded. The construction schedule should also attempt to define the anticipated maintenance period when plant establishment should be occurring.
3. **Climate:** The project site location should be located on a local isohyetal map and a copy of the map with the site location should be attached to the RUSLE2 Worksheet. The isohyetal maps are generated based on available rainfall recording stations at various locations in the area. The map considers microclimatic aspects on different topographic conditions. The Caltrans RUSLE2-R value for the project site can also be located on maps from the Natural Resources Conservation Service (NRCS) Field Office Technical Guide (FOTG) website. Unlike the R factor used in the RUSLE formula, the Caltrans RUSLE2-R are average annual precipitation and intensity values determined from the sum of daily R factors.
4. **Soil Conditions:** During the site visit, soil conditions at the site should be observed, with particular notation of the amount of rock present at the soil surface. The geotechnical investigation conducted for the project should be reviewed and compared to the existing soil conditions and the soil types at exposed cut and fill slopes. The geotechnical investigation may also have included the investigation of soil types at and in the immediate vicinity of the project site. If the geotechnical report is not available, or if it doesn't include this information, use appropriate reference site soils data or U.S. Department of Agriculture (USDA)-NRCS soil survey data, which are available from online soil surveys provided on the USDA-NRCS website. As a final option, use best professional judgment based on field texture analyses, laboratory results or fill specifications. See Appendix C for details on how to obtain and incorporate soil sample information into RUSLE2.
5. **Topography:** Project mapping with 1-foot contour intervals should be obtained for the site. The available mapping, date of that mapping, source, scale, and contour interval should be noted. Vegetation and canopy shown on mapping based on an earlier site visit or aerial photography can vary considerably depending on the time of the previous site visit or the aerial photography. Therefore, it is important to compare the information compiled for the site (vegetation type, canopy coverage %, and slope complexity) to information and photographs obtained during the site visit.

   If multiple cross-sections along the project segment are to be simulated in Caltrans RUSLE2, the slope length and slope steepness at each cross-section will need to be determined. The slope length values used in Caltrans RUSLE2 are horizontal measurements and not measurements along the hill slopes. In the field, it is more accurate to measure along the hill slope. For gradients less than 20 percent slope, the difference between the calculated slope length and the slope length measured along the hill slope is minimal. Hill slope length measurements can be obtained from topographic maps. The slope length can be read accurately with 1- or 2-foot interval contour maps and fair accuracy can be attained with up to 10-foot contour intervals. Generally, project mapping is drawn with either 1- or 2-foot contour intervals. The RUSLE2 profiles can be generated from the project mapping for all three project phases (pre-construction, construction, and post-construction) based on the project layout.

6. **Vegetation:** The type and density of groundcover grasses and shrubs on the project site should be estimated during the site visit. The percentage of each type of vegetation should be noted using the categories in Caltrans RUSLE2, which are described in Section 3.3.2. The existing vegetation on the site should be documented with digital photographs.
7. **Reference Site:** It may be impossible to determine pre-construction site conditions for some projects because of their extensive grading operations or other conditions limiting access to proposed soil profiles and vegetation cover. For these instances, a reference site should be selected that is similar in structure and nature to the site under analysis. Ideally, this reference site should have similar topography, soil, and climate as explained in previous sections. This reference site should be used to gather site-specific information that is relative to the project site and used accordingly. Reference sites should be in an undisturbed state prior to analysis.
8. **Harvested Topsoil:** Certain projects will have areas that have harvested topsoil and duff, which can be stored onsite and re-applied at a later time once grading operations are completed. For these sites, it is best to select a reference site to collect site-specific information and then conduct a soil analysis of the harvested topsoil or duff to determine the soil classification. Note that since this is a disturbed site, it will be susceptible to higher erosion than a non-disturbed site.

3.2 Obtain Data for Caltrans RUSLE2 Simulations

Information in the RUSLE2 Worksheet needed for the Caltrans RUSLE2 simulations can be obtained from a number of Caltrans resources. These include the:

- **Project Report**, which will include a detailed project description; a description of the site conditions, particularly soils and geotechnical information; preliminary design plans; phasing; construction methods; topography; hazardous materials; and other related information.
- **Preliminary project design and specifications**, which will include more detailed design information, information on existing drainage and flow characteristics, and other information related to the site during all three project phases.
- **SWDR**, which will provide a project description, site conditions, and information on existing and proposed site drainage and flow characteristics.
- **Detailed field visit** to document and confirm the existing conditions at the project site, including vegetation, drainage, slope, soil, etc.
- **District 8 GIS Website** (http://sv08arcgis/cgp2009/), which will include a compilation of GIS map layers displaying most of the required site information available from public sources. These include the surface soil (0 to 6 inches) K-factor from the USDA-NRCS website and the RUSLE2-R values from the NRCS FOTG website.

These technical sources and the field visit should be used as the sources for finding the data inputs needed for the Caltrans RUSLE2 model for the proposed project. As noted elsewhere in this EPP, the Caltrans RUSLE2 model does have default or generic options that can be used if certain types of information (e.g., soil or precipitation information) are not available in Caltrans technical supporting documents or from public sources.

3.3 Project Site-Specific Data

The RUSLE2 Worksheet should be used to develop the project and site-specific information for input into the Caltrans RULSE2 model. The primary inputs to this form are described in the following sections and the worksheet is described and illustrated in Section 3.3.7.

3.3.1 Climate/Rainfall

Climate should be determined by the specific project location. Record the project name and EA, a brief description of the construction activity, and its location (district, county, route, and KP/MP). The project location will determine the climatic zone and NRCS service area, which, in turn, will determine the specific RUSLE2-R to use.

If isohyetal maps are used to determine the rainfall intensity (typically 10-year, 24-hour rainfall) for a project location, the local isohyetal mapping can typically be found at the District hydraulics unit or County Flood Control Agency. The rainfall intensity is represented as contours on the isohyetal map. If the project site location is between two rainfall intensity contours, the rainfall intensity should be interpolated between the contours. This rainfall intensity value is used to select the climate data in Caltrans RUSLE2.

3.3.2 Vegetation

Visual analysis of the site is used to identify vegetation type, density, and vegetation cover. Select an area (or areas if there are distinctly different vegetation types) that best represents the typical vegetation, vegetation density, and coverage for the project site. Within this area, a square plot should be established that is approximately 20 strides (about 60 feet) along the bottom of the slope and then another 20 strides up the slope. The area within the plot should be assessed as the average vegetation site condition. Subsequently, the area should be subdivided into four equal quadrants and each quadrant evaluated separately to determine vegetation density and vegetation coverage. This analysis should combine the separate evaluations for the total sample area and the four quadrants and average them into one number. This will assist in determining the average vegetation density and vegetation cover for the project site.

3.3.2.1 Vegetation Classification

The user should determine the type of existing vegetation based on the following available options in Caltrans RUSLE2:

- Bare Ground
- Grasses and Forbs
- Mixed Grasses and Shrubs
- Shrubs

The user should use this list as a reference and select the most appropriate vegetation type to represent the existing vegetation onsite. This vegetation selection is used as input information into the Caltrans RUSLE2 model.

3.3.2.2 Vegetation Cover and Density

Vegetation cover and density should be determined using the above-referenced sample area. The user should visually inspect the project sample area, evaluate the selected vegetation type, and determine the density of vegetation. The user should select the appropriate vegetation density as sparse, moderate, or dense. This should be determined by evaluating the ratio of the vegetation cover actually in contact with the soil compared to the total area. In evaluating Grasses and Forbs, note that grass has numerous contact points per area as compared to forbs, which typically have fewer points of contact for the same area. To determine the density of the selected vegetation type, visually analyze the total number of plant material contacts of that vegetation type. Figure 3-1 gives a graphical overview of how different cover percentages may appear.

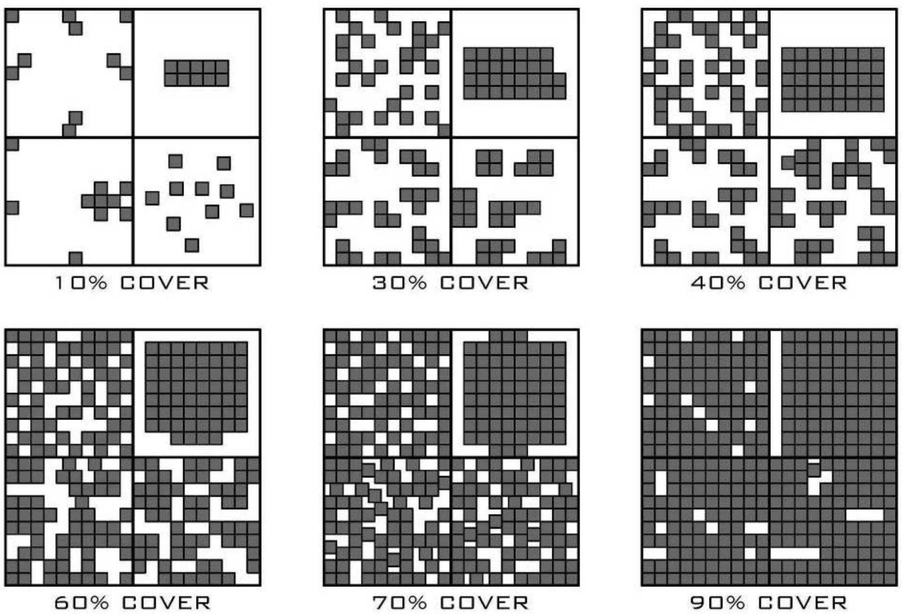

Figure 3-1. Vegetation/Rock Coverage Classification

Caltrans has subdivided the RUSLE2 vegetative cover into the following categories:

- 0 to 25 percent cover is considered sparse cover
- 25 to 35 percent cover is sparse to moderate cover
- 35 to 70 percent cover is considered moderate cover
- Greater than 70 percent cover is considered dense cover

The vegetation type with corresponding coverage classification should be used as input information in Caltrans RUSLE2. A series of photos are provided as Figures 3-2a through 3-2d to facilitate appropriate assessment of plant cover.

Figure 3-2a. Vegetation Cover Approximately 20%

Figure 3-2b. Vegetation Cover Approximately 50%

Figure 3-2c. Vegetation Cover Approximately 90%

Figure 3-2d. Vegetation Cover Approximately 95%

3.3.3 Rock Cover

Rock fragments are unattached pieces of rock material three-eighths inches or greater in diameter. Rock cover reduces soil loss and should be incorporated into the erosion model. Site rock cover is determined using the same visual technique as used for the vegetation cover shown in Figure 3-1.

The value for rock cover should take into account the values for other cover types to avoid overlapping values when the various cover percentages are combined (i.e., to avoid total percentages greater than 100 percent).

3.3.4 Other Cover Factors

There are factors other than vegetation that influence erosion. These are factors in RUSLE2 that do not require input by the user. These are summarized below.

3.3.4.1 Groundcover

Groundcover is material in contact with the soil that both intercepts raindrops and slows runoff. It includes all types of cover, such as mulches and compost, as well as live vegetation in contact with the soil surface and plant litter (dead plant matter). The surface cover must be anchored to the surface or be of sufficient size so that it is not blown away by wind or washed away by runoff. Caltrans RUSLE2 includes a number of these materials as Rolled Erosion Control Products (RECP) and as loose material (e.g., pine needles, curled wood).

3.3.4.2 Canopy Cover

Canopy cover is vegetative cover above the soil surface that intercepts the raindrops but does not contact the soil surface. Open spaces in a canopy, whether within the perimeter of a plant canopy or the space between adjacent plants, are not considered canopy in Caltrans RUSLE2. The two characteristics of canopy that are used in Caltrans RUSLE2 calculations are (1) the percent of surface covered by the canopy, and (2) the height within the canopy from which intercepted rain drops reform into water droplets and fall to the ground; this fall distance is known as the "effective fall height." The effective fall height is measured from the ground up to the level within the canopy from which the majority of water droplets fall. The effective fall height of a canopy varies with the vegetation type, the density of the canopy, and the architecture of the plants (Toy and Foster, 1998).

The impact velocity of water drops falling from a canopy is lower when the effective fall height is less than 30 feet and higher when the fall height is above 30 feet because of the increased mass of the drops falling from the canopy. Therefore, canopies greater than 30 feet are not considered to provide erosion control benefits. The portion of canopy cover that is directly above groundcover has no effect on erosion because the groundcover is considered the governing factor in erosion control in that instance.

3.3.5 Soils

Accurate soil properties are needed to run the Caltrans RUSLE2 model because soil type has a significant influence on erosive potential. The soil properties may be obtained from the geotechnical report for the project site or by conducting a soil analysis and input into RUSLE2 by soil texture. Alternately, the soil classification determined for the site from NRCS soil surveys can be input into RUSLE2 to provide the soil information.

3.3.5.1 Site Observation

The user needs to determine the existing soil types at the project location and should do this by conducting a visual analysis of the site. The number of representative areas is usually easy to identify based upon slope steepness, slope aspect, changes in vegetative cover, soil color, etc. Two samples per representative area are considered sufficient for highway projects for the purposes of the EPP.

3.3.5.2 Soil Collection and Onsite Analysis

If soils data (i.e., texture) are unavailable from sources such as a geotechnical study or soil survey soil, soil sample collection and analysis can be performed for the site. A visual analysis should be conducted by selecting an area on the project site that best represents the average soil type in appearance, including color, texture, and density. If possible, the analyst should auger a 3-inch wide, 24-inch deep hole. Samples of soil should be collected from the top, middle, and bottom of the sample hole and the three samples composited into a single sample. Enough soil should be taken for the composite sample to fill a 1-quart container. Samples should be sealed in an airtight container and the container marked with the date and location of sample collection. Soil samples should be delivered to an approved soils lab to conduct the soil tests.

3.3.5.3 Laboratory Analysis

Site soil samples should be submitted to an approved soils lab for testing. Soil testing guidance and a sample soils report are provided in Appendix C. The soils report can provide an analysis of the soil texture (% sand, %silt, and % clay according to the USDA classification system). Additional soil testing can provide other soil chemical properties such as organic matter and soil nutrient levels as well as an indication of the appropriate amendments necessary to properly sustain plant vegetation. The soil classification, percentages of sand, silt, and clay, and organic matter can be used as input information for the Caltrans RUSLE2 model. The soils report should specify which soil category best represents the project soil sample as outlined in the Caltrans RUSLE2 model soil classifications or the soil texture triangle can be used.

3.3.5.4 Other Sources for Soil Properties

If the user cannot collect soil samples for analysis from the project site, the user may collect representative reference site samples, following the same procedures outlined for the project site. If soil samples are not an option at the project or reference site, the user may be able to obtain soil properties for the project site from a geotechnical report as an alternative source of information. Information from a soil survey data would provide soil properties from the soil horizon that would represent a conservative erodibility factor (most erodible). For this, the latitude and longitude of the project and approximate disturbed soil area boundaries are needed to identify the soil classification. However, if significant construction or other soil disturbing activities were performed previously at the project site and the top 5 feet of native soil removed, the soil survey information may no longer be appropriate.

3.3.5.5 Soil Classifications

Soil properties in Caltrans RUSLE2 are grouped into four categories: Disturbed land examples, Disturbed/mixed soils by textures, Undisturbed soils by texture, and individual folders of soils by county or area. Input within the first three categories is by soil texture, while the fourth lists soil classifications found within a specific county or area. Table 3-1 provides the soil analysis textures used in Caltrans RUSLE2. Details of how the soil options are organized within RUSLE2 are provided in Appendix E.

Table 3-1. Soil Analysis Textures

Clay	**Sandy Clay Loam**
clay (greater than 50% clay)	sandy clay loam (high OM)
clay (low-mod OM, less than 50% clay)	sandy clay loam (low-mod OM)
clay (mod-high OM, less than 50% clay)	sandy clay loam (low-mod OM, v. slow perm.)
Clay Loam	sandy clay loam (mode-high OM)
clay loam (high OM)	sandy clay loam (mod-high OM, v. slow perm)
clay loam (low-mod OM)	sandy clay loam (subsoil, substratum)
clay loam (low-mod OM, v. slow perm)	**Sandy Loam**
clay loam (mod-high OM)	sandy loam (low-mod OM)
clay loam (mod-high OM, v. slow perm)	sandy loam (low-mod OM, slow perm)
clay loam (subsoil, substratum)	sandy loam (mod-high OM)
Gravelly	sandy loam (mod-high OM, slow perm)
Gravelly clay (greater than 50% clay)	sandy loam (subsoil, substratum)
Gravelly clay loam (subsoil, substratum)	**Silt**
Gravelly loam (subsoil, substratum)	**Silt Loam**
Gravelly sand	silt loam (high OM)
Gravelly sandy clay loam (subsoil, substratum)	silt loam (low-mod OM)
Gravelly sandy loam (subsoil, substratum)	silt loam (low-mod OM, subsoil, substr)
Gravelly silt loam (low-mod OM)	silt loam (low-mod OM, v. slow perm)
Gravelly silty clay	silt loam (mod-high OM, v. slow perm)
Gravelly silty clay loam (low-mod OM)	silt loam (mod-high OM)
Loam	**Silty Clay**
loam (high OM)	silty clay (less than 50% clay)
loam (low-mod OM)	silty clay (low-mod OM, less than 50% clay)
loam (low-mod OM, v. slow perm)	silty clay (mod-high OM, less than 50% clay)
loam (mod-high OM)	**Silty Clay Loam**
loam (mod-high OM, v. slow perm)	silty clay loam (high OM)
loam (subsoil, substratum)	silty clay loam (low-mod OM)
Loamy Sand	silty clay loam (low-mod OM, subsoil, substratum)
Sand	silty clay loam (low-mod OM, v. slow perm)
	silty clay loam (mod-high OM)
	silty clay loam (mod-high OM, v. slow perm)

Note: OM = Organic Matter

3.3.6 Slope Profile

The slope length and gradient are combined into a single topographic factor (LS) in the Caltrans RUSLE2 model. The estimated loss is based on the proportion of the watershed that each topographic condition factor represents. The user should measure the horizontal distance and elevation drop from where the runoff flows from the origin of overland flow in the project area to the end of the segment or bottom of the concentrated flow. The user should then verify the site conditions for slope against project contour grading plans and typical cross-sections. The following slope profile information is input into the Caltrans RUSLE2 model: (1) segment horizontal slope length, and (2) average slope steepness.

The project site profile for the pre-construction phase is based on existing ground contours and can be read from project contour grading plans. Typically, for undisturbed ground, the slope is relatively constant. The project plans provide the final (post-construction) slope profiles, which may be made up of varying slope segments resulting in a more complex slope.

3.3.7 RUSLE2 Worksheet

The data obtained from the various tasks above should be entered into the RUSLE2 Worksheet (Figure 3-3). The worksheet results should then be used to complete the project MDF (Figure 3-4). Examples of completed RUSLE2 Worksheets and MDFs can be found in the supplemental guidance (see Appendix B for how to obtain copies). These inputs are used in Caltrans RUSLE2 to simulate the various project phases and BMP scenarios. The data collection locations of the site should be noted, including whether these locations are typical or represent the worst-case scenario. Each site should have a minimum of three data collection areas. On larger sites, the user needs more data collection areas wherever variations occur in the slope, soils, rock, canopy, or cover.

Caltrans RUSLE2 model outputs (soil loss and sediment delivery rates) should be recorded to allow straightforward comparisons of the erosion potential of various scenarios. For a typical project, a minimum of four simulations are needed to determine the baseline and allowable erosion rate limits. Multiple iterations beyond the minimum are typically required to select an effective and cost conscious BMP combination. The predicted pre-construction and post-construction with permanent BMPs erosion rates should be compared to determine if the final stabilization criterion can be met. The maximum construction phase erosion (disturbed soil without BMPs) is determined for calculation of the construction MAER. The construction phase with applied temporary BMPs should be compared against the construction MAER to determine that 80% reduction can be achieved.

RUSLE2 Worksheet

Project: ______________________________

Location: ______________________________

Site Characteristics

CLIMATE		SOIL		TOPOGRAPHY	
Rainfall Erosivity (R):		Soil type:		Slope % factor (S):	
		Soil erodibility (K):		Slope length factor (L):	

RUSLE2 Program Runs

PROJECT PHASE	RUSLE2 Run no.	COVER (C) and PRACTICE (P)		OUTPUT	
		Management (Vegetation type / % cover / BMP)	Permeable Barrier	Soil loss (t/ac/yr)	Sediment delivery (t/ac/yr)

Figure 3-3. RUSLE2 Worksheet

METHOD DEMONSTRATION FORM

This form documents the selected method for demonstrating final stabilization as required under Section II.D., “Conditions for Termination of Coverage” of the Construction General Permit (Order No. 2009-0009-DWQ, NPDES No. CAS000002).

Project Description

Project EA/ID:
Dist-County-Route:
Post Mile Limits:
Project Type:

Project Risk Level:
Sediment Risk:
Receiving Water:

Caltrans RUSLE2 Method

Caltrans RUSLE2 software was used to evaluate soil loss and sediment delivery for the project. Input criteria and results are summarized in the following tables.

Pre-Construction:

Soil Erodibility (K)	Climate/Rainfall (R)	Location

Slope (Typical)		Management			Erosion/ Soil Loss (t/ac/yr)	Sediment Delivery (t/ac/yr)
Steepness (%)	Length (ft)	Soil Stab. BMP	Vegetation	Permeable Barriers		

Post-Construction:

Soil Erodibility (K)	Climate/Rainfall (R)	Location

Slope (Typical)		Management			Erosion/ Soil Loss (t/ac/yr)	Sediment Delivery (t/ac/yr)
Steepness (%)	Length (ft)	Soil Stab. BMP	Vegetation	Permeable Barriers		

Edit as appropriate:

The post-construction slope shows a decrease in both the erosion/soil loss and sediment delivery when compared to the pre-construction slope. This provides computational proof indicating final stabilization. Consequently, the site will not pose any additional sediment discharge risk than it did prior to the commencement of construction activity.

Figure 3-4. Method Demonstration Form

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Section 4

Erosion Prediction Using Caltrans RUSLE2

The RUSLE2 program was originally developed by USDA to guide conservation planning and estimate soil erosion and sediment delivery. RUSLE2 was modified into Caltrans RUSLE2 to facilitate erosion prediction calculations for Caltrans highway construction projects. The Caltrans RUSLE2 program is available for download on the Caltrans Storm Water website (http://www.dot.ca.gov/hq/oppd/stormwtr/rusle2.htm).

4.1 Source of Model

RUSLE2 is the culmination of a series of model developments. The first model developed to estimate rill and inter-rill erosion on overland flow areas was called the USLE (Universal Soil Loss Equation). The USLE was developed by Wischmeier and Smith in 1960 for erosion control on cropland in the mid-western and eastern U.S. It was later extended to other land uses, such as mining and construction, and applied to the western U.S. This first revision to USLE (RUSLE1) was released in the 1990s and is land use independent.

RUSLE1 evolved into RUSLE2 to apply to any land use having exposed soil and overland flow. RUSLE2 was released in 2003, but is it still based on agricultural land use. Development of RUSLE2 was a joint project involving the USDA-Agricultural Research Service (ARS), the National Resources Conservation Service (NRCS), and the University of Tennessee. Originally, the USDA-ARS provided overall leadership for the project, especially in developing the scientific components of RUSLE2. The University of Tennessee provided leadership in developing the computer aspects of RUSLE2, including its computational engine, user interface, and computer code.

RUSLE2 was developed to be land use independent and to serve a diverse set of users. The principal application of RUSLE2 is conservation planning in the local and county-level field offices of the USDA-ARS. The Illinois State Water Survey, NRCS, USDA-ARS, and the University of Tennessee analyzed weather data to obtain new erosivity values. The NRCS advised the project on its requirements for RUSLE2, evaluated RUSLE2, and developed a comprehensive RUSLE2 operational database.

Whereas USLE was an index-based, empirically derived model, RUSLE2 uses a different mathematical integration and has been adopted by the NRCS as the standard tool for erosion prediction on disturbed lands. The RUSLE2 program provides the same analysis of erosion as the RUSLE1 method. However, the RUSLE2 program computes average annual soil loss for a particular day, unlike USLE and RUSLE1, which only computed average soil loss on an annual basis. Additionally, the internal calculations in the RUSLE2 program code do not consist of a direct application of USLE. RUSLE2 was modified further in a version known as the ARS version, which has a database of highly disturbed lands and is more suitable for construction projects. The ARS-RUSLE2 also calculates sediment yield.

4.2 Caltrans Modifications to RUSLE2

The ARS-RUSLE2 database was modified by Caltrans in 2005, 2007, and again in 2011 to develop BMPs to those applicable to Caltrans projects. To customize the RUSLE2 program for Caltrans purposes, a reorganization of the program database and corresponding folders was required. The soil survey data and management zone data for California were loaded and typical construction site management options, such as fiber rolls and track-walked side slopes, were added. The addition of applicable Caltrans BMPs required the matching and replacement of BMPs from the original RUSLE2 database with those Caltrans BMPs that are most similar. A number of options for items such as contouring and strip farming were removed as they are not applicable to Caltrans construction sites. The resulting modified ARS-RUSLE2 and modified database are referred to as Caltrans RUSLE2.

In 2011, Caltrans RUSLE2 was refined to meet Caltrans ongoing needs for its construction projects and to incorporate some of the updates developed by NRCS and the University of Tennessee since 2007. The enhancements included expanded features, such as a permeable barrier placement tool and additional BMP options, improved program accuracy by modeling vegetation after California native growth patterns, and re-organized management options and re-named BMP choices to make it more intuitive to Caltrans users. The BMPs in Caltrans RUSLE2 are based on the Caltrans Construction Site BMP Manual (Caltrans, 2003) and the CASQA Stormwater BMP Handbook: Construction (CASQA, 2009). To facilitate future updates, compatibility to current and past RUSLE2 versions was also maintained. A summary of the 2011 upgrades is below with a full listing provided in Appendix D.

- **Management Practices:** The management options were simplified and made more intuitive to users. The management practice folders were reorganized and the names of the practices were revised to commonly used Caltrans nomenclature. Descriptors, i.e., BFM 3400 lb/ac with seed, were also added to the BMPs in place of the Caltrans BMP notations (i.e., SS-3 for hydraulic mulch). A separate reference guide was developed to relate the many BMPs in RUSLE2 to their Caltrans and CASQA designations (see Appendix A). A number of new BMPs commonly used by Caltrans were also added to the management practices database, such as compost erosion control blankets and more grasses and forbs. See Appendix E for summaries and the layout of the Caltrans RUSLE2 tabs, including the Management tab.
- **Permeable Barrier Placement Tool:** This new tool allows multiple permeable barriers, e.g., silt fences and fiber rolls, to be placed more easily at set intervals defined by the user. Additional permeable barrier types were also added, such as gravel bag berms and sand bag barriers.
- **Improved Accuracy:** Pre-construction and post-construction vegetation options were revised to follow California native vegetation growth patterns, which has summer dormancy for annual grasses. The effectiveness of permeable barriers is now based on observed storm water and surface water flow conditions and the effectiveness of RECPs and mulch materials were calibrated to independent studies conducted in Texas and San Diego, California.
- **Advanced Functionality:** The new user screen template allows visual tracking of the daily vegetative canopy development, mulch and cover degradation, and changes in surface roughness and ridge roughness using graphs.

4.3 Description of RUSLE2 Model

Caltrans RUSLE2 content is organized within tabs, dropdown menus, and nested folders. Tabs within RUSLE2 group together the major categories of data, with similar selections sub-grouped into nested folders. A reference guide for RUSLE2 users that describes the organization and operations of each tab and displays each tab's internal structure is provided in Appendix E.

BMPs are found mainly in the Management tab, with the exception of permeable barriers such as silt fences, which are found within the Permeable Barrier Placement Tool tab. The primary folders in the Management tab are Existing Undisturbed Vegetative Cover, Highly Disturbed, Strip/Barrier Managements, and Local. Secondary folders group the construction and post-construction BMPs and paving options within the Highly Disturbed primary folder. This structure provides clear categories for management practices that are directly applicable to Caltrans projects. Descriptions of the content of each primary folder are provided below.

- **Highly Disturbed.** Management practices representative of the BMPs typically used for erosion and sediment control during the construction and post-construction phases are found here. The BMPs are divided into subcategories to better direct the user to the appropriate type of management practices: Construction with Temporary Practices, Post-construction Cut / Fill Surfaces, and Paving and Armoring.
- **Existing Undisturbed Vegetative Cover.** This category provides the baseline, pre-construction condition for project analysis. Subcategories (Natural Condition/Undisturbed and Agriculture) were removed in 2011 and replaced with cover typically observed during pre-construction, such as grasses and forbs, shrubs, and bare ground. Crop Management Zones were also removed as the revised vegetation growth curves now follow California growth patterns.
- **Strip/Barrier Management.** This category includes required programming data that links to other management practices with Caltrans RUSLE2. Caltrans RUSLE2 does not currently use the strips and barriers function within this folder as they are primarily for agricultural erosion control. The permeable barriers commonly used by Caltrans are found under the Permeable Barrier Placement Tool tab.
- **Local.** This folder is intended for use by advanced users. Customized BMPs can be saved here for future use without affecting the integrity of the standard BMPs included in Caltrans RUSLE2.

4.4 Caltrans RUSLE2 Site Analysis Process

Caltrans RUSLE2 allows users to predict erosion at sites with highly disturbed soil such as those typically found in roadway construction projects. This section summarizes the steps the user should implement to complete the Caltrans RUSLE2 analysis for the project. Model runs for the pre-construction and post-construction phases are needed to demonstrate final stabilization, while model runs for the construction phase are needed to demonstrate construction MAER. Flowcharts depicting the process for selecting BMPs to achieve final stabilization and construction MAER requirements are shown in Figure 4-1 and Figure 4-2, respectively. Examples of how to create the RUSLE2 profiles for the different project phases and the steps needed to fill out the RUSLE2 Worksheet are available in the Caltrans RUSLE2 training course exercises (see Appendix B for how to obtain copies).

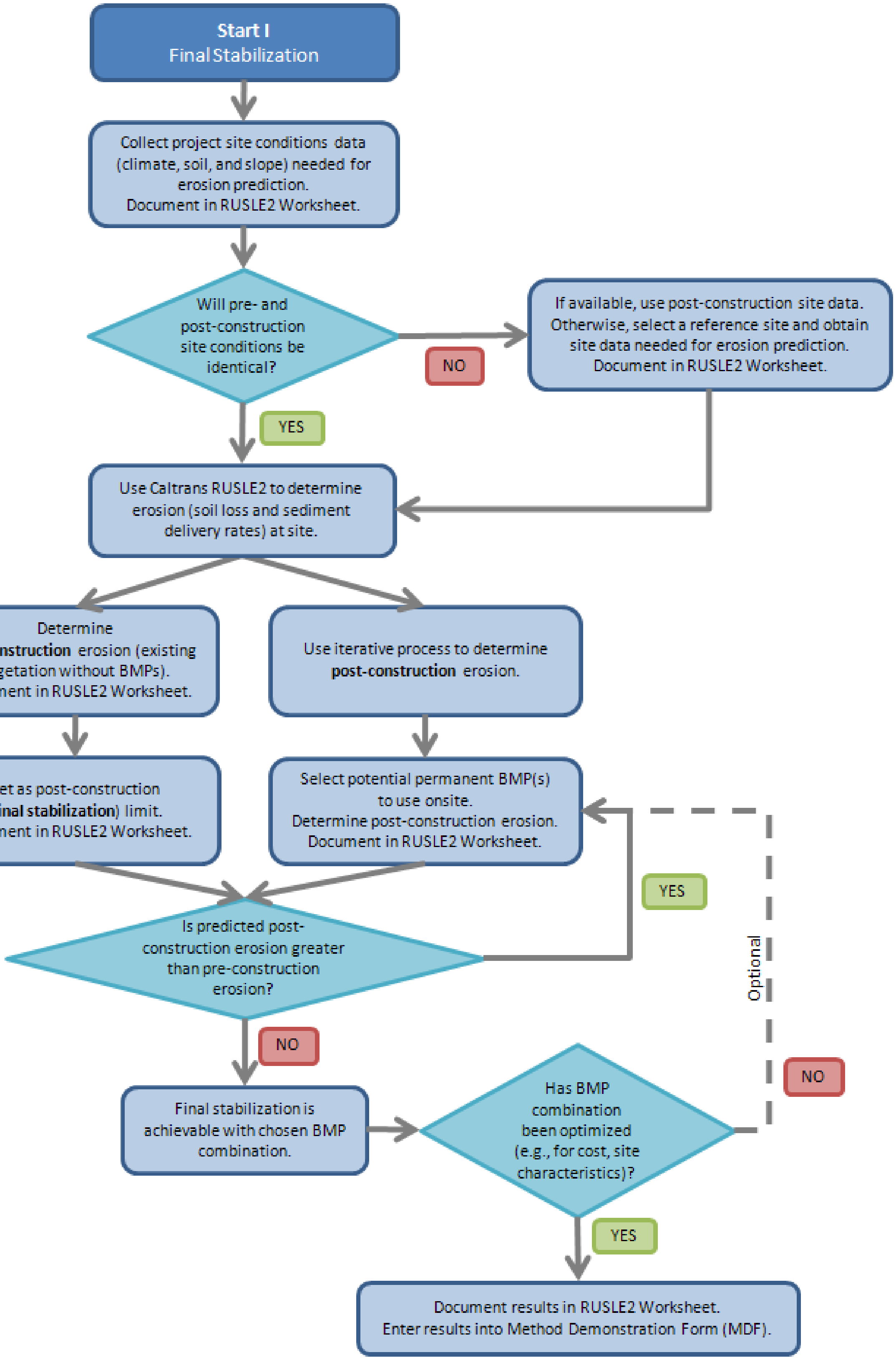

Figure 4-1. Final Stabilization Flow Chart

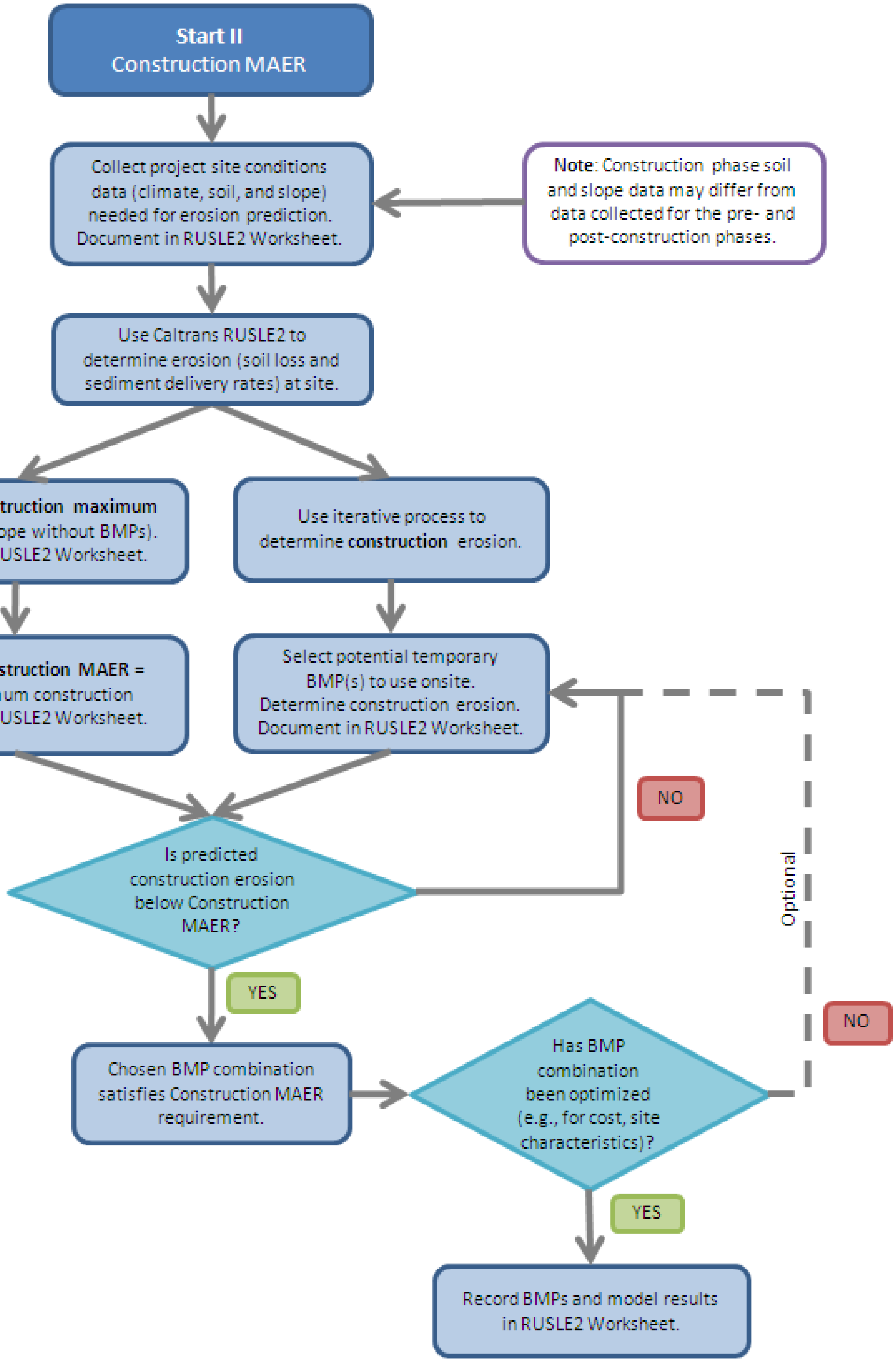

Figure 4-2. Construction MAER Flow Chart

4.4.1 RUSLE2 Worksheet Input Data

The EPP process begins with data collection for the project, as described in Section 3. The user should document the source and date for all data identified for use in Caltrans RUSLE2 to provide a project history of the inputs used. In cases where the existing data were interpolated or extrapolated, the user should provide notations and the reason for use of that data. The model data input variables are defined in more detail in Section 4.5.

The RUSLE2 Worksheet should be filled out prior to Caltrans RUSLE2 program initiation to facilitate effective input of the data into the Caltrans RUSLE2 program. Erosion rates from the different RUSLE2 runs for a project should be recorded on the same RUSLE2 Worksheet to allow for easy comparison between phases and BMP choices.

4.4.2 Pre-construction Phase RUSLE2 Analysis

The pre-construction site data are used to determine the pre-construction soil loss for the project site prior to the start of any project construction activities. This pre-construction data run generates the baseline for use in evaluating the post-construction phase of the project to determine if the selected BMPs would meet final stabilization. The steps involved to model the pre-construction condition are described below.

Step 1: Input pre-construction variables: climate, soil, and topography (slope length and slope steepness).

Step 2: Prepare a Caltrans RUSLE2 pre-construction model run using existing vegetation without management practices (BMPs). Set the resulting erosion rates (soil loss and sediment delivery, t/ac/yr) as the post-construction limit for comparing BMPs to determine if they can achieve final stabilization.

Step 3: Record results in the RUSLE2 Worksheet and move on to the post-construction analysis.

4.4.3 Post-construction Phase RUSLE2 Analysis

The post-construction phase Caltrans RUSLE2 analysis is an iterative process for selecting BMPs to control erosion during site establishment after construction activities are finished. The steps involved to model the post-construction phase are:

Step 1: Input the post-construction variables. The climate selection doesn't change, but the soil and topography conditions can be different from the pre-construction phase. The post-construction topography can differ from the pre-construction conditions now that the highway project is complete. Depending on the construction activities (e.g., cut or fill), the soil type at post-construction may have changed as well.

Step 2: Prepare a Caltrans RUSLE2 post-construction model run using minimal management practices. Compare the resulting erosion rate to the pre-construction phase erosion (the final stabilization limit). If the result is greater than the allowable erosion limit, go to Step 3. If the result is less than the erosion limit, final stabilization can be achieved and post-construction runs are complete; move on to Step 4.

Step 3: Prepare a modified Caltrans RUSLE2 post-construction model run using a different combination of management practices. Compare the resulting erosion rate to the final stabilization limit. If the result is still greater than the erosion limit, repeat this step until the erosion is below the limit. Once the erosion result is below the limit, the final stabilization criterion can be achieved and post-construction runs are complete; move on to Step 4.

To optimize the BMP combination, consider the installed costs of the selected BMPs and also its applicability to the site characteristics. Installed costs of the BMPs in Caltrans RUSLE2 can be found in the Caltrans RUSLE2 training course materials (see Appendix B for details).

Step 4: Record results in the RUSLE2 Worksheet. Then transfer the RUSLE2 information from the pre-construction and post-construction model runs to the MDF for the project.

4.4.4 Construction Phase RUSLE2 Analysis

The construction phase Caltrans RUSLE2 analysis is an iterative process to select appropriate BMPs for controlling the erosion during construction activities. The steps involved to model the construction condition are described below.

Step 1: Input the construction variables. The climate selection doesn't change, but the soil and topography conditions can be different from the pre-construction phase. Construction of the highway project typically alters the slope length and steepness (topography) of the site. If construction involves activities such as cut or fill, the soil type can differ from the pre-construction condition.

Step 2: Prepare a Caltrans RUSLE2 construction model run with bare soil and no management practices to determine the maximum erosion during construction. Use the maximum erosion rate to calculate the construction MAER for the project.

Construction MAER = 20% x maximum erosion rate

Step 3: Prepare another Caltrans RUSLE2 construction model run using minimal management practices (i.e., silt fence at toe of slope and hydraulic mulch). Compare the resulting erosion rate to the construction MAER. If the result is greater than construction MAER, go to Step 4. If the result is less, the construction MAER limit can be achieved and construction runs are complete; move on to Step 5.

Step 4: Prepare a modified Caltrans RUSLE2 construction model run using a different combination of management practices. Compare the resulting erosion rate to the construction MAER limit. If the result is still greater than the erosion limit, repeat this step until the erosion is below the limit. Once the erosion result is below the limit, the construction MAER criterion can be achieved and construction runs are complete; move on to Step 5.

To optimize the BMP combination, consider the installed costs of the selected BMPs and also its applicability to the site characteristics. Installed costs of the BMPs in Caltrans RUSLE2 can be found in the Caltrans RUSLE2 training course materials (see Appendix B for details).

Step 5: Record results in the RUSLE2 Worksheet.

4.5 Model Inputs

Descriptions of the Caltrans input variables and how the data are used in the program are provided in this section. Refer also to Appendix E for details on how Caltrans RUSLE2 is organized and descriptions of the program's data tabs. Examples demonstrating how to find and apply the model inputs are available in the Caltrans training course exercises (see Appendix B for how to obtain copies). Information on how to install and run Caltrans RUSLE2 for the first time is also available in Appendix B.

4.5.1 Climate/Rainfall Erosivity 'R'

The project location will determine the climate factor to be used for the project site. The climate is determined by individual R values. R is the product of storm energy times the maximum 30-minute rainfall intensity. The RUSLE2-R value is an average annual sum of these individual storm values. How much it rains (amount) and how hard it rains (intensity) are the two main characteristics of rainfall that determine its erosivity. The rainfall intensity corresponding to the project site location is based on local isohyetal maps or the eFOTG website. The erosivity values should be considered for project scheduling to minimize the erosion during construction. Figure 4-3 shows an example of the monthly erosivity factor values over a calendar year. For this sample project, construction activity and exposed soil surfaces should be avoided from November to March, which are high erosivity periods.

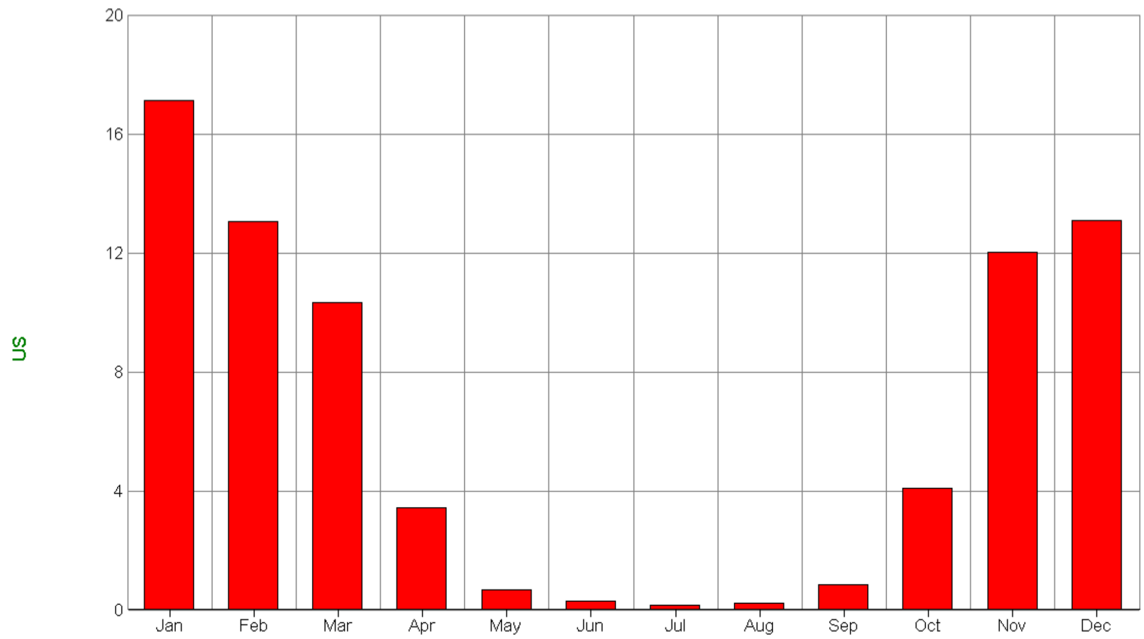

Figure 4-3. Graphic Representation of Monthly Erosivity Values

The RUSLE2-R factor for the project area is selected from the Caltrans RUSLE2 database by choosing the correct RUSLE2-R option from the drop-down menu. It is recommended that this climate database not be changed because users of Caltrans RUSLE2 must use the same database to avoid inconsistencies in analyses among different projects. The rainfall intensity for the project site location, and therefore the erosivity values, are the same for the pre-construction, construction, and post-construction phases. Therefore, this input will not need to be changed for any of the project phases.

4.5.2 Soil Erodibility 'K'

The K value is the erodibility of soil that is susceptible to erosion.

4.5.2.1 Pre-construction Phase

There are several ways to select the soil erodibility factor data for the pre-construction phase:

- Based on the project location, the value of soil-erodibility (K) for undisturbed soil can be selected from the RUSLE2 database, which is based on the NRCS database. Choose the site K factor from the county and soil number options in the drop-down menu. This selection method will be approximate because the top layers of soil on the project site are typically disturbed (i.e., stockpiled) in the early phases of construction.
- Choosing the soil K factor from the disturbed soils by texture folder for the project site is another method for selecting soil erodibility. The user will need to obtain the soil texture from the geotechnical report as discussed in Section 3.
- The last method is to consider using the soil properties of a nearby project, or the reference site, whose properties might be considered similar to the properties of the project site.

The input data for the soil properties can be entered either directly as the percentage of clay/silt/sand or by selecting the soil texture from the pull-down menu.

The rock cover percentage is entered in the upper right input box. This is the value obtained during the site visit. These rock fragments, which are unattached pieces of 10 millimeters (mm) or greater in diameter that are within the soil profile, are considered a factor in the estimation of soil erodibility. The rock fragments resting on the soil surface act like surface mulch, similar to residue and plant litter. Rock cover reduces soil loss, and Caltrans RUSLE2 considers rock cover as part of the cover (C) factor.

The soil loss is based on soil content, so if the user inputs the breakdown of clay, silt, and sand, along with permeability, hydrologic class, and subsurface design, if available, Caltrans RUSLE2 will generate an estimated soil loss from input data and the database.

4.5.2.2 Construction Phase

Caltrans RUSLE2 includes a procedure for estimating soil erodibility for highly disturbed soil for construction sites. It estimates soil erodibility using the soil erodibility nomograph program in RUSLE2. The soil texture and properties for the project site during construction will need to be generated from the project-specific geotechnical information. Based on the type of soil used for construction and various soil types in the cut and fill areas, a construction soil type can be developed and input into Caltrans RUSLE2.

Caltrans currently attempts to conserve the native, pre-existing top soil, so that after construction grading and compaction are complete, the original topsoil can be replaced. The disturbance of the native soil will cause some properties to change, but the NRCS soil type will still apply.

On slopes that will not use vegetation to achieve final stabilization, rock or aggregate can be used instead. In cut and fill areas for road embankments, the aggregate base class 2 or engineering fill can be used as a top layer. Hence the texture of cover soil material input in Caltrans RUSLE2 should be reflective of that base material.

4.5.2.3 Post-construction Phase

The post-construction process for estimating soil erodibility is similar to the construction phase and will be based on the final soil surface conditions at construction completion.

4.5.3 Topography

In Caltrans RUSLE2, slope length and gradient are entered as separate values and RUSLE2 calculates them into a single topographic factor (the LS factor) automatically.

4.5.3.1 Pre-construction

The estimated soil loss for the pre-construction phase is based on the proportion of the watershed that each LS factor represents. The total soil loss in the project area is obtained by adding up these different segments. This pre-construction value represents the baseline pre-construction soil erosion for the project site.

For most projects, the user can measure the horizontal distance and elevation drop from the project mapping. The measurements should be from where runoff flows from the origin of overland flow in the project area to where it enters major flow concentration or the lower end of each segment. Slope segment data are from the top to the bottom of the slope profile in the area proposed to be disturbed. The profile shape of the overland flow path will be divided into segments and the length and slope for each segment entered. The pre-construction input data for the slopes are determined from the site visit or project plans, as described in Section 3.

4.5.3.2 Construction

The construction phase topography is usually different than the pre-construction phase topography. In many cases, hill slope profiles are complex, consisting of several segments of differing lengths, gradients, and shapes, which must be entered in Caltrans RUSLE2. Caltrans RUSLE2 computes a slope length value for non-uniform slope profiles by estimating an "effective LS value" or length of slope value. The slope profile is divided into segments reflecting length and gradient characteristics for each type of slope**.** Typically on construction sites, these segments will have discrete grade breaks and constant slopes. Therefore, the slope length for each segment should be entered into RUSLE2 as a separate segment.

4.5.3.3 Post-construction

The post-construction soil texture and corresponding properties used in Caltrans RUSLE2 should be estimated from the configuration of the final design and any project requirements such as soil amendments. The identified reference site should allow for comparison of predicted soil properties versus actual soil properties.

The post-construction phase topography may be different than the construction phase topography, especially on multiyear projects that have distinct phases for grading operations. The segments corresponding to the final phase slopes are entered in Caltrans RUSLE2 as the final topography.

4.5.4 Management Practices

In Caltrans RUSLE2, management practices include both cover and practice factors that can be used independently or in combination.

Cover includes all living (vegetative), non-living organic (mulch), soil, rock, or paved (concrete, asphalt) surfaces that cover the soil surface before and after construction is completed. Management practices describe the soil surface smoothness and compaction primarily from heavy equipment. For paved surfaces, scraping, leveling, track-walking, or rolling equipment is used. For plant establishment, tractors accomplish ridging, disking, plowing, or tilling of the soil surface.

Establishing vegetative cover is key to attaining erosion control in most construction projects, with the exception of projects in paved urban areas or desert environments. RUSLE2 simulates the growth of annual grasses and forbs based on the growth curve of California native grasses. This curve has peak biomass production in spring and dormancy in summer because of drought. An example of the typical annual growth pattern used in RUSLE2 for grasses and forbs is shown in Figure 4-4.

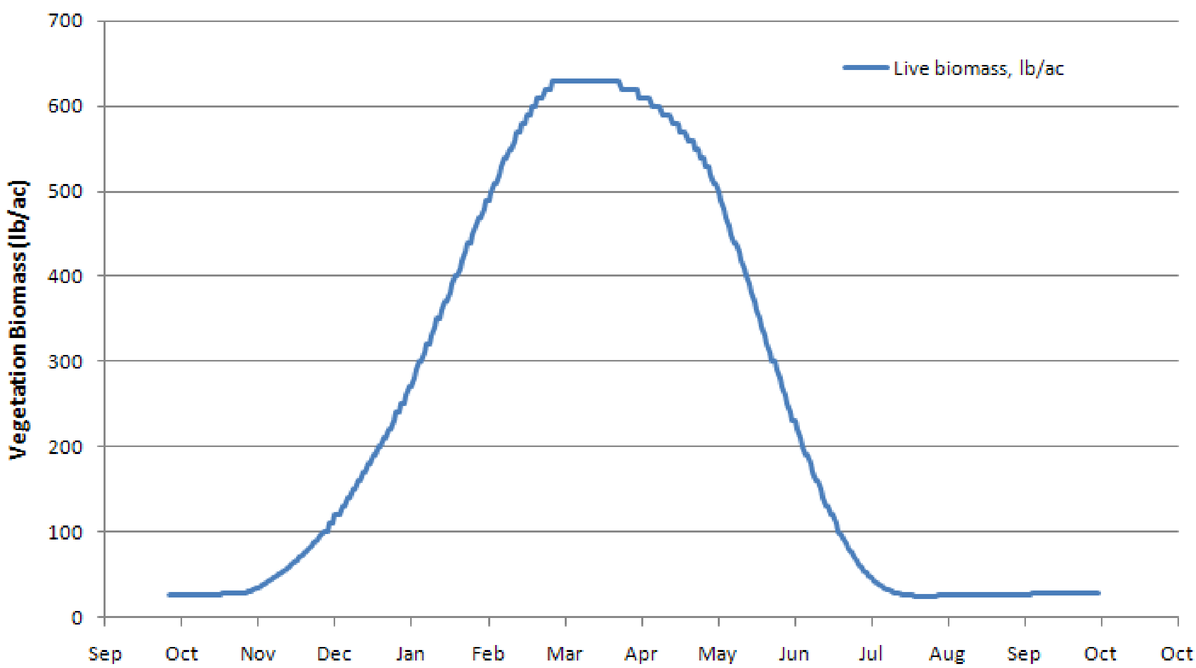

Figure 4-4. Typical Annual Growth Pattern for Grasses and Forbs

Growth curve for 1-inch compost blanket with seed in Nevada County, CA (R40-44).

In RUSLE2, BMPs with vegetation are typically simulated for 15 years to model post-construction average annual erosion. An example of the 15-year growth pattern used in Caltrans RUSLE2 for grasses and forbs in California is shown in Figure 4-5. It shows an increasing growth rate during the first four years, with steady state growth in years 5 through 15. Figure 4-5 also illustrates how the 1-inch compost blanket RECP supplemented the net surface cover for the first few years while the vegetation was becoming established. This combination of a RECP and vegetation is an example of the benefits of using an initial surface cover that degrades over time to support vegetation establishment.

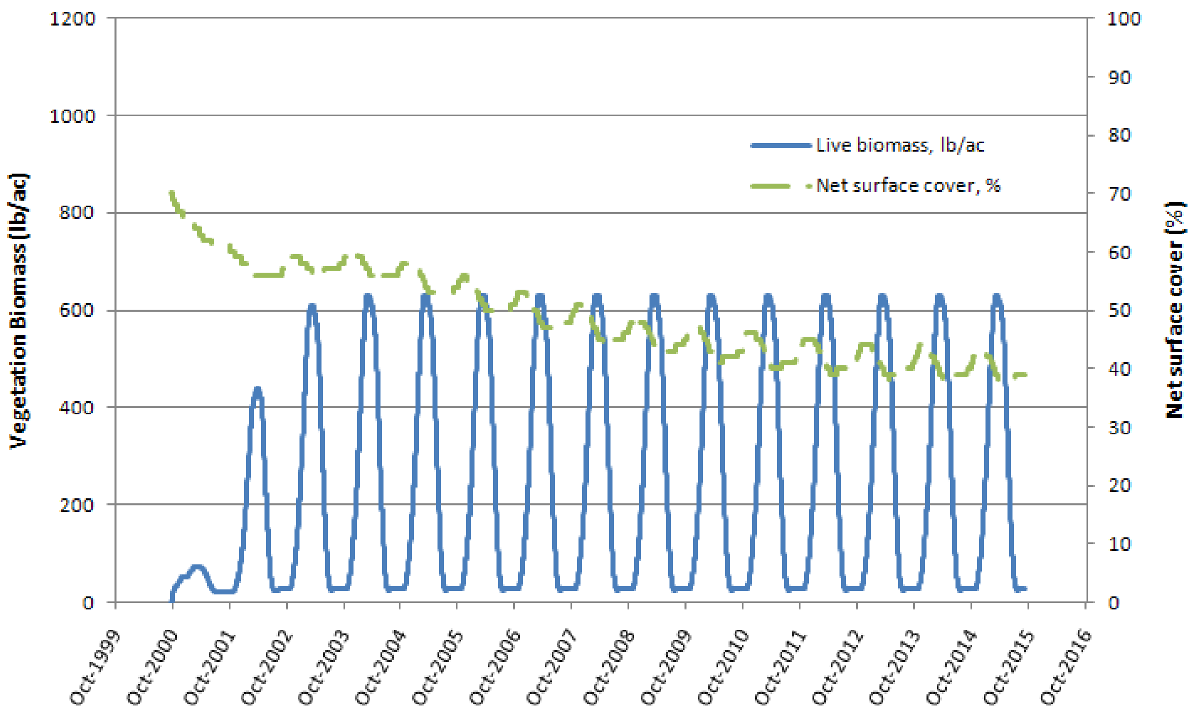

Figure 4-5. Typical 15-year Growth Pattern and Surface Cover for Grasses and Forbs

Growth curve for 1-inch compost blanket with seed in Nevada County, CA (R40-44).

The vegetative growth cycle assumes that after the plant reaches maturity, stems, leaves, and seeds cover the soil surface and roots biodegrade under the surface at rates based on the climatic factors. This annual cycle repeats itself until steady state is achieved after approximately 4 years. Caltrans RUSLE2 simulates the growth of some perennial shrubs, but trees were not included because of the diversity of species and the complexity of estimating cover given the wide range of tree growth habits present in California.

4.5.4.1 Pre-construction (Existing/Undisturbed) Cover

The pre-construction phase management practices are characterized by existing cover. The management options were revised to include typical cover vegetation types found in California. Key to this input is estimating the type and amount of vegetative cover on the project site, as discussed in Section 3.3.2. Section 3.3.2 also provides the user with guidance on how to visually estimate density and categorize it into cover percentage.

4.5.4.2 Construction - Temporary BMPs

Caltrans RUSLE2 has a database of management options for use on highly disturbed land such as construction areas. The pull-down menu offers various options including hydroseeding, mulch, etc. The user can change management types, operation, vegetation, and type of mulch cover to suit the project-specific requirements.

In construction projects, minimizing sediment delivery from complex slopes is necessary. The slope length model may need to include seed, mulch and straw bale barriers, fiber rolls, and silt fences to achieve the construction MAER goal. These types of BMPs are typically designed for periods of a year or limited to a particular season. Therefore, the user will need to ensure that the proposed BMP is appropriate for the duration of the project.

4.5.4.3 Post-construction - Permanent BMPs

Permanent BMPs are designed, constructed, and maintained to function during the operational life of the project. These BMPs may include highway planting and landscaping, etc. RUSLE2 output does account for changes in vegetation over time as the vegetation matures and ages. The user should know that the typical post-construction RUSLE2 erosion rate is based on 15 years of vegetation establishment.

The user should consider the post-construction BMPs while planning for the construction phase and recognize that sedimentation basins may need to be maintained until the disturbed areas are stabilized. Predicted soil loss in excess of the established post-construction erosion limit may require permanent sediment control systems, some of which must be modeled outside of the Caltrans RUSLE2.

4.6 Report Template

When the user has completed the pre-construction, construction, and post-construction Caltrans RUSLE2 model runs for the project site and has reviewed the results for accuracy and completeness, the user can prepare the MDF for the proposed project. The user should use the template provided in Section 3 and refer to the examples available in the supplemental guidance (see Appendix B).

4.7 Program Limitations

The Caltrans RUSLE2 program incorporates modifications that improve its applicability to California construction activities. However, there are certain limitations of the program that the user should be aware of to achieve optimal model results. Caltrans RUSLE2 program limitations are as follows:

- The ARS RUSLE2 version that the Caltrans RUSLE2 program is based on does not effectively calculate root biomass and residue. It models vegetation growth as a crop; thus, long-term growth patterns are not accurately accounted for.
- Root biomass and yield change soil loss calculations substantially; thus, one general vegetation type cannot accurately be applied to the entire state of California. Several types of vegetation need to be considered to represent different regions of California. The next revision of ARS RUSLE2 may take this into consideration. In the meantime, the user should be aware that this may account for some error in Caltrans RUSLE2 results, particularly for long-term permanent vegetation conditions.
- California vegetation (e.g., California Brome) produces results that behave as expected. However, non-native vegetation does not produce as accurate or as realistic results.
- Grasses and Forbs and their corresponding ARS database were modified in 2011 to simulate typical growth in the California climate and reasonable results are produced, in general, in the Caltrans RUSLE2 model runs.
- The user should be aware that many of ARS RUSLE2, and thus Caltrans RUSLE2, calculations are based on extrapolations and not actual data, especially for long-term calculations (e.g., post-construction). Caltrans RUSLE2 model results should be evaluated with caution and compared with expected values and empirical evidence to the extent feasible.

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Section 5

References

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Appendix A:
Reference Guide – Caltrans Construction BMPs in RUSLE2

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APPENDIX A
REFERENCE GUIDE: CALTRANS CONSTRUCTION BMPs IN RUSLE2

Caltrans RUSLE2 Program (2011 version)			Caltrans Storm Water Quality Handbooks Construction Site BMP Manual		CASQA Stormwater BMP Handbook: Construction	
BMP Type	**Full Name in RUSLE2 [1, 7]**	**Description [2, 3, 4, 5, 6]**	**ID**	**BMP Type**	**ID**	**BMP Type**
TEMPORARY SOIL STABILIZATION						
Not modeled in RUSLE2.			SS-1	Scheduling	EC-1	Scheduling
			SS-2	Preservation of Existing Vegetation	EC-2	Preservation of Existing Vegetation
Hydraulic mulch	Hydraulic Mulch 2500 lbs	2500 lb/ac of fiber only. Tackifier is included, but not part of dry weight.	SS-3	Hydraulic Mulch	EC-3	Hydraulic Mulch
	Hydraulic Mulch PSFM 2500 lbs	2500 lb/ac of fiber only. Adhesive PSFM is included, but not part of dry weight.				
	Hydraulic Mulch, BFM 3400 lbs/ac	3400 lb/ac of fiber only. Adhesive BFM is included, but not part of dry weight.				
Hydraulic mulch w/ seed	Hydraulic Mulch, PSFM 2500 lbs with seed	2500 lb/ac of fiber mulch with tackifier (PSFM). Seed mix of grass and forbs, good stand, applied with hydroseeder. Starting storage biomass of 40 lb/ac and 600 lb/ac yield.				
	Hydraulic Mulch, BFM 3400 lbs/ac with seed	3400 lb/ac of fiber mulch with tackifier (BFM). Seed mix of grass and forbs, good stand, applied with hydroseeder. Starting storage biomass of 40 lb/ac and 600 lb/ac yield.				
Hydraulic mulch w/ volunteer vegetation	Hydraulic Mulch 2500 lbs+tackifier+volunteer veg	2500 lb/ac of fiber mulch with tackifier. Seed mix of volunteer grass and forbs, poor stand. Starting storage biomass of 10 lb/ac and 60 lb/ac yield.				
	Hydraulic Mulch PSFM 2500 lbs + volunteer veg	2500 lb/ac of fiber mulch with tackifier (PSFM). Seed mix of volunteer grass and forbs, poor stand. Starting storage biomass of 10 lb/ac and 60 lb/ac yield.				
	Hydraulic Mulch, BFM 3400 lbs/ac + volunteer veg	3400 lb/ac of fiber mulch with tackifier (BFM). Seed mix of volunteer grass and forbs, poor stand. Starting storage biomass of 10 lb/ac and 60 lb/ac yield.				
Hydroseeding	Hydroseeding, grain or annual rye with fiber emulsion	Winter wheat seed, applied with hydroseeder, 20 lb/ac harvest yield. Hydroseed mixture includes 2000 lb/ac of fiber mulch with tackifier.	SS-4	Hydroseeding	EC-4	Hydroseeding
	Hydroseeding + fiber + tackifier + 2000lb punched straw	Seed mix of grass and forbs, good stand, applied with hydroseeder. Starting storage biomass of 50 lb/ac and 600 lb/ac yield. Hydroseed mixture includes 2500 lb/ac of fiber mulch with tackifier. Includes 2000 lb/ac (1 ton) of straw mulch, applied with sheepsfoot roller.				
	Hydroseeding + fiber + tackifier + 2000lb blown straw	Seed mix of grass and forbs, good stand, applied with hydroseeder. Starting storage biomass of 50 lb/ac and 600 lb/ac yield. Hydroseed mixture includes 2500 lb/ac of fiber mulch with tackifier. Includes 2000 lb/ac (1 ton) of blown straw mulch.				
	Hydroseeding + fiber + tackifier + 4000lb blown straw	Seed mix of grass and forbs, good stand, applied with hydroseeder. Starting storage biomass of 50 lb/ac and 600 lb/ac yield. Hydroseed mixture includes 2500 lb/ac of fiber mulch with tackifier. Includes 4000 lb/ac (2 tons) of blown straw mulch.				

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BMP Type	**Full Name in RUSLE2 (1, 7)**	**Description (2, 3, 4, 5, 6)**	**ID**	**BMP Type**	**ID**	**BMP Type**
Not modeled in RUSLE2.			SS-5	Soil Binders	EC-5	Soil Binders
Straw mulch	Straw Mulch 2000 lbs/ac	Applied at 2000 lb/ac (1 ton).	SS-6	Straw Mulch	EC-6	Straw Mulch
	Straw Mulch 4000 lbs/ac	Applied at 4000 lb/ac (2 tons).				
Straw mulch w/ seed	Straw Mulch 2000 lbs/ac, with seed	2000 lb/ac (1 ton) of straw mulch, applied with crimper. Seed mix of grass and forbs, good stand, applied with broadcast seeder. Starting storage biomass of 40 lb/ac and 600 lb/ac yield.				
	Straw Mulch 4000 lbs/ac, with seed	4000 lb/ac (2 tons) of straw mulch, applied with crimper. Seed mix of grass and forbs, good stand, applied with broadcast seeder. Starting storage biomass of 40 lb/ac and 600 lb/ac yield.				
Straw mulch w/ volunteer vegetation	Straw Mulch 2000 lbs/ac with volunteer vegetation	2000 lb/ac (1 ton) of straw mulch. Seed mix of volunteer grass and forbs, poor stand. Starting storage biomass of 10 lb/ac and 60 lb/ac yield.				
	Straw Mulch 4000 lbs/ac with volunteer vegetation	4000 lb/ac (2 tons) of straw mulch. Seed mix of volunteer grass and forbs, poor stand. Starting storage biomass of 10 lb/ac and 60 lb/ac yield.				
Pine needle mulch	Spread Pine Needles, 2000 lbs/ac	Applied at 2000 lb/ac (1 ton).				
	Spread Pine Needles, 4000 lbs/ac	Applied at 4000 lb/ac (2 tons).				
Pine needle mulch w/ volunteer vegetation	Spread Pine Needles, 2000 lbs/ac with volunteer vegetation	Applied at 2000 lb/ac (1 ton). Seed mix of volunteer grass and forbs, poor stand. Starting storage biomass of 10 lb/ac and 60 lb/ac yield.				
	Spread Pine Needles, 4000 lbs/ac with volunteer vegetation	Applied at 4000 lb/ac (2 tons). Seed mix of volunteer grass and forbs, poor stand. Starting storage biomass of 10 lb/ac and 60 lb/ac yield.				

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BMP Type	Full Name in RUSLE2 (1, 7)	Description (2, 3, 4, 5, 6)	ID	BMP Type	ID	BMP Type
Rolled erosion control products (RECP)	Coconut/Coir Netting RECP	Open weave netting, decays slowly.	SS-7	Geotextiles, Plastic Covers, and Erosion Control Blankets / Mats	EC-7	Geotextiles and Mats
	Combination Straw/Coir RECP	70% straw/30% coconut fiber blanket with double netting, decays moderately slowly.				
	Curled Wood Fiber RECP	Excelsior blanket with double netting.				
	Jute Netting RECP	Open weave netting, moderate decay rate.				
	Straw Blanket RECP	Blanket with double netting, decays rapidly.				
Rolled erosion control products (RECP) w/ seed	Coconut/Coir Netting RECP with seed	Open weave netting, decays slowly. Seed mix of grass and forbs, good stand, applied with broadcast seeder. Starting storage biomass of 40 lb/ac and 600 lb/ac yield.				
	Combination Straw/Coir RECP with seed	70% straw/30% coconut fiber blanket with double netting, decays moderately slowly. Seed mix of grass and forbs, good stand, applied with broadcast seeder. Starting storage biomass of 40 lb/ac and 600 lb/ac yield.				
	Curled wood fiber RECP with seed	Excelsior blanket with double netting. Seed mix of grass and forbs, good stand, applied with broadcast seeder. Starting storage biomass of 40 lb/ac and 600 lb/ac yield.				
	Jute Netting RECP with seed	Open weave netting, moderate decay rate. Seed mix of grass and forbs, good stand, applied with broadcast seeder. Starting storage biomass of 40 lb/ac and 600 lb/ac yield.				
	Straw Blanket RECP with seed	Blanket with double netting, decays rapidly. Seed mix of grass and forbs, good stand, applied with broadcast seeder. Starting storage biomass of 40 lb/ac and 600 lb/ac yield.				
Rolled erosion control products (RECP) w/ volunteer vegetation	Coconut/Coir Netting RECP with volunteer vegetation	Open weave netting, decays slowly. Seed mix of volunteer grass and forbs, poor stand. Starting storage biomass of 10 lb/ac and 60 lb/ac yield.				
	Combination Straw/Coir RECP with volunteer vegetation	70% straw/30% coconut fiber blanket with double netting, decays moderately slowly. Seed mix of volunteer grass and forbs, poor stand. Starting storage biomass of 10 lb/ac and 60 lb/ac yield.				
	Curled wood fiber RECP with volunteer vegetation	Excelsior blanket with double netting. Seed mix of volunteer grass and forbs, poor stand. Starting storage biomass of 10 lb/ac and 60 lb/ac yield.				
	Jute Netting RECP with volunteer vegetation	Open weave netting, moderate decay rate. Seed mix of volunteer grass and forbs, poor stand. Starting storage biomass of 10 lb/ac and 60 lb/ac yield.				
	Straw Blanket RECP with volunteer vegetation	Blanket with double netting, decays rapidly. Seed mix of volunteer grass and forbs, poor stand. Starting storage biomass of 10 lb/ac and 60 lb/ac yield.				

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BMP Type	**Full Name in RUSLE2** [1, 7]	**Description** [2, 3, 4, 5, 6]	**ID**	**BMP Type**	**ID**	**BMP Type**
Compost erosion control blankets (CECB)	0.5 inch Compost Blanket CECB	0.5-inch thick CECB, with 54,800 lb/ac of medium coarse compost.	SS-8	Wood Mulching	EC-8 EC-14	Wood Mulching Compost Blanket
	1 inch Compost Blanket CECB	1-inch thick CECB, with 108,000 lb/ac of medium coarse compost.				
	2 inch Compost Blanket CECB	2-inch thick CECB, with 216,000 lb/ac of medium coarse compost.				
Compost erosion control blankets (CECB) w/ seed	0.5 inch Compost blanket with seed	0.5-inch thick CECB, with 54,800 lb/ac of medium coarse compost. Seed mix of grass and forbs, good stand, applied with hydroseeder. Starting storage biomass of 40 lb/ac and 600 lb/ac yield. Hydroseed mixture includes 1500 lb/ac of fiber mulch with tackifier.				
	1 inch Compost blanket with seed	1-inch thick CECB, with 108,000 lb/ac of medium coarse compost. Seed mix of grass and forbs, good stand, applied with hydroseeder. Starting storage biomass of 40 lb/ac and 600 lb/ac yield. Hydroseed mixture includes 1500 lb/ac of fiber mulch with tackifier.				
	2 inch Compost blanket with seed	2-inch thick CECB, with 216,000 lb/ac of medium coarse compost. Seed mix of grass and forbs, good stand, applied with hydroseeder. Starting storage biomass of 40 lb/ac and 600 lb/ac yield. Hydroseed mixture includes 1500 lb/ac of fiber mulch with tackifier.				
Compost erosion control blankets (CECB) w/ volunteer vegetation	0.5 inch Compost Blanket CECB with volunteer vegetation	0.5-inch thick CECB, with 54,800 lb/ac of medium coarse compost. Seed mix of volunteer grass and forbs, poor stand. Starting storage biomass of 10 lb/ac and 60 lb/ac yield.				
	1 inch Compost Blanket CECB with volunteer vegetation	1-inch thick CECB, with 108,000 lb/ac of medium coarse compost. Seed mix of volunteer grass and forbs, poor stand. Starting storage biomass of 10 lb/ac and 60 lb/ac yield.				
	2 inch Compost Blanket CECB with volunteer vegetation	2-inch thick CECB, with 216,000 lb/ac of medium coarse compost. Seed mix of volunteer grass and forbs, poor stand. Starting storage biomass of 10 lb/ac and 60 lb/ac yield.				
Not modeled in RUSLE2.			SS-9	Earth Dikes / Drainage Swales and Lined Ditches	EC-9	Earth Dikes and Drainage Swales
			SS-10	Outlet Protection / Velocity Dissipation Devices	EC-10	Velocity Dissipation Devices
			SS-11	Slope Drains	EC-11	Slope Drains
			SS-12	Streambank Stabilization	EC-12	Streambank Stabilization
			Not in Caltrans BMP Manual.		EC-13	Formerly PAM; BMP factsheet removed
See "Compost erosion control blankets" sections.			See SS-8 above.		EC-14	Compost Blanket (see EC-8 listed above)
Not modeled in RUSLE2.			Not in Caltrans BMP Manual.		EC-15	Soil Preparation / Roughening
Rock slope protection	Rock slope protection	Applied at 200,000 lb/ac, rock size of 6- to 12-inches and greater is the norm.	Not in Caltrans BMP Manual.		EC-16	Non-vegetative Stabilization

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BMP Type	Full Name in RUSLE2 (1, 7)	Description (2, 3, 4, 5, 6)	ID	BMP Type	ID	BMP Type
TEMPORARY SEDIMENT CONTROL						
Silt fence	Silt Fence - SE-1	Moderate permeable barrier retardance class in RUSLE2. Refers to "retardance" to surface water flow.	SC-1	Silt Fence	SE-1	Silt Fence
	Silt Fence reinforced with metal fabric	Moderate permeable barrier retardance class in RUSLE2. Refers to "retardance" to surface water flow.				
	Silt Fence reinforced with straw bales	Extreme permeable barrier retardance class in RUSLE2. Refers to "retardance" to surface water flow.				
Modeled in RUSLE2 under "Diversion / terrace, sediment basin" Tab.			SC-2	Sediment / Desilting Basin	SE-2	Sediment Basin
Not modeled in RUSLE2.			SC-3	Sediment Trap	SE-3	Sediment Trap
			SC-4	Check Dam	SE-4	Check Dams
Fiber rolls	Fiber roll, wattle 6 inch	6-inch diameter straw wattle. Low permeable barrier retardance class in RUSLE2. Refers to "retardance" to surface water flow.	SC-5	Fiber Rolls	SE-5	Fiber Rolls
	Fiber roll, wattle 9 inch	9-inch diameter straw wattle. Moderate permeable barrier retardance class in RUSLE2. Refers to "retardance" to surface water flow.				
	Fiber roll, wattle 12 inch	12-inch diameter straw wattle. High permeable barrier retardance class in RUSLE2. Refers to "retardance" to surface water flow.				
	Fiber roll, wattle 24 inch	24-inch diameter straw wattle. Extreme permeable barrier retardance class in RUSLE2. Refers to "retardance" to surface water flow.				
Compost sock	Compost Sock, 8-inch	8-inch diameter. Moderate permeable barrier retardance class in RUSLE2. Refers to "retardance" to surface water flow.			SE-13	Compost Socks and Berms
	Compost Sock, 12-inch	12-inch diameter. High permeable barrier retardance class in RUSLE2. Refers to "retardance" to surface water flow.				
Gravel bag berm	Gravel Bag Berm SE-6	1-inch gravel. Moderate permeable barrier retardance class in RUSLE2. Refers to "retardance" to surface water flow.	SC-6	Gravel Bag Berm	SE-6	Gravel Bag Berm
Not modeled in RUSLE2.			SC-7	Street Sweeping and Vacuuming	SE-7	Street Sweeping and Vacuuming
Sandbag barrier	Sand Bag Barrier SE-8	Course sand. Moderate permeable barrier retardance class in RUSLE2. Refers to "retardance" to surface water flow.	SC-8	Sandbag Barrier	SE-8	Sandbag Barrier
Straw bale barrier	Straw Bale Barrier- SE-9	High permeable barrier retardance class in RUSLE2. Refers to "retardance" to surface water flow.	SC-9	Straw Bale Barrier	SE-9	Straw Bale Barrier
Not modeled in RUSLE2.			SC-10	Storm Drain Inlet Protection	SE-10	Storm Drain Inlet Protection
			Not in Caltrans BMP Manual.		SE-11	Active Treatment Systems
					SE-12	Temporary Silt Dike
See "Fiber rolls" section.			See SC-5 above.		SE-13	Compost Socks and Berms (near SE-5 above)
Not modeled in RUSLE2.			Not in Caltrans BMP Manual.		SE-14	Biofilter Bags

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BMP Type	Full Name in RUSLE2 [1, 7]	Description [2, 3, 4, 5, 6]	ID	BMP Type	ID	BMP Type
OTHER BMPs						
Not modeled in RUSLE2.			WE-1	Wind Erosion Control	WE-1	Wind Erosion Control
			TC-1	Stabilized Construction Entrance / Exit	TC-1	Stabilized Construction Entrance / Exit
			TC-2	Stabilized Construction Roadway	TC-2	Stabilized Construction Roadway
			TC-3	Entrance / Outlet Tire Wash	TC-3	Entrance / Outlet Tire Wash
			NS-1	Water Conservation Practices	NS-1	Water Conservation Practices
			NS-2	Dewatering Operations	NS-2	Dewatering Operations
			NS-3	Paving and Grinding Operations	NS-3	Paving and Grinding Operations
			NS-4	Temporary Stream Crossing	NS-4	Temporary Stream Crossing
			NS-5	Clear Water Diversion	NS-5	Clear Water Diversion
			NS-6	Illicit Connection / Illegal Discharge Detection and Reporting	NS-6	Illicit Connection / Discharge
			NS-7	Potable Water / Irrigation	NS-7	Potable Water / Irrigation
			NS-8	Vehicle and Equipment Cleaning	NS-8	Vehicle and Equipment Cleaning
			NS-9	Vehicle and Equipment Fueling	NS-9	Vehicle and Equipment Fueling
			NS-10	Vehicle and Equipment Maintenance	NS-10	Vehicle and Equipment Maintenance
			NS-11	Pile Driving Operations	NS-11	Pile Driving Operations
			NS-12	Concrete Curing	NS-12	Concrete Curing
			NS-13	Material and Equipment Use Over Water	NS-14	Material Over Water
			NS-14	Concrete Finishing	NS-13	Concrete Finishing
			NS-15	Structure Demolition / Removal Over or Adjacent to Water	NS-15	Demolition Adjacent to Water
			Not in Caltrans BMP Manual.		NS-16	Temporary Batch Plants
			WM-1	Material Delivery and Storage	WM-1	Material Delivery and Storage
			WM-2	Material Use	WM-2	Material Use
			WM-3	Stockpile Management	WM-3	Stockpile Management
			WM-4	Spill Prevention and Control	WM-4	Spill Prevention and Control
			WM-5	Solid Waste Management	WM-5	Solid Waste Management

APPENDIX A
REFERENCE GUIDE: CALTRANS CONSTRUCTION BMPs IN RUSLE2

Caltrans RUSLE2 Program (2011 version)			Caltrans Storm Water Quality Handbooks Construction Site BMP Manual		CASQA Stormwater BMP Handbook: Construction	
BMP Type	Full Name in RUSLE2 [1, 7]	Description [2, 3, 4, 5, 6]	ID	BMP Type	ID	BMP Type
Not modeled in RUSLE2.			WM-6	Hazardous Waste Management	WM-6	Hazardous Waste Management
			WM-7	Contaminated Soil Management	WM-7	Contaminated Soil Management
			WM-8	Concrete Waste Management	WM-8	Concrete Waste Management
			WM-9	Sanitary / Septic Waste Management	WM-9	Sanitary / Septic Waste Management
			WM-10	Liquid Wste Management	WM-10	Liquid Waste Management

NOTES:

(1) BMPs in the RUSLE2 Management Tab are listed in both the Construction phase folder (temporary BMPs) and Post-construction phase (permanent BMPs) folder under the similar names. They differ by how long they are simulated to be in service by RUSLE2. The Construction phase BMPs are in use for 2 years, whereas the Post-construction phase BMPs are in use for 15 years.

(2) Application rates (lb/ac) are dry weights of fiber material. Tackifiers and stabilizing emulsions, if included in the mixture, are not part of the dry weights.

(3) Materials (e.g., wood fiber, netting, tackifier, etc) used in the BMPs are biodegradable.

(4) Caltrans RUSLE2 uses a mix of perennial ryegrass and white clover to model a seed mix of grass and forbs.

(5) Fiber for hydromulch can be wood, cellulose (paper), or an alternative fiber such as cotton or corn stalks, fine screened compost, or a combination. Caltrans RUSLE2 does not show a difference in the type of fiber used.

(6) Tackifier for Bonded Fiber Matrix (BFM) is a high performance, cross-linked adhesive. Polymer Stabilized Fiber Matrix (PSFM) uses polyacrylamide (PAM). Other hydromulch applications use guar, psyllium, starch, polymeric blends, polysaccharides, or a combination. RUSLE2 does not show a difference in the type of tackifier used.

(7) RUSLE2 Management BMPs and corresponding 2010 Standards Bid Items:

2010 Bid Item	RUSLE2 Management
Hydromulch	Hydraulic Mulch
Hydroseed	Hydroseeding
Bonded Fiber Matrix	Hydraulic Mulch, BFM
Polymer Stabilized Fiber Matrix	Hydraulic Mulch, PSFM
Straw	Straw Mulch

ACRONYMS:

BFM = Bonded fiber matrix
CECB = Compost erosion control blanket
EC = Erosion control
NS = Non-stormwater management
PSFM = Polymer stabilized fiber matrix
RECP = Rolled erosion control product
SC = Sediment control
SE = Sediment control
SS = Soil stabilization
TC = Tracking control
WE = Wind erosion
WM = Waste management and materials pollution control

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Appendix B:
Caltrans RUSLE2 Resource Materials

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Appendix B
Caltrans RUSLE2 Resource Materials

Detailed supporting guidance for using the RUSLE2 program is available from two sources: the Caltrans RUSLE2 training course and the Caltrans RUSLE2 webpage. The training classes, taught between 2009 and 2011 throughout the Districts, were attended by over 250 Caltrans staff. The course was created with Caltrans needs in mind and aimed at demonstrating how Caltrans RUSLE2 could be applied to designing and assessing the effectiveness of erosion control measures used on Caltrans construction projects. The course materials have evolved over the years in response to course feedback and users' suggestions on how the RUSLE2 program could better meet project needs. The most recent version of Caltrans RUSLE2 was completed in 2011.

Caltrans posted some of the RUSLE2 resources from the training course onto its Storm Water website so that people who were not able to attend a training class could still learn to use the program. From the website, people can download the Caltrans RUSLE2 program, the training course presentations and exercises, and the EPP Manual. It also includes directions for installing the program and two quick start guides.

Complete listings of the training binder and CD contents are provided in Section B.1. Summaries of the Caltrans RUSLE2 website contents, program installation steps, and RUSLE2 user's manual are in Section B.2. Copies of the quick start guides (how to run RUSLE2 and how to incorporate compost) are in Section B.3.

B.1 Caltrans RUSLE2 Training Course

The training course materials were distributed in a binder with an accompanying CD. The hardcopy materials in the course binder were also provided electronically on the course CD (see Sections B.1.1 and B.1.2, respectively, for listings). In addition, the CD included a copy of the RUSLE2 program and user's manual, the training class presentation slides by module, and blank forms in editable file formats. The course materials included:

1. An in-class example and 3 exercises to demonstrate how to use RUSLE2 simulations to evaluate BMPs. Steps and sources to obtain project data are included, as well as examples of the model runs typically needed to determine if a BMP choice could meet the final stabilization and Construction MAER requirements.
2. Useful handouts such as the RUSLE2 program organizational chart, tables of BMP installed costs, and maps of receiving water risk and KLS values from the State Water Resources Control Board.
3. Supplemental guidance documents, such as this EPP Manual and the Caltrans Project Risk Level Determination Guidance.

B.1.1 Training Course Binder Contents

- Tab 0: Course Agenda and table of contents
- Tab 1: In-class Materials
  - Pre-exam and Post-exam
  - Course Feedback

- Websites for Risk Level Determination Factors
- RUSLE KLS Values Map, Revised
- Receiving Water Risk Map
- BMP Installed Costs
- RUSLE2 Organizational Chart
- Class Example: Truckee Bypass

- Tab 2: Exercise 1 – Devil's Slide
  - Project site description, questions, and answer key
- Tab 3: Exercise 2 – Highway 905
  - Project site description, questions, and answer key
- Tab 4: Exercise 3 – Willits Bypass
  - Project site description, questions, and answer key
- Tab 5: Caltrans Guidance Documents
  - Erosion Prediction Procedure Manual (September 2008)
  - Project Risk Level Determination Guidance (July 2010)
  - Draft Design Guidance for Notice of Termination (March 2011)

B.1.2 Training Course CD Contents

- RUSLE2 Program and User's Manual
- Class Presentation Slides
  - Module 1: Construction General Permit Risk Level Determination
  - Module 2A: RUSLE2 Setup
  - Module 2B: Final Stabilization and Notice of Termination Documentation
  - Module 2C: Predicting Construction Erosion
  - Module 3: Using RUSLE2 for Final Stabilization and Construction Maximum Allowable Erosion Rate (MAER)
- Live editable files of the:
  - Handout, Websites for Risk Level Determination Factors (MS Word)
  - RUSLE2 Worksheet (MS Word)
  - Method Demonstration Form (MS Word)
  - Soil Sample Sieve Analysis (MS Excel)
- Binder contents by tab (Adobe PDF) <<see Section B.1.1 for full listings>>
  - Tab 0: Cover, table of contents, and course agenda
  - Tab 1: In-class Materials
  - Tab 2: Exercise 1 – Devil's Slide
  - Tab 3: Exercise 2 – Highway 905
  - Tab 4: Exercise 3 – Willits Bypass
  - Tab 5: Caltrans Guidance Documents

B.2 Caltrans RUSLE2 Website

The RUSLE2 resources webpage, Erosion Prediction with RUSLE2, is part of the Caltrans, Division of Design, Storm Water website. The website address is http://www.dot.ca.gov/hq/oppd/stormwtr/rusle2.htm. The RUSLE2 webpage provides summaries of, and links to supporting documents for, three resources: the RUSLE2 software, Erosion Prediction Procedure (EPP), and Caltrans RUSLE2 Training Course. Available for download are copies of the EPP Manual, the training course presentations and exercises, and the RUSLE2 program with installation instructions. The website content is periodically reviewed and updated as the resources are modified by Caltrans.

B.2.1 RUSLE2 Program Installation and Startup

Installation of the Caltrans RUSLE2 software is straightforward. Once the zip file is downloaded, extract and save the zipped files to the computer. For most Caltrans machines, the files should be saved to the C-drive (C:\). Within the main "Rusle2" folder are several loose files and subfolders, such as Archives, Binaries, Import, and Users. The file structure should not be altered as the program requires it to operate properly.

To start the program, locate the "Rusle2.exe" file within the "Binaries" subfolder. Double-clicking the file opens the RUSLE2 program. For additional details, including program screenshots, refer to the installation instructions file that is available for download on the Caltrans RUSLE2 webpage.

B.2.2 RUSLE2 Program User's Manual

Caltrans RUSLE2 was originally based on ARS-RUSLE2 (2005 version). Much of the program has been modified in its evolution into Caltrans RUSLE2. However, the fundamental science and technical basis of the program can be found in the draft user's manual and used for reference. The draft user's manual for ARS-RUSLE2 (January 2003) can be downloaded at http://fargo.nserl.purdue.edu/rusle2_dataweb/RUSLE2_Technology.htm. An electronic copy is also provided on the Caltrans RUSLE2 training course CD.

B.3 RUSLE2 Quick Start Guides

Two quick start guides were developed in 2011 for Caltrans RUSLE2 users that provide snapshots of 1) how to run RUSLE2 and where to find technical support and 2) how to model compost incorporation in RUSLE2. Both guides are provided in this section and copies are also available for download from the Caltrans RUSLE2 website.

Quick Start Guide:

Download and Run Caltrans RUSLE2

August 2011

Caltrans RUSLE2 is an interactive computer program that estimates soil erosion based on the Universal Soil Loss Equation (USLE, Wischmeier and Smith, 1960). The Caltrans RUSLE2 software predicts erosion based on project site characteristics: climate (R), soil (K), slope steepness (S), slope length (L), compaction/tillage practices (P), and vegetative or mulch cover (C), Erosion prediction using Caltrans RUSLE2 is an approved method in the Construction General Permit (Order No. 2009-0009-DWQ) for demonstrating final stabilization.

A. Download Caltrans RUSLE2

1. Go to the Caltrans Division of Design, Storm Water website located at: http://www.dot.ca.gov/hq/oppd/stormwtr/rusle2.htm
2. Follow the instructions for downloading and installing Caltrans RUSLE2 under the section entitled "Caltrans RUSLE2 Software."
3. Before running the RUSLE2 program for the first time, make sure to first delete any existing versions of RUSLE from your computer.

B. How to Run RUSLE2

1. Open the "RUSLE2" folder, select the "Binaries" folder, and open the "Rusle2.exe" file.
2. Select "OK" to close the window that appears – it is a warning note for advanced users.
3. The first time you open RUSLE2, an "Introduction" window appears.
   a. Select "Profile" under question 1. Where would you like to start?
   b. Select the "Caltrans Basic Complex slope advanced" option under question 2. Which template would you like to use?
4. Create a new RUSLE2 profile or modify an existing one:
   a. In the "File" menu of the main toolbar, select "Open" then select "Profile."
   b. An "Open" window appears. Open the profile "default" to begin a new profile.
   c. To save your profile, always do a "save as" so you do not save over the existing "default" profile.
   d. To open an existing profile, in Step 4b, search for your file when the "Open" window appears and open that one instead of the "default" profile.
5. Modify **climate (R)** by
   a. Selecting the ▼ symbol on the right side of the "Location" box
   b. Climate options are organized by Caltrans District or California County.
   c. To open a folder or make a selection, double-click on the climate file.
6. Modify **slope steepness (S)** by entering the numeric value (%) of your slope.
7. Modify **slope length (L)** by entering the numeric value of the horizontal slope length for your site.

8. Modify **soil (K)** by:
    a. Selecting "Soil" tab.
    b. Click on the ▼ symbol on the right side of the "Soil" field to view the soil options.
    c. Soils are organized by soil texture or California region or County.
    d. Double click to open a folder or to select the soil type corresponding to your site.
9. Modify **C and P Factors to select BMPs.**
    a. Select the "Management" tab. The C and P factors are combined into "Management" options in RUSLE2.
    b. Click on the ▼ symbol on the right side of the "Management" field to view the management options.
    c. Double click to open a folder or to select the BMP or vegetative cover that corresponds to your site.
    d. BMPs organization:
        i. Pre-construction phase BMPs are found under the "Existing Undisturbed Vegetative Cover" folder.
        ii. Construction phase BMPs are found under the "Construction with Temporary Practices" subfolder within the "Highly Disturbed" folder.
        iii. Post-construction phase BMPs are found under the "Post Construction Cut/Fill Surfaces" subfolder within the "Highly Disturbed" folder.
10. Predicted **erosion results** are reported in tons per acre per year (t/ac/yr). The results are displayed in two fields at the top right corner of the RUSLE2 profile: "Soil loss erodible portion" and "Sediment delivery."

C. Where to Find RUSLE2 Help

1. Caltrans RUSLE2 training class materials
    a. Go to Caltrans Division of Design, Storm Water website (see step in A.1).
    b. Download class presentations and exercises from "Caltrans RUSLE2 Training" section of website.
    c. See presentation slides in Modules 2A for detailed discussions regarding how to select RUSLE2 climate (R) and soil (K) slope steepness (S) and length (L) factors. Modules 2B and 2C provide details on how to select cover (C) and practices (P) within the management tab in RUSLE2 for erosion prediction.
2. Caltrans Erosion Prediction Procedure Manual
    a. Go to Caltrans Division of Design, Storm Water website (see step in A.1).
    b. Download EPP Manual from "Erosion Prediction Procedure" section of website.
    c. The EPP Manual details how to predict erosion on Caltrans construction sites, the components and development history of the RUSLE2 program, and the resources available to users in the EPP Manual appendices.

Quick Start Guide

Compost Incorporation in RUSLE2

August 2011

It is possible to model incorporation of compost in RUSLE2. This is done by modifying the Soil option instead of changing the Management option. Compare a low organic soil with a high organic soil of identical texture.

A. Low organic matter soils (simulates no compost incorporation)

1. Identify your site soil texture (USDA classification).
2. Within the Soil tab, select the "Disturbed/Mixed Soil by Texture" folder.
3. Open the soil texture folder that matches your site soil texture.
    a. This applies to only these textures: clay loam, silty clay loam, sandy clay loam, silt loam, sandy loam, and loam.
    b. Textures, such as sand, do not have variable organic matter.
4. Within the folder, choose the option with the lowest organic matter. This is either the low organic matter (l OM) or the low to medium organic matter (l-m OM) selection.
5. Now enter the remaining RUSLE2 inputs for your model run; the R, L, S, and Management factors.
6. Record the RUSLE2 outputs.

B. High organic matter soils (simulates compost incorporation)

7. Change to a higher organic matter option within the same soil texture folder. This is either the medium to high organic matter (m-h OM) or high organic matter (h OM) selection.
8. Now confirm the remaining RUSLE2 inputs for your model run; the R, L, S, and Management factors.
9. Record the RUSLE2 outputs.

Limitations

– Increasing the soil organic matter does not quantitatively conform to any specific compost incorporation rate.

– Compost blankets are a different Management option than compost incorporation.

Appendix C: Soil File Creation

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Appendix C
Soil File Creation

Descriptions of soil characteristics, especially soil erodibility (K) factors, do not exist for many highly disturbed lands typical of construction sites, landfills, and reclaimed mined land. Therefore soil characteristics must be developed by collecting a soil sample and testing it in a geotechnical laboratory. The soil sample should be analyzed for particle size distribution according to the USDA classification system. The organic matter content and infiltration rate should also be estimated.

After receiving the results from the laboratory, a new soil data file in Caltrans RUSLE2 can be developed for each soil sample. This is most easily accomplished by modifying an existing soil file found in the "Disturbed/mixed soils by texture" folder found within the Soil tab of RUSLE2. Information can then be entered based on field observations and the laboratory soil test. Save the customized soil file into the "Local" folder within the RUSLE2 Soil tab. The soil sample and field observed conditions can represent the project site or reference site. The soil information entered into the file must be consistent with Table C-1.

The modified RUSLE2 nomograph provides details on the data needs, testing requirements and interpretation of the data to estimate K factors for soils. The nomograph is a mathematical algorithm, which uses soil characteristics such as permeability, structure, texture, and organic content to provide a K factor. The National Soil Survey Manual contains the nomograph used to estimate K. The complete Soil Survey Manual is available online at http://soils.usda.gov/technical/handbook/ and the nomograph for estimating K is Part 618.91 of this manual.

Table C-1. Variables Used in RUSLE2 Soil Erodibility Nomograph

Variable	Comment	Data Source
Soil Texture Breakdown	Based on mass (weight), proportion of the total for the clay, silt, and sand: **?? % Clay** < 0.002 mm **?? % Silt** 0.002 mm to < 0.05 mm **?? % Sand** 0.05 mm to < 2.0 mm	Laboratory Test
Soil Texture Classification	USDA soil texture classification based on proportion of sand, silt, and clay. Clay — Sandy clay loam Clay loam — Silt Loam — Silt loam Loamy sand — Silty clay Sand — Silty clay loam Sandy clay — Unknown Sandy loam	Laboratory Test

Table C-1. Variables Used in RUSLE2 Soil Erodibility Nomograph

Variable	Comment	Data Source
Inherent Organic Matter Content	Based on mass (weight), proportion of the total sand, silt, clay and organic matter. **?? %** **Organic matter**	Laboratory Test
Permeability Class	The permeability class reflects the runoff potential of the soil profile. Possible selections: Rapid > 6.0 in/hr Moderate to rapid 2.0 to < 6.0 in/hr Moderate 0.6 to < 2.0 in/hr Slow to moderate 0.2 to < 0.6 in/hr Slow 0.06 to < 0.2 in/hr Very slow 0.0015 to < 0.06 in/hr	Laboratory Test, NRCS Soil Survey Map, or other
Structure Class (soil)	Soil structure should be consistent with texture and categorized as one of the following: Very fine granular (< 1 mm) Fine granular (1 - 2 mm) Medium or Coarse granular (2 - 10 mm) Blocky, platy, or massive	Field Observation
Hydrologic Soil Group (undrained)	Index for potential of undrained soil profile to produce runoff under unit plot conditions. A (lowest runoff potential) B (moderate – low runoff potential) C (moderate – high runoff potential) D (highest runoff potential)	Field Observation/ Professional Judgment or NRCS Soil Survey Map
Hydrologic Soil Group (drained)	Index for potential of soil profile with a subsurface drainage system to produce runoff under unit plot conditions (usually same). A (lowest runoff potential) B (moderate – low runoff potential) C (moderate – high runoff potential) D (highest runoff potential)	Field Observation/ Professional Judgment
Rock Cover	Portion of soil surface covered by stone fragments sufficiently large to not be moved by runoff. Rock diameter must be ≥ 10 mm (≥ 3/8") to qualify as cover.	Field Observation

mm = millimeter(s)

C.1 Soil Analysis from Caltrans Labs

Although a soil analysis can be obtained from a private lab, Caltrans District and Headquarters Soils Labs can also be used. Whereas the private lab will provide results in the USDA-NRCS soil texture format, the Caltrans labs will provide a gradation that can be converted into several classifications systems, including USDA. The following discussion describes this process.

Deliver your samples to the soils lab and request tests. Caltrans labs cannot perform permeability, organic content, rock cover, or soil structure characterizations as are needed for Caltrans RUSLE2, but they can determine the distribution of the various sized particles. Request California Test 202 to perform a sieve analysis. The sieve analysis separates the gravel and sand particles. Also request California Test 203 to perform a hydrometer test at 1 hour and 6 hours and, if possible, at 24 hours. The hydrometer test provides information on the clay and silt content of the sample.

C.2 Using the Lab Results

Upon completion of the soil tests, the lab will provide a classification test summary. This summary gives the percentage of each sample passing various sized sieves and hydrometer readings.

The next step is to graph the lab results. Graphing can be done using the Excel file called "Sieve Analysis Plot.xls" found on the Caltrans RUSLE2 training course CD (see Appendix B for how to obtain a copy). Extensive knowledge of Excel graphing techniques is not necessary. Select the "Data 3" tab and just substitute your lab data and project information. With macros enabled, the graphs will automatically plot to "Form 3."

The resulting graph will show a full gradation curve for one or more samples. This curve will include all from gravel to clay. You may want to save several versions of this file if you have more than one soil sample.

C.3 Converting the Gradation Curve to USDA Soil Texture

The gradation curve can be used to convert to any soil classification system. To produce a USDA-NRCS Soil Texture, you will be concerned with all the particles smaller than 2.0 mm. Using the graph, trace a vertical line directly above the line separating sand from gravel until you touch the sample plot line. Next trace horizontally to the left until you touch the "percent passing" axis. This will indicate the percent of the sample that is smaller than 2.0 mm.

To get the percentages of the sand, silt, and clay components, you will need to perform some simple mathematics. To get sand, subtract the percentage of silt and clay. To get silt, subtract clay. Still, you will need to adjust these percentages to meet the USDA requirements. For example, if a sample is 55 percent finer then 2.0 mm, this number will need to be converted to 100 percent since the USDA system does not include the gravel component. Check your conversions by adding the percentages of sand, silt, and clay to confirm that you get 100 percent. It may be possible to have the lab provide the gradation curve and calculate the USDA-NRCS soil texture for you. It would certainly be worth requesting the data in this format.

C.4 Soil Texture and Permeability

Since infiltration correlates to soil texture, once the soil texture is known, the permeability can be determined. Use a Texture Triangle to determine the soil texture from the percentages found above. For example, from Table B-3 of the Project Planning and Design Guide (see below), a loamy sand would have an HSG Class A soil with an infiltration rate of 2.0 in/hr. This infiltration rate is on the border between Moderate and Moderate to Rapid permeability (see Table C-1).

from Project Planning and Design Guide (PPDG), July, 2005:

Table B-3: Typical Infiltration Rates for NRCS Type, HSG, and USCS Classifications

NRCS Soil Type	HSG Classification	USCS Classifications See Note 1/	Typical Infiltration Rates See Note 2/	
			cm/hr	(in/hr)
Sand	A	SP, SW, or SM	20	(8.0)
Loamy sand	A	SM, ML	5.1	(2.0)
Sandy loam	A	SM, SC	2.5	(1.0)
Loam	B	ML, CL	0.8	(0.3)
Silt loam and silt	B	ML, CL	0.6	(0.25)
Sandy clay loam	C	CL, CH, ML, MH	0.4	(0.15)
Clay loam, silty clay loam, sandy clay, and silty clay	D	CL, CH, ML, MH	<0.2	(<0.05)
Clay	D	CL, CH, MH	<0.1	(<0.05)

Note 1: USCS classifications are shown as approximation to the NRCS classifications. Note that the NRCS textural classification does not include gravel, while the USCS does. Note also that the gradation criteria (particle diameter) for the three soil types as used in the NRCS and the USCS, while agreeing in large part, are not congruent. Dual classifications in the USCS omitted. Infiltration estimates for USCS found in standard geotechnical references may vary from those shown for NRCS classifications, especially if significant gravel is present.

C.5 Geotechnical Reports

A geotechnical report is one of many investigative studies prepared early in the design process. Although predominately prepared for engineering problem solving such as structural and foundation design, the information in the geotechnical report could also include data necessary to prepare the erosion control and revegetation design. To be useful, however, the data, such as soil characteristics, must be in a format usable by the designers. Sampling methods, locations, and testing must be clearly communicated prior to preparation of the geotechnical report.

C.6 Example Report

The following pages show examples of Caltrans Soil Analysis Reports and its graphed lab results from the Excel file called “Sieve Analysis Plot.xls”.

Test Data

Measuring Unit	Particle Diam. (mm)	Sieve Size/No.	Passing Percentage
Inches	76.2	3"	
	63.5	2 1/2"	
	50.8	2"	
	38.1	1 1/2"	
	25.4	1"	
	19.05	3/4"	
	12.7	1/2"	
	9.525	3/8"	
Sieve No.	4.75	# 4	100.0
	2.36	# 8	100.0
	1.18	# 16	34.0
	0.6	# 30	1.0
	0.3	# 50	0.0
	0.15	# 100	
	0.075	# 200	
Hydrometer	0.005	5μ	
	0.001	1μ	

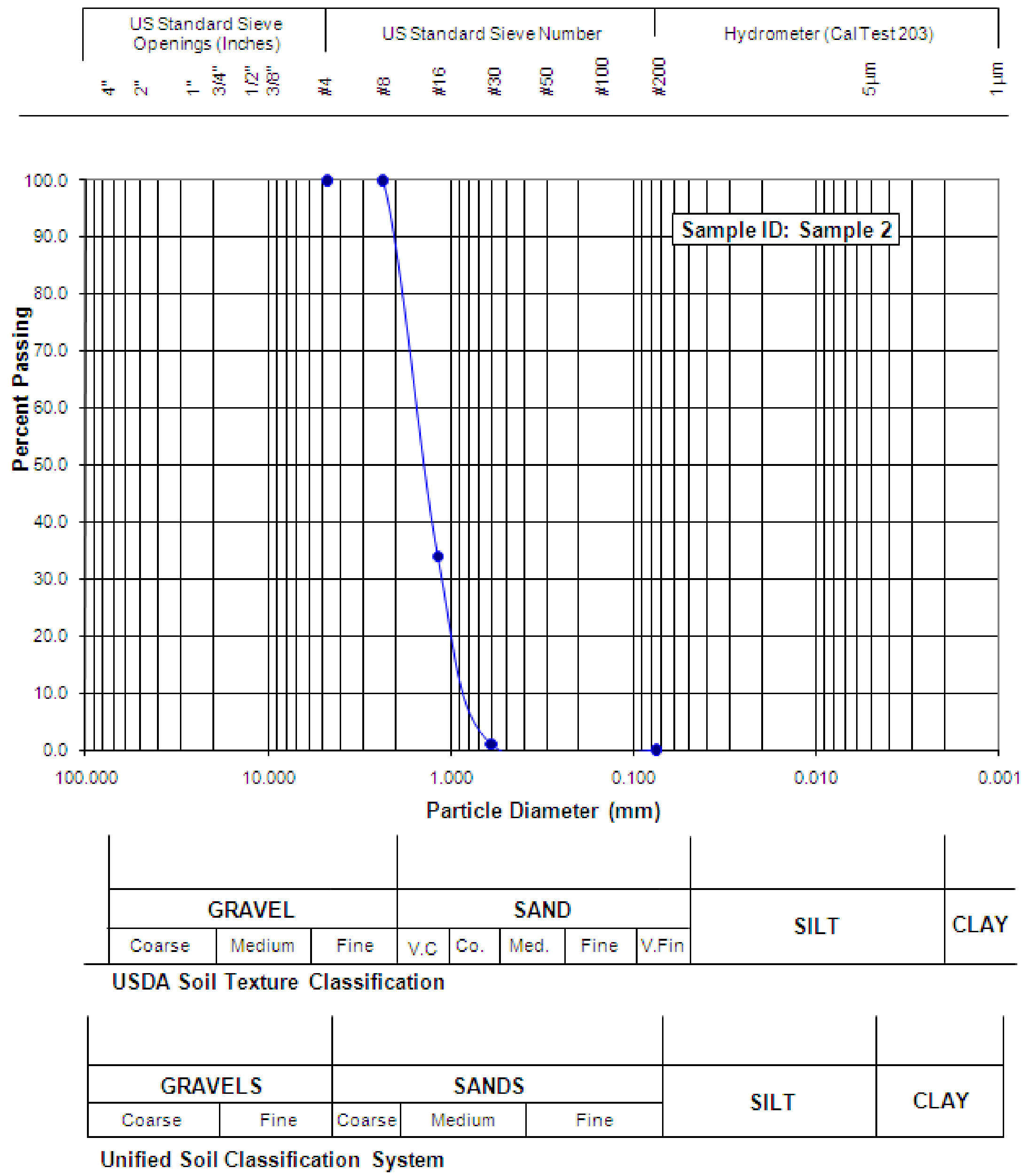
Project Information

Project Name:	Soils & Foundation Workshop
EA:	59-910076
D-Co-Rt-KP:	

Sample Information

Sample ID:	Sample 2
Test Date:	May. 9, 2005

Gradation Analysis Test Results



Caltrans

Division of Engineering Services
Geotechnical Services

EA: 59-910076	Sieve Analysis Results
Date: May-05	
Soils and Foundation Workshop	Plate No.

Test Data

Measuring Unit	Particle Diam. (mm)	Sieve Size/No.	Passing Percentage			Envelope	
			No.1	No.2	No.3	Lower	Upper
Inches	76.2	3"					
	63.5	2 1/2"					
	50.8	2"					
	38.1	1 1/2"		100.0			
	25.4	1"		98.0			
	19.05	3/4"		97.0			
	12.7	1/2"	100.0	96.0			
	9.525	3/8"	99.0	94.0			
Sieve No.	4.75	# 4	93.0	79.0			
	2.36	# 8	84.0	63.0			
	1.18	# 16	70.0	45.0			
	0.6	# 30	58.0	31.0			
	0.3	# 50	47.0	22.0			
	0.15	# 100	40.0	16.0			
	0.075	**# 200**	**34.0**	**11.0**			
Hydrometer	0.005	5μ	18.0	4.0			
	0.001	1μ	10.0	2.0			
	Sample ID:		DS-1	DS-2			

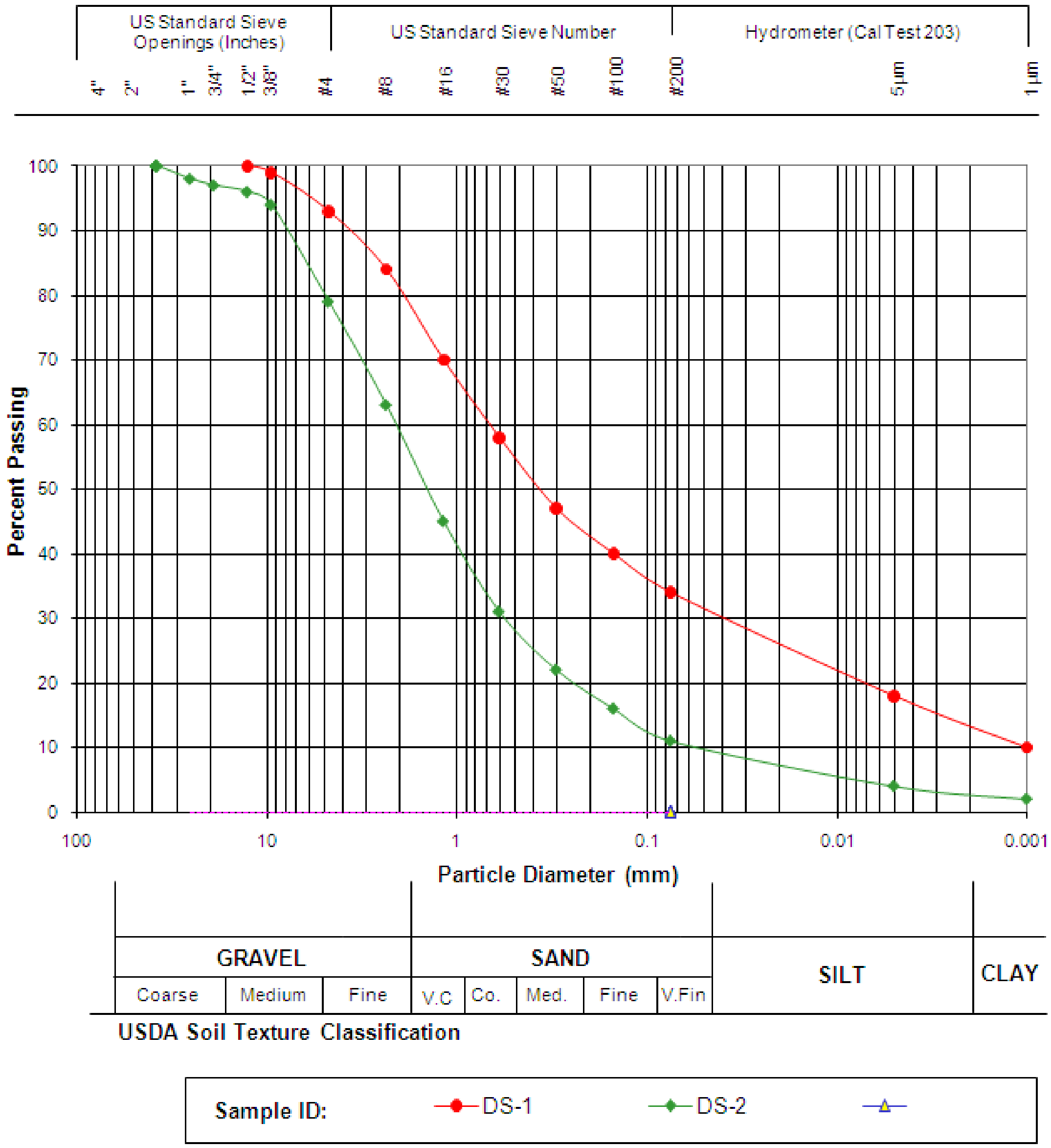
Project Information

Project Name:	**Devil's Slide South Portal**
EA:	**04-1123C1**
D-Co-Rt-KP:	**04-SM-1-**

Sample Information

Test Date:	**Sep. 29, 2005**

Gradation Analysis Test Results



Engineering Service Center
Office of Materials and Foundations
Roadway Geotechnical
Engineering - North

Project:	Devil's Slide South Portal
EA:	04-1123C1
D.-Co.-Rt.-:	04-SM-1-
Test Date:	Sep. 29, 2005

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Appendix D:
Caltrans RUSLE2 Program Improvements

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Appendix D

Caltrans RUSLE2 Program Improvements

The Caltrans RUSLE2 program was upgraded in 2011 to include expanded features, improved program accuracy, and re-organized BMP folders to improve ease of use. The 2007 version of the Caltrans RUSLE2 program was the starting point for the program modifications, as described in Section 4 of this EPP Manual. A listing of the RUSLE2 program improvements made in 2011 is provided in Section D.1. Ideas for potential future program upgrades were discussed by Caltrans in May 2011 and the ideas evaluated to determine if it was feasible and desirable to pursue in the near term. A matrix summarizing the potential program changes and the key points of the evaluation is in Section D.2.

D.1 RUSLE2 Improvements

1. Maintained compatibility
   - Caltrans RUSLE2 is completely compatible with the current RUSLE2 version 2.0.4.0 (2011) developed by the USDA/ARS and NRCS.
   - This will facilitate updating future versions of RUSLE2 or updating the Caltrans RUSLE2 database.
2. Expanded Features
   - Compost Erosion Control Blankets (CECBs) were added.
   - Erosion Control Blankets and rolled netting products were revised.
   - 24-inch diameter fiber rolls (permanent) were added.
   - Multiple permeable barriers can be placed more easily at set intervals defined by the user.
   - Permeable barrier types were added in addition to the fiber roll barriers, including gravel bag berms, sand bag barriers, silt fence reinforced with metal fabric, and silt fence reinforced with straw bales.
   - More options of grasses, forbs, and shrubs were made available to the user.
   - New vegetation files are used to model established stands with seasonal variations in canopy cover, leaf fall and residue accumulation.
   - All rolled erosion control blankets (RECBs) and mulch materials can be modeled with or without vegetation, including volunteer vegetation.
   - A succession of grasses to shrubs following construction was developed.
3. Improved Accuracy
   - The effectiveness of all RECBs and mulch materials were calibrated to two independent studies conducted in Texas and San Diego, California.
   - The growth patterns for pre-existing and post-construction vegetation were modeled after California native plants, with summer dormancy for annual grasses.
   - The effectiveness of all permeable barriers was based on more realistic storm water and surface water flow conditions.
   - Earthwork (e.g., cut, fill, track walking) associated with construction activities were improved.

4. Simplicity
   - The BMP management options and folder titles were revised to be more intuitive for the user.
   - A new local management folder was added to allow users to save changes to the management BMPs as custom BMP choices without compromising the integrity of the default BMP data.
5. Advanced User Capability
   - A new user screen template (Caltrans Basic Complex Slope Advanced) was developed that allows the user to visually track and graph daily vegetative canopy development, daily mulch and cover degradation, and daily changes in surface roughness and ridge roughness.

D.2 Potential RUSLE2 Modifications

In May 2011, Caltrans reviewed ideas for further modifying Caltrans RUSLE2. The potential program changes and key considerations from the evaluation are summarized in Table D-1. It was decided that these changes could be implemented in the future, but it was not feasible to make them in the near term. Analysis of the potential programming modifications was based on the rationale or need for the change, the technical data needed to make the change, and also the side effects that could result from the change.

Table D-1. Potential Future Modifications to RUSLE2

Item	Rationale / Proposed Modifications to RUSLE2	Programmable / Data Needed	Potential Effects	Recommendation
1. Increase the slope steepness beyond 100%	**Demand** – Caltrans has projects with existing or finished slope sections that are greater than 1V:1H, e.g., earthwork performed on decomposed granite, short 10-ft benches along slope. **Proposed Change** – Expand slope steepness range to allow input of >100% slope.	Modification may not be programmable within RUSLE2. Current RUSLE2 science limited to ≤ 100% slope and is based on sheet and rill erosion; mass slumping and landslides cannot be simulated by RUSLE2. Data needs – K values for decomposed rock and other competent material stable beyond 1V:1H. • Modify or create a new nomograph to estimate K with sand, silt, and clay (and perhaps gravel) • Field test to confirm accuracy • Test using RUSLE2 to confirm reasonableness of results	May be expensive to collect and verify data. Will require extensive RUSLE2 programming and troubleshooting. Uncertain timeframe for collecting data.	**Yes** – Would be very useful to Caltrans if internal program code could be revised. To pursue further, discuss programming options with RUSLE2 experts (USDA-NRCS).
2. Develop additional vegetation growth curves for CA climate zones.	**Demand** – Currently, RUSLE2 has a single plant growth pattern for all vegetation throughout California and does not model the numerous microclimates that exist. **Proposed Change** – develop four growth curves for California to represent desert, Central Valley, coast, and mountain climates.	This programming can be done within existing RUSLE2 code. However, maintaining and updating RUSLE2 would become complex. Seasonal growth data needed for each climate to develop separate growth patterns.	This would require either developing: 1) multiple versions of RUSLE2 for each climatic region or 2) four times the number of vegetation BMP choices for existing and post-construction seeding. May require extensive RUSLE2 programming and troubleshooting initially, then maintenance. Significant revisions to training class materials.	**No** – Difficult to maintain and update multiple versions of RUSLE2 or multiple sets of BMPs. Time needed for preparing supporting materials, classroom delivery, and student training would be increase.

Table D-1. Potential Future Modifications to RUSLE2

Item	Rationale / Proposed Modifications to RUSLE2	Programmable / Data Needed	Potential Effects	Recommendation
3. Include more realistic erosion rates for rock-faced slopes and rock mulch	**Demand** – RUSLE2 currently models this as permanent rock mulch with 0 t/ac/yr erosion and sediment delivery. Only variable under user control is % cover. **Proposed Change** – develop and add parameters to the Management or Soil tabs for rock faced slopes.	Modification may be programmable in RUSLE2; testing required. In the field, fines fall between the rocks and are later washed out as sediment. This is not currently be modeled in RUSLE2. • Mixtures (i.e., gravel, clay and rock) are not modeled • Is this runoff from sheet or rill erosion? If not, it's beyond science of RUSLE2. It may be possible to simulate gravel with fines. This would usually go under the Soil tab. However, as Caltrans thinks of this as a BMP, it would need to be added to the Management tab somehow. Or this topic taught differently. Data from rock faced slopes needed. • K factors for rock faced slopes and gravels from literature search or field measurements • Field calibration and testing in RUSLE2 to confirm results.	May require extensive RUSLE2 programming and troubleshooting. May be expensive to collect field data, if information is not available from literature search. Uncertain timeframe for collecting data.	**Maybe** – Would improve program usefulness for Caltrans, but depends on how often these BMPs are used. To pursue further, provide detailed BMP characteristics to USDA-NRCS and discuss how this could be modeled in RUSLE2.

Table D-1. Potential Future Modifications to RUSLE2

Item	Rationale / Proposed Modifications to RUSLE2	Programmable / Data Needed	Potential Effects	Recommendation
4. Develop an installation wizard	**Demand** – Would make RUSLE2 similar to other programs. **Proposed change** – Program installation would be via an install wizard instead of directions to copy the RUSLE2 folder to the desktop.	Modification can be done within current RUSLE2. No additional data needed.	Will likely require more IT support (Administrative permission) to install the program onto Caltrans computers. This is not required now. Revisions to training class materials. Increased complexity to upgrade all current RUSLE2 program users. Once installed, future upgrades could be completed by directing users to a central Caltrans source to download and install the upgrade.	**Maybe** – Wizard is not a necessity, but would give users the impression that RUSLE2 is a formal "regular" program. If RUSLE2 is used extensively, may provide benefit to Caltrans by facilitating updates.
5. Incorporate drainage into terraces	**Demand** – Accurate prediction of erosion rates using terraces must consider drainage of surface water. **Proposed Change** – Incorporate surface water drainage into terraces	A NRCS terracing feature is available that could be added to Caltrans RUSLE2. In RUSLE2, terraces and basins are a combination of impoundments and channels cut into the slope. Need to understand Caltrans design standards for terracing. Then confirm that RUSLE2 is capable of simulating Caltrans designs.	Programming could be: 1) minimal if existing tool matches Caltrans needs or 2) extensive if terracing feature needs to be revised. May require extensive troubleshooting. This would be taught in the Advanced RUSLE2 Webinar and not in the training class, so no revisions to class materials anticipated.	**Yes** – Would improve program usefulness for Caltrans.

Table D-1. Potential Future Modifications to RUSLE2

Item	Rationale / Proposed Modifications to RUSLE2	Programmable / Data Needed	Potential Effects	Recommendation
6. Improve user interface	**Demand** – Screen content can be difficult to read, particularly during training sessions. The number of significant figures can imply a higher level of precision than is available, e.g., 0.16 t/ac/yr instead of 0.2 t/ac/yr. **Proposed change** – Various suggestions (see next column)	Depending on the requested change, it would require either re-programming or changing user settings. **Re-programming – modifications may not be do-able** • Enlarge font – all text can be 8 pt or 10 pt font. Text in some fields would wrap or fall off the screen. • Gray background to white background. • Enlarge drop down menu boxes so more rows of text show. • Zoom in so RUSLE2 content fills entire screen without needing to modify resolution of computer screen. **User Settings – modifications can be done within RUSLE2** • Change red text to black text. • Limit digits displaying after the decimal.	Some changes affect the program base code, so may require extensive changes and troubleshooting. Changes to user settings can be done either manually by each person, or a new template with them can be created and sent as an update to users. Revisions to training class materials.	**Yes** – Would improve ease of use. To pursue further, discuss programming options with RUSLE2 experts (USDA–NRCS).

Table D-1. Potential Future Modifications to RUSLE2

Item	Rationale / Proposed Modifications to RUSLE2	Programmable / Data Needed	Potential Effects	Recommendation
7. Develop more automated method to document RUSLE2 profiles and model runs.	**Demand** – Documentation is required for NOT. Facilitating records of input/outputs in trial runs would greatly benefit user. User could more easily compare multiple designs, slopes, and BMP combinations. **Proposed change** – Create Caltrans reporting templates within RUSLE2 to easily provide documentation for profiles and model runs.	Modifications can be done within current RUSLE2. Inputs/outputs from one model run or a series of runs can be exported to MS Word. This can look like a report and be used to compare runs without needing to manually copy/paste into a document. Printing and spreadsheet features in RUSLE2 can be tailored to Caltrans needs. • Program update needed to make RUSLE2 printing feature compatible with MS Word 2007 • Develop report templates (print feature) • Develop templates to compare model runs (spreadsheet feature)	Will require testing of the new features and troubleshooting. Would training materials need to be revised? Or would this be taught only in the Advanced RUSLE2 Webinar? This would streamline documentation: 1) for designing or comparing BMPs and 2) for NOT computational proof and to supplement Method Demonstration Form.	**Yes** – Would be very useful to Caltrans.

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Appendix E:
Caltrans RUSLE2 Program Components and Organization

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Appendix E

Caltrans RUSLE2 Program Components and Organization

This appendix is intended to serve as a reference guide for RUSLE2 users. Brief descriptions of each tab are provided below along with the names and organization of the major nested folders within them. The RUSLE2 program stores information in: tabs that group together the major categories of data, series of nested folders within the tabs, and fields for direct input of data. Dropdown menus found throughout the program show the different subfolders and selections available within the categories.

The "Default" selection within each tab is a generic starting point for creating a new model run. "Default" should not be used for calculation of erosion rates or to determine the effectiveness of a BMP option.

E.1 "Location" Field

The RUSLE2-R factor for the climate of the project area is selected in this field. The RUSLE2-R factors can be found directly by county or by Caltrans District, which groups together the counties within each District. Below are the major groupings of the climate options, with some examples. The user can drill down further into the folders as there are extensive options available.

- USA
  - California
    - Folders by county <<various>>
    - Alameda County <<example>>
      - CA_Alameda_R11
      - CA_Alameda_R12
      - <<various others>>
    - Folders by Caltrans District <<various>>
    - Dist-04 <<example>>
      - Folders by county <<various>>
      - Alameda County <<example>>
        - CA_Alameda_R11
        - CA_Alameda_R12
        - <<various others>>
- Default

E.2 Soil Tab

The soil type of the project site soil can be chosen by either the soil texture or by soil series determined by NRCS Soil Survey mapping. Soil textures are grouped under the disturbed and undisturbed soils folders. The folders named by California county or region group together the soil classifications found within that county or region. Below are the major groupings of the soil options, with some examples. The user can drill down further into the folders as there are extensive options available. Soil types outside of California are available through the NRCS and can be imported into RUSLE2 using the NRCS online data.

The "Concrete surface" and "Concrete/asphalt surface" selections are not soil types. They represent the subsurface layers of a paved road. In RUSLE2, when a paved option is selected in the Management Tab (e.g., asphalt under the Highly disturbed\Paving and Armoring folder), the corresponding subsurface layer (e.g., Concrete/asphalt surface) must be selected in the Soil tab.

- Folders by county or region <<various>>
- Monterey, CA <<example>>
  - Folders by soil classification <<various>>
  - AaC Alo silty clay, 2 to 9 percent slopes <<example>>
    - Alo silty clay 85%
    - <<various others sometimes>>
- Disturbed land examples
  - Clay loam (l-m, s perm)
  - <<various others>>
- Disturbed/mixed soils by texture
  - Folders by texture <<various>>
  - Clay <<example>>
    - Clay (l-m OM vs perm, greater than 50% clay)
    - <<various others>>
- Undisturbed soils by texture
  - Folders by texture <<various>>
  - Clay <<example>>
    - Clay (greater than 50 percent clay)
    - <<various others>>
  - Default
- Concrete surface
- Concrete/asphalt surface
- Default

E.3 Management Tab

BMPs are grouped within the Management tab by their usage within the project lifecycle: “Existing undisturbed vegetative cover” is for the pre-construction phase and “Highly disturbed” is for the construction and post-construction phases. Both temporary (construction phase) and permanent (post-construction phase) BMPs are listed within the “Highly disturbed” folder. Vegetated and non-vegetated options for the BMPs are also available in the “Highly disturbed” folder. Below are the major groupings of the management options, with some examples. The user can drill down further into the folders as there are extensive options available.

Custom designed BMPs should be saved to the “Local” folder so they are available for later use and so the changes do not impact the standard BMPs. The “Strip/Barrier Managements” folder is no longer used as those BMPs have either been re-located to the “Permeable Barrier Placement Tool” tab or to other folders within the “Management” tab.

- Existing undisturbed vegetative cover
    - Grass and forbs, existing, 0 to 25 pct canopy cover
    - <<various others>>
- Highly disturbed
    - Construction with temporary practices
        - Construction with no practices
            - Bare cut slope, natural shrub revegetation
            - <<various others>>
        - Erosion control blankets and mulch materials
            - 1 inch compost blanket CECB
            - <<various others>>
        - Surface modification
            - Clearing and grading
            - <<various others>>
    - Paving and armoring
        - Asphalt
        - <<various others>>
    - Post construction cut/fill surfaces
        - Practices with vegetation
            - 0.5 inch compost blanket with seed
            - <<various others>>
        - Practices without vegetation
            - 1 inch compost blanket CECB
            - <<various others>>
- Local
    - Straw Mulch 4000 lbs/ac test
    - <<various others>>
- Strip/Barrier Managements <<no longer used; see “Permeable Barrier Placement Tool” tab>>
    - Alfalfa Hay, estab harv for hay
    - <<various others>>
- Default

E.4 Topography Tab

The topography of the slope along the overland flow path is designated here. Based on the "Steepness" and "Segment length (horizontal)" values, RUSLE2 calculates the "Soil loss" and "Sediment delivery" rates. In RUSLE2, the slope can be divided into multiple segments and the steepness and slope length of each segment designated separately in this tab. The values for the separate segments determines the overall "Average slope steepness" and "Slope length (horizontal)" of the slope. The overall values are shown on the main screen in fields directly below the slope graphic and the "Location" field. The user can choose to either have the overall slope values remain constant (and the last segment calculated automatically) or have the segment values control the slope (and the overall values adjusted automatically).

E.5 Permeable Barrier Placement Tool Tab

The Permeable Barrier Placement Tool can be used to automatically set BMPs, such as fiber rolls, at regular distances along the slope. The number and spacing of the BMPs are set using the first row of fields: "How set barriers?", "Barrier spacing," "Num barriers," and "Barrier at bottom?". The type of BMP is selected using the "Barrier type" dropdown menu and the installation and removal dates for the BMPs are in the "Op install barriers" and "Op remove barriers" dropdown menus. Click on the "Apply perm barrier system" to apply the BMPs to the slope and to calculate the erosion rates. Alternately, the same information can be inputted into RUSLE2 by clicking the "Perm. barrier set" folder icon, which opens a separate window for data input.

E.6 Diversion/Terrace, Sediment Basin Tab

The hydraulic path for overland flow is designated here. The horizontal slope length ("Slope length to flow path") for each flow path segment is inputted along with the channel or basin type ("Type of flow path"), which is selected from the dropdown menu. From these two factors, the sediment delivery in and out ("Sed. del. in" and "Sed del. out") of each segment is automatically calculated in RUSLE2.

E.7 General Composite Segment Info Tab

This tab provides a tabular summary for segment of the slope. It shows the steepness, slope length, and management (i.e., BMP) and soil selections. The erosion rates calculated by RUSLE2 are also provided here by segment. Changes to the inputs (e.g., soil type) can be made here or from its source location (e.g., Soil tab).

E.8 Erosion by Year Tab

The annual soil loss calculated for each segment of the project slope is reported here. The estimated annual erosion for 15 years is provided in a table. To view the erosion from different segments, select the appropriate tab at the bottom of the table.

E.9 Track Daily Roughness, Cover and Canopy Tab

The daily “Consol[idation] factor,” “Roughness,” and “Ridge height” values used in RUSLE2 to determine the cover and canopy proportions for 15 years are listed here by segment. The cover and canopy results are reported as “Live biomass,” “Live canopy cover,” “Net surf. cover,” “Non-erod. cover,” and “Total surf res.” To view the inputs and results for the different segments, select the appropriate tab at the bottom of the table.

E.10 Info Tab

The Info tab provides space for adding comments to a RUSLE2 profile file so that the user can maintain notes specific to a model run.

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