Caltrans

Erosion Prediction Procedure Manual

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Office of Storm Water Management - Design

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GLOSSARY OF TERMS

Best Management Practice, Practices. A practice that eliminates or reduces the discharge pollutants from construction sites to waters of the state.

Caltrans Basin Sizer: A Caltrans program that can be used to calculate water quality volumes for anywhere in California

Caltrans Revised Universal Soil Loss Equation 2 (Caltrans RUSLE2). The Revised Universal Soil Loss Equation 2, modified for Caltrans use.

Cover Management "C Factor". Represents how soil, vegetation, and residue affect soil loss.

Construction Phase. 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 predict erosion rates in all three project phases, with greater accuracy and confidence than the current subjective erosion control design procedures.

Erosion Control Report. A report generated by RUSLE2 with input and output results.

Erosivity. The product of storm energy times the maximum 30-minute rainfall intensity.

Fiber Rolls. Used on the toe and face of slopes to intercept runoff, reduce iflow velocity, release the runoff as sheet flow, and provide removal of sediment from the runoff. Fiber rolls consist of wood, rice, or 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 based on rainfall recording stations in the area. The map considers microclimatic aspects on different topographic conditions.

Cover - Management Practices. List of dates, operations, vegetation, and external residue used to describe most erosion control practices.

Maximum Allowable Erosion Rate. (MAER) The performance goal to be used in 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.

Permissible Soil Loss. Allowable soil loss based on preexisting conditions of project site.

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

GLOSSARY OF TERMS

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 utilizing 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 times the maximum 30-minute rainfall intensity. (repeated above)

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 and steepness and similar 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 much like 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 10mm.

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

Screenshot. A snapshot of screen.

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

Sediment Delivery. A quantity of detached soil discharges offsite from construction site.

Shotcrete. A type of concrete used to retain the earth.

Site Summary Form. Provides certain base information regarding the proposed project and the project site that will be used in the Caltrans RUSLE2 model runs.

Slope Length/L. Distance along overland flow path.

Slope Percent/S. Percentage of slope along overland flow path.

GLOSSARY OF TERMS

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 unit plot 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.

Steepness. Percentage of slope along overland flow path.

T-Value. Soil loss tolerance value assigned by NRCS. It is a standard for protecting soil as a natural resource and includes specific conservation planning criteria.

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(s)
ARS	Agricultural Research Service
BAT	best available technology
BMP	best management practice
Caltrans	California Department of Transportation
Caltrans RUSLE2	Caltrans Revised Universal Soil Loss Equation Version 2
CASQA	California Stormwater Quality Association's
CMZ	Crop Management Zone
EC Report	Erosion Control Report
EPP	Erosion Prediction Procedure
ESA	environmentally sensitive area
K	soil erodibility
KP	kilopost
m	meter(s)
MAER	maximum allowable erosion rate
MEP	maximum extent practicable
MP	milepost
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
R	erosivity value
RUSLE1	Revised Universal Soil Loss Equation
RUSLE2	Revised Universal Soil Loss Equation Version 2
RWQCB	Regional Water Quality Control Board
SWDR	Storm Water Data Report
SWMP	Storm Water Management Plan
T	soil loss tolerance
t	ton(s)
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USLE	Universal Soil Loss Equation
yr	year(s)

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. Using actual project site characteristics and proposed erosion and sediment control measures, anticipated erosion rates may be calculated for the following project phases:

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

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

Post-Construction: A period after the project construction work has been completed and the permanent erosion control and revegetation, such as seeding and planting, are established and matured. This period will usually be 5 to 15 years although shorter periods may be achievable under optimum conditions and longer periods may be acceptable under less favorable (e.g., arid) conditions.

The general procedure for achieving the above is as follows:

1. Obtaining site data and calculating the predicted pre-construction erosion rates.
2. Establishing a Maximum Allowable Erosion Rate (MAER) for the construction and post-construction phases of the project.
3. Selecting construction and post-construction soil stabilization and sediment control Best Management Practices (BMPs) and revegetation techniques to limit erosion to achieve the established MAER for each phase.
4. Documenting the findings in an Erosion Control Report (EC Report).

To facilitate the execution of steps 1 and 3, the Revised Universal Soil Loss Equation Version 2 (RUSLE2) model has been modified to meet the specific requirements of the Caltrans. The benefits of using RUSLE2, specifically modified for Caltrans as an erosion prediction tool, include:

- The ability to predict erosion rates in all three project phases, with greater accuracy and confidence than the current erosion control design procedures.
- The ability to use a quantitative iterative process to select the most appropriate combination of permanent and temporary BMPs for soil stabilization and erosion and sedimentation control during the construction and post-construction project phases.
- The ability to use EC Reports to communicate design approaches, BMPs, and erosion control plans and findings, included as part of defined projects, to review agencies including the Regional Water Quality Control Board and the U.S. Environmental Protection Agency (USEPA), and resources agencies including the U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, and the California Department of Fish and Game.

- The increased ability to address public concerns related to water quality issues by incorporating detailed erosion control plans in the project construction and post-construction phases.

- The ability to prepare high-quality studies specifically addressing erosion control and management during the construction and post-construction project phases.

- An improved capability to facilitate compliance with environmental laws applicable to the construction and post-construction phases of each project, including the California Environmental Quality Act, the National Environmental Policy Act, and the federal and state Clean Water Acts.

- The improved ability of Caltrans and its contractors to better compare, understand, and improve the effectiveness of individual and combinations of BMPs in the construction and post-construction project phases.

The above procedure may be used to assist Caltrans in meeting the requirements of the Caltrans Statewide National Pollutant Discharge Elimination System (NPDES) permit and the Caltrans Storm Water Management Plan (SWMP, Caltrans 2007).

1.2 Purpose

The purpose of this EPP is to communicate the method 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 erosion and sediment control requirements identified in the Caltrans statewide NPDES Permit (Provisions C-2, E, and H) and the SWMP (Sections 3 and 4).

1.3 EPP Objectives

The objectives of this EPP are:

- To identify methods for collecting project-specific information necessary as inputs to RUSLE2.

- 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.

- To identify a method for estimating the amount and type of existing vegetative cover on a project site.

- To identify a method for establishing the MAER for a project site. This MAER is used in the Caltrans RUSLE2 modeling process to assess the effectiveness of

the identified project BMPs in reducing erosion associated with the construction and post-construction project phases. This method will allow performance goals to be applied to erosion control and revegetation design.

- To consider the diverse topographical and climate conditions across California and identify how the appropriate topography and climate data for each project site should be selected from the tailored choices in Caltrans RUSLE2 or by inputting project-specific information and options for the pre-construction, construction, and post-construction phases.

- To consider the wide range in soil types and conditions across California and identify how the appropriate soil characteristics for each project site should be selected from the existing choices in Caltrans RUSLE2 or by inputting project-specific information and options. The options include relatively undisturbed native soils, substantially disturbed soils during construction, and substantially modified soils in the post-construction phase, as appropriate for the three project phases.

- To provide a process to assess the effectiveness of vegetation growth and establishment during the post-construction phase to control erosion and reduce runoff and sedimentation from the project site. The EPP considers the effectiveness over a sufficient time period (years) to assess the effectiveness of the vegetation growth and maturation and when/if the vegetation needs to be replaced or modified. The EPP includes a comparison of 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.

- To provide a report template that allows each user to use the Caltrans RUSLE2 erosion prediction model and to prepare EC Reports effectively and consistently across the state for all state projects.

- To describe the Caltrans RUSLE2 model process, which will allow users to select effective BMPs for the construction and post-construction phases of highway projects, consistent with the requirements of the Caltrans statewide NPDES permit, the Caltrans SWMP, and Caltrans Storm Water Quality Handbook Construction Site BMPs.

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, and establishing the MAER.

Section 3 (Site Characterization): This section provides guidance to the user on the collection of information to describe the project and the collection of other relevant site data for input into Caltrans RUSLE2, using a standardized Site Summary Form.

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 (Climate, Soil, and Crop Management Databases): This appendix describes the climate, crop, and soil databases included in the Caltrans RUSLE2 model as modified for Caltrans projects.

Appendix B (Soil File Creation): This appendix has a soil testing guideline for erosion control projects.

Appendix C (Final Management Practices Structure): This appendix outlines the layout for BMP options in Caltrans RUSLE2, explaining the assumptions on which the options are based.

Appendix D (BMP Data Sheets and Caltrans RUSLE2 Assumptions): This appendix provides a BMP listing as it relates to the Caltrans RUSLE2 program and assumptions used in the program.

Appendix E (Caltrans RUSLE2 Components and Analyses): This appendix contains instructions and a sample project run-through of the EPP for a sample project (Truckee Bypass.) It also contains computer screenshots of the Caltrans RUSLE2 model input and output.

This section describes the overall process for predicting and managing erosion on highway construction projects. The process includes the following steps: site characterization, identifying the MAER, identifying appropriate reference sites, predicting erosion rates, selecting appropriate BMPs, and preparing the EC 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. These are entered into the Site Summary Form, which is covered in detail in Section 3. 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 much of this information.

2.2 Maximum Allowable Erosion Rates

Another essential step in erosion prediction is establishing the MAER for the project site. MAER was developed specifically for Caltrans RUSLE2 and is the performance goal to be used in 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.

MAER values are primarily source control criteria and not sediment control goals for protecting offsite resources from excessive sedimentation or water quality degradation. However, the MAER for sites that are subject to NPDES-regulated discharge requirements (e.g., sites that discharge to environmentally sensitive areas [ESAs]) should take into account the corresponding water quality objectives.

Selecting an appropriate MAER for a particular project site can be difficult and at times controversial, as studies to support such values are somewhat limited. RUSLE2 addressed this issue by reducing soil loss to a rate less than the “soil loss tolerance” (T), which would protect the soil and maintain its productive capacity. However, soil loss tolerance values were originally derived for agricultural purposes, with cropland productivity and preservation in mind, and are based on U.S. Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS) soil surveys (Wischmeier and Smith 1978). Thus T values, by nature, are not directly applicable for construction sites. Additionally, the use of T values requires the setting of an accurate numeric value that would apply equally for all project sites. Conversely, MAERs can be site or region specific and can include socioeconomic considerations by establishing a level of erosion control that can reasonably be achieved with current soil conservation technology. Therefore, utilization of T values in Caltrans RUSLE2 is inappropriate and is the reason why RUSLE2 was modified to compare the computed erosion to a percentage or performance-based goal (MAER).

The MAER must be established for two stages of the project, the construction phase and the post-construction phase. The options for selecting an appropriate MAER for each phase are discussed below.

2.2.1 Construction MAER

Option 1: For non-ESAs, erosion should be reduced on the proposed cut and fill slopes by 80 percent though the design and deployment of BMPs. For instance, if the resulting erosion rate (calculated using Caltrans RUSLE2) for a construction site for proposed cut and fill slopes 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. Some NPDES-delegated authorities have used this 80 percent benchmark as a method to establish BMP utilization to the MEP (Wisconsin Department of Commerce 2007; City of Sheboygan 2007; Wisconsin DNR 2007; USEPA 2005).

Option 2: For ESAs, permitting agencies may require different or more restrictive rates of erosion. These may be expressed in terms of limits on sediment delivery or discharge. This option requires collaboration with the NPDES coordinator at each respective construction site's District office, in order to facilitate compliance with local conditions. The corresponding limits would then need to be translated into a MAER.

2.2.2 Post-Construction MAER

Option 1: For non-ESAs, the allowable erosion when vegetation is established should be no more than the pre-construction condition. For· this option, the erosion rates would be compared to conditions 15 years after construction completion when the vegetation is assumed to be fully established and considered structurally similar to the surrounding vegetation.

Option 2: For ESAs, the MAER is established as presented in Section 2.2.1, Option 2, for the construction phase.

2.3 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 selected to assist in selecting the appropriate erosion control measures for a proposed project. When the post-construction condition of the project site (slope steepness, slope length, disturbed soil characteristics, etc.) matches the pre-construction condition, 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 (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.

2.4 Erosion Prediction

Once site characterization, MAER selection, and reference site selection (if needed) 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 in the Caltrans RUSLE2 program until a specific scheme is found that meets the established MAER for each phase. The types of BMPs included in the program include:

- Construction BMPs: track walking, ripping/ridging, fiber rolls, hydraulic mulch, hydroseeding, straw mulch, hydraulic mulch, bonded fiber matrix, straw blankets, coconut/coir blankets, blankets plus seed, rock slope protection, silt fences, compost/mulch berms, and wood mulch.

- Post-construction BMPs: wood mulch, pine needles, compost, rock (landscaping), hydroseeded grasses and forbs, tree and shrub planting, groundcover/low-growing shrub planting, non-biodegradable (permanent) blanket, and non-biodegradable blanket plus seed.

- Strips/Barrier Management: silt fence, fiber rolls, straw bale barriers, and compost/mulch berms.

A detailed description of the step-by-step process to calculate the erosion rates using the Caltrans RUSLE2 program is presented in Section 4.0.

2.5 BMP Selection

An integral part of the process to achieve the MAER during construction and post-construction is the selection of appropriate BMPs to control soil loss and erosion. For the construction phase, temporary BMPs are selected until the erosion rate is reduced to the MAER or less. This selection process is an iterative process until the desired erosion rate is achieved. For the post-construction phase, permanent BMPS, including vegetative cover, are selected until the predicted erosion rate is reduced to the established MAER or less (e.g., pre-construction level for non-ESAs).

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 costs for different options and look for comparable performance between BMPs to facilitate cost-effective solutions that meet both the MEP treatment goals and stay within the project budget.

2.6 Report Preparation

After the Site Summary Form has been completed, Caltrans RUSLE2 is applied to predict erosion rates, and the appropriate construction and post-construction BMPs have been selected, the final step in the process is to document the findings in an EC Report. The EC Report included in the EPP is suggested for documentation of the findings but the project's SWDR may also be used. An EC Report template is provided in the attached CD to facilitate consistent and complete reporting.

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

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
- Kiloposts/post miles (KPs/PMs), for the beginning and the end of the project segment
- 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 prior to any site disturbance associated with the proposed project through a site visit. Digital photographs of the site should include views of both vegetative and nonvegetative (e.g., rock, mulch) cover, canopy, and exposed soil. Any areas of existing erosion or concentrated flows should be noted along with project site runoff discharge 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 Site Summary Form for use during the Caltrans RUSLE2 model input phase:

i) Location Information: Note the county, route number, and beginning and ending KPs/PMs for the project segment. For small projects, the PM or nearest street address to the project segment should be noted to assist other agencies with locating the site as well as locating the project site on other documents such as the isohyetal mapping.

ii) Construction: The proposed construction activities and schedule should be identified. The anticipated depth, area, and amount of earth-moving activities should be noted.

iii) 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 Site Summary Form. 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.

iv) Soil Conditions: During the site visit, the 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 on 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 USDA-NRCS soil survey data or reference site soils data. As a final option, use best professional judgment based on reasonable assumptions.

v) Topography: Project mapping with 1-foot contour intervals should be available when reviewing the site. The available mapping, date of that mapping, source, scale, and contour interval should be noted on the Site Summary Form. Vegetation and canopy shown on mapping based on an earlier site visit or aerial photography can vary considerably depending on the time of previous site visit or the aerial photography. Therefore, it is important to compare the information (vegetation, canopy, drainage, and erosion features) on the mapping used for the site visit with the actual site conditions during the site visit and to note any differences on the Site Summary Form.

   The hill slope length values used in Caltrans RUSLE2 can be either horizontal measurements or 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. Usually, length is overestimated when U.S. Geological Survey 7.5-minute quadrangle maps, i.e., 20-foot intervals, are used but it will give a fair accuracy for small concave watershed areas. Generally, project mapping is drawn with either 1- or 2-foot contour intervals. The profiles can be generated from the project mapping for all three project phases (pre-construction, construction, and post-construction) based on the project layout.

vi) Vegetation: The type and quantity of groundcover shrubs and canopy on the project site should be noted on the Site Summary Form during the site visit. The percentage of each type of vegetation should be estimated and circled on the form. The existing vegetation on the site should be documented with digital photographs attached to the Site Summary Form.

vii) 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.

viii) Harvested Topsoil: Certain projects will have areas that have harvested topsoil and duff, which can be stored onsite and reapplied 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 and will be susceptible to higher erosion than a non-disturbed site, the next highest soil classification should be used in determining site-specific soil classification.

3.2 Obtain Data for the Site Summary

The information in the Site Summary Form can be obtained from a number Caltrans resources. These include:

- The Project Report, which will include a detailed project description; a description of the conditions at the project site, particularly soils and geotechnical; 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.

- The 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.

These technical sources and the field visit should be used as the data sources for input into the Caltrans RUSLE2 model for the proposed project. As noted elsewhere in this EPP, the Caltrans RUSLE2 model does have some default or generic options when certain types of information are not available in Caltrans technical supporting documents or other available sources for a proposed project (e.g., certain soil or precipitation information).

3.3 Project Site-Specific Data

The Site Summary Form should be used to develop the project and site-specific information for input in the Caltrans RULSE2 model. The primary inputs to this form are described in the following sections and the form is described and illustrated in Section 3.3.6.

3.3.1 Climate/Rainfall

Climate should be determined by the specific project location. Fill in the project name, location, route number, and KP/MP. The Caltrans District and county in which the project is located will determine the climate zone. The exact location will determine the specific values for the climate rainfall zone (see Appendix A for a description of the climate and soil databases available for use in the Caltrans RUSLE2 program).

Use the isohyetal maps as the primary source for determining rainfall intensity for project locations (typically 10-year, 24-hour rainfall). Typically, the District hydraulics unit or County Flood Control Agency will have the local isohyetal mapping. The rainfall intensity is represented as contours on the isohyetal map. Usually, the project site location is between two rainfall intensity contours and the rainfall intensity should be interpolated between the contours. This rainfall intensity value is used to select the climate data values in Caltrans RUSLE2.

3.3.2 Vegetation Site Analysis

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 and vegetation density and coverage for the project site. Within this area, a square plot should be established that is approximately 20 strides 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
- Grasses/Forbs and Shrubs
- Grasses/Forbs, Shrubs, and Trees
- Shrubs
- Agricultural Options in Crop Management Zones (CMZs) 31, 32, 34, 36, 39, and 45

The user should use this list as a reference and select the most appropriate vegetation type that best represents 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 minimal, medium, 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. Note that trees provide minimal density and will not make a significant difference in the density number. In evaluating Grasses and Forbs, note that grass has numerous contact points per area as compared to forbs that 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.

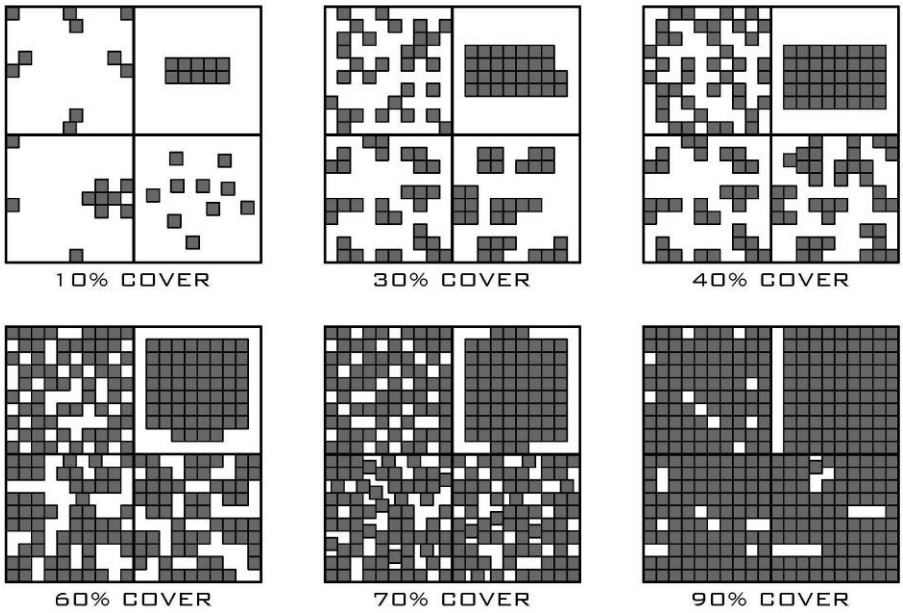

Figure 3-1 Vegetation/Rock Coverage Classification

To convert percent cover into vegetation classifications and density for use in Caltrans RUSLE2 use the following guidelines:

- 0 to 30 percent cover is considered minimal cover
- 30 to 70 percent cover is considered medium cover
- Greater than 70 percent cover is considered dense cover

The 70 percent cutoff number is typically the trigger for termination of coverage under the California General Construction Permit, as a site with 70 percent cover is considered stable. 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% – (Less than 30%)

Figure 3-2b Vegetation Cover Approximately 50% – (30% to 70%)

Figure 3-2c Vegetation Cover Approximately 90% – (Greater than 70%)

Figure 3-2d Vegetation Cover Approximately 95% – (Greater than 70%)

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 as shown in Figure 3-1.

Visual Rock Cover (Percent Ranges)
10% to 30%
30% to 40%
40% to 60%
60% to 70%
70% to 90%

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 and are used as factors in RUSLE2 but 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.

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 utilized in the 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.

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) is unavailable from another source such as a geotechnical study, soil collection and analysis need to 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. At this point, the analyst should dig or augur a 10-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 should be composited into a single sample. Enough soil should be taken from the composite sample to fill a 1-gallon container. Samples should be sealed in an airtight container and the container marked with the date and location of sample taken. Soil samples should be delivered to an approved soils lab to have an agronomic soils test conducted.

3.3.5.3 Laboratory Analysis

Site soil samples should be taken and submitted to an approved soils lab for agronomic testing. An example soils report and soil testing guidance are provided in Appendix B. The agronomic soils report provides a detailed breakdown of soil. This breakdown will include classification of the soil type, soil nutrient levels, and appropriate amendments necessary to properly sustain plant vegetation. The report will identify the soil classification and specify the percent of sand, silt, and clay. The soil classification and percentages of sand, silt, and clay will 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. Table 3-1 provides soil classifications used in Caltrans RUSLE2.

3.3.5.4 Other Sources for Soil Properties

If the user is not able to collect soil samples for analysis from the project site, the user may collect representative reference site samples, following the same procedures used for the project site, as summarized above. 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. The last option would be to use the soil survey data and

use the soil properties from the soil horizon that would represent a conservative erodibility factor (most erodible).

Table 3-1
Soil Analysis Classifications

Clay	Silt Loam
clay (greater than 50% clay)	silt loam (high OM)
clay (l-m OM, less than 50% clay)	silt loam (l-m OM)
clay (m-h OM, less than 50% clay)	silt loam (l-m OM, subsoil, substr)
Clay Loam	silt loam (l-m OM, v. slow perm)
clay loam (high OM)	silt loam (m-h OM, v. slow perm)
clay loam (low-mod OM)	silt loam (mod-high OM)
clay loam (low-mod OM, v. slow perm)	Silty Clay
clay loam (mod-high OM)	silty clay (less than 50% clay)
clay loam (mod-high OM, v. slow perm)	silty clay (low-mod OM, less than 50% clay)
clay loam (subsoil, substratum)	silty clay (mod-high OM, less than 50% clay)
Loam	Silty Clay Loam
loam (high OM)	silty clay loam (high OM)
loam (low-mod OM)	silty clay loam (low-mod OM)
loam (low-mod OM, v. slow perm)	silty clay loam (low-mod OM, subsoil, substratum)
loam (mod-high OM)	silty clay loam (low-mod OM, v. slow perm)
loam (mod-high OM, v. slow perm)	silty clay loam (mod-high OM)
loam (subsoil, substratum)	silty clay loam (mod-high OM) .37b
Loamy Sand	silty clay loam (mod-high OM, v. slow perm)
Sand	Sandy Loam
Sandy Clay Loam	sandy loam (l-m OM)
sandy clay loam (high OM)	sandy loam (l-m OM, slow perm)
sandy clay loam (low-mod OM)	sandy loam (m-h OM)
sandy clay loam (low-mod OM, v. slow perm.)	sandy loam (m-h OM, slow perm)
sandy clay loam (mode-high OM)	sandy loam (subsoil, substratum)
sandy clay loam (mod-high OM, v. slow perm)	
sandy clay loam (subsoil, substratum)	

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:

- Segment flow length
- Vertical difference
- 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 Site Summary Form

The data obtained from the various tasks above are entered into the Site Summary Form shown below in Figure 3-3 and included for use in the attached CD. These values are used in Caltrans RUSLE2 for the various project phases and BMP scenarios. The data locations along 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, and/or cover.

Rev: 1 (12/05)

CALTRANS EROSION PREDICTION PROCEDURE

RUSLE 2 - SITE SUMMARY

PROJECT NAME & NO : **SITE VISIT DATE:**

CALTRANS DISTRICT : **ROUTE: KP/PM:**

DETAILED LOCATION :

ESTIMATED PROJECT START DATE:

TYPE OF CONSTRUCTION:

MAPPING/SURVEY SOURCE AND DATE:

GEOTECHNICAL REPORT SOURCE AND DATE:

REFERENCE SITE LOCATION:

REFERENCE SITE SUMMARY:

	3.3.1 Rainfall / Climate			3.3.2: Soil Texture					3.3.1.1: Vegetation				3.3.3: Topography		BMPs		Results		
Construction Phase	District #	County #	Rainfall Intensity	Texture	Clay	Silt	Sand	Hydrologic Class	Vegetation Classification	% Vegetation Cover	% Rock Cover	% Canopy Cover	Flow Length (%)	Steepness / (Slope)	Erosion Control	Sediment Control	Soil Loss t/ac/yr	Sediment Delivery t/ac/yr	Notes

(Attach photos of site & reference site data locations, general and close-up of cover)

Figure 3-3 Site Summary Form

The RUSLE2 was developed to guide conservation planning and estimate soil erosion and sediment delivery. The RUSLE2 program, along with the required databases, is available for download on the RUSLE2 website (http://fargo.nserl.purdue.edu/rusle2_dataweb/RUSLE2_Index.htm). RUSLE2 was modified in Caltrans RUSLE2 to facilitate erosion prediction calculations for Caltrans highway construction projects.

4.1 Source of Model

RUSLE2 is the result of a series of model developments. The first program developed to estimate rill and inter-rill erosion on overland flow areas was called the USLE (Universal Soil Loss Equation). The USLE was released in the 1960s and was developed for cropland and was later extended to other land uses. The first revision to the USLE (RUSLE1) was released in the 1990s and is land use independent.

RUSLE1 then evolved into RUSLE2, which was released in 2003 and applies to any land use having exposed soil and overland flow but is based on agricultural site analysis. Development of RUSLE2 was a joint project involving the U.S. Department of Agriculture (USDA)-Agricultural Research Service (ARS), the USDA-NRCS, and the University of Tennessee. 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-NRCS. The Illinois State Water Survey, NRCS, ARS, and the University of Tennessee analyzed the 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 RUSLE, which only computed average soil loss at an annual level. Additionally, the internal calculations (in the RUSLE2 program code) do not consist of a direct application of USLE. Recently, 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.

4.1.1 Caltrans Modifications to RUSLE2

The ARS-RUSLE2 database was further modified by Caltrans in 2005 and again in 2007 to limit 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 have been added to the Caltrans RUSLE2 version. The addition of applicable Caltrans BMPs required the matching and replacement of BMPs from the original RUSLE2 database with those

Caltrans BMPs that were most equivalent. A number of options for items such as contouring and strip farming were removed by Caltrans as they are not applicable to construction sites for highway projects. The resulting modified ARS-RUSLE2 and modified database are referred to as Caltrans RUSLE2.

4.2 Description of RUSLE2 Model

Caltrans RUSLE2 is based on the ARS-RUSLE2, January 2005 version. The latest version of the *Draft Users Guide for RUSLE2,* dated January 2003, can be found at http://fargo.nserl.purdue.edu/rusle2_dataweb/RUSLE2_Technology.htm. Specific changes made to RUSLE2 to develop the Caltrans RUSLE2 version include:

- Climate Database: The climate database is limited to California and is the Caclimate120303.gdb file from the NRCS database, which represents the December 2003 database. The files were obtained from http://fargo.nserl.purdue.edu/rusle2_dataweb/RUSLE2_Index.htm with separate climate file revision dates as noted on the detailed listing provided in Appendix A.

- Soil Database: The Caltrans RUSLE2 soil database includes all California counties with some counties subdivided into smaller areas. The files were obtained from ftp://fargo.nserl.purdue.edu/pub/RUSLE2/Soils_Data/ California/ with separate soil file revision dates as noted on the detailed listing provided in Appendix B.

- Crop Management Database: The Caltrans RUSLE2 CMZ files are CMZ 31, 32, 34, 36, 39, 45 and 71 .gdb files. The files were obtained from ftp://fargo.nserl.purdue.edu/pub/RUSLE2/Crop_Management_ Templates/ with separate CMZ file revision dates as noted on the detailed listing provided in Appendix A.

- Management Practices: The management practices were revised to limit the database to approved Caltrans BMPs and the names were revised to match approved Caltrans BMPs. A number of Caltrans BMPs were added to the management practices database. Several BMPs and BMP categories such as contouring, diversion/terraces, and practices in a particular month, which are not suitable for highway and/or California projects, were deleted. See Appendix C for the layout of the management practices database.

The BMPs in Caltrans RUSLE2 are based on Caltrans' Best Management Practice Construction Manual (Caltrans 2003), as well as the California Stormwater Quality Association's (CASQA) Best Management Practice Construction Handbook (CASQA 2003). Thus the existing Caltrans Construction Site BMP Fact Sheets can be used with Caltrans RUSLE2-BMP data sheets, which are enclosed in Appendix D. The Caltrans RUSLE2 BMP data sheets reflect modifications made to the original RUSLE2 BMPs to match existing Caltrans BMP sheets and available input rates/ranges in RUSLE2. The Caltrans notations seen in several Caltrans-specific BMPs are provided in Table 4-1.

Table 4-1
Caltrans Best Management Practices

Best Management Practice	Caltrans Identification
Sediment Control	
Silt Fence	SC-1
Fiber Rolls	SC-5
Straw Bale Barrier	SC-9
Erosion Control/Soil Stabilization	
Hydraulic Mulch	SS-3
Hydroseeding	SS-4
Straw Mulch	SS-6
Geotextiles, Mats, Plastic Covers, and Erosion Control Blankets	SS-7
Wood Mulch	SS-8

Several modifications have been made for the Caltrans RUSLE2 program to simplify the management practices database and BMP content for the user.

The content within each primary (upper level) folder of the RUSLE2 management practices database was revised, as were the primary folders themselves. The resulting primary folders in Caltrans RUSLE2 include Highly Disturbed, Existing Vegetative Cover, and Structural Solutions. The revised structure provides three clear categories for management practices that are directly applicable to Caltrans projects. The Cropland category was changed to Agriculture and was retained as a subcategory under the Existing Vegetative Cover category for consistency with previous programs and for completeness of the Caltrans RUSLE2 program. A description of the intended content of each category is provided below.

(1) Highly Disturbed. This category provides management practices representative of the construction and post-construction phases and typical BMPs that may be implemented to provide erosion and sediment control. The category contains subcategories to better direct the user to the appropriate types of management practices, including bare surfaces (cut and fill), erosion control products, vegetation cover, etc.

(2) Undisturbed (Existing) Vegetative Cover. This category provides the baseline, pre-construction condition for project analysis. This category includes two subcategories: Natural Condition/Undisturbed and Agriculture. Management practices in the first subcategory, Natural Condition/Undisturbed, include native habitats with established vegetation and undisturbed bare surfaces. This subcategory is to be primarily used for the pre-construction calculations to establish baseline conditions and also includes the default value (i.e., Management Practice C*P = 1). The second subcategory, Agriculture, includes the traditional RUSLE2 management practices applicable to agricultural operations. This category was maintained for consistency and potential applicability in rural areas; however, it has been limited to CMZs applicable to California.

(3) Structural Solutions. This category includes unnatural management practices that affect erosion and sediment control such as paved roads and concrete walls.

A summary of the Caltrans RUSLE2 management practices database structure/layout is included in Appendix C.

4.3 Modifications to RUSLE2 Interface

A simplified interface was developed for Caltrans RUSLE2 by eliminating duplicate function tabs and unnecessary "data controls." Eliminated information is summarized below.

Modified function tabs are as follows:

1. Strips/barriers – This "Strips/barriers" tab folder was incorporated into the "Management" tab for user convenience.

2. Subsurface drainage – This tab information is available under "Soils" details.

Eliminated data controls are as follows:

1. Detachment on slope, t/ac/yr – This is the total separation of soil particles from the soil mass on the slope over the entire overland flow path length, including some amount of sediment deposition on the slope itself. The Caltrans RUSLE2 program has been simplified to eliminate factors that account for enroute deposition on the hillslope.

2. Soil loss for cons. plan, t/ac/yr – Soil loss for conservation planning (important for NRCS purposes) is the soil loss on the total profile length that takes into account local (in the profile) soil deposition and the distance between soil detachment and deposition.

3. Enrichment fraction – Enrichment fraction is the specific surface area of sediment at the lower end of the last Caltrans RUSLE2 element divided by the specific surface area of the sediment at the point of detachment. The Caltrans RUSLE2 program has been simplified to eliminate factors that account for particle size and enroute deposition on the hillslope.

4. Critical slope length - The point at which contouring practices (i.e., ridge height and orientation) become ineffectual at dealing with the runoff that is flowing over them. In Caltrans RUSLE2 the project site is assumed to have furrowing (ridging) up and down slope as opposed to on contour, as the base condition.

5. The "Man align years offset, Yr" data control in "Management" function tab and "actual row grade, %" data control in the "Contouring" function tab were eliminated.

4.4 Caltrans RUSLE2 Site Analysis Process

This section summarizes the steps the user should implement to complete the Caltrans RUSLE2 analysis for the project. A detailed example of this process, including screenshots of model inputs and outputs, is included in Appendix E for the Truckee Bypass Project.

4.4.1 Site Summary Form Input Data

The EPP process begins with the data collection for the project as described in detail in Section 3 (Site Characterization). The Site Summary Form should be filled out by the user and available prior to the Caltrans RUSLE2 program initiation to facilitate effective input of the data into the Caltrans RUSLE2 program.

The user should document the source and date for all data identified for use in the Caltrans RUSLE2, to provide a project history of the inputs used. In cases where the existing data was interpolated or extrapolated, the user should provide notations used and the reason for use of that data.

The model input variables are defined in more detail in Section 4.5 below.

4.4.2 Caltrans RUSLE2 Program Initiation

The RUSLE2 program was modified by Caltrans to allow for use on construction sites with highly disturbed soil such as are typically found in roadway construction projects. There are several steps in the Caltrans RUSLE2 process that the user implements to achieve the necessary analysis as part of the EPP. The Caltrans RUSLE2 program is initiated by opening the program and beginning a new project using a default worksheet. The details on the associated steps are provided in Appendix E.

4.4.3 Pre-construction Phase RUSLE2 Analysis

The pre-construction site data is used to develop the pre-construction soil loss for the project site. This pre-construction data run generates the baseline for use in evaluating the construction and post-construction phases of project. The pre-construction soil loss is based on the existing conditions on the project site prior to the start of any project construction activities. The steps involved to model the pre-construction condition are described below and shown in Figure 4-1.

Step 1: Set up the pre-construction Caltrans RUSLE2 analysis for program input variables: climate, soil, and topography.

Step 2: Caltrans RUSLE2 Run 1 with existing vegetation and no management practices. Resulting erosion rate is set as the MAER for post-construction comparisons for projects that do not discharge to ESAs.

Step 3: When the user has completed the Caltrans RUSLE2 analysis (Step 2), print the output results and move to construction analysis (Section 4.4.4).

4.4.4 Construction Phase Caltrans RUSLE2 Analysis

The user should save the pre-construction profile as a construction profile prior to beginning the data input and model run for the construction phase. The rainfall intensity for the project site location and the erosivity values are the same for the pre-construction, construction, and post-construction phases; therefore, this input will not need to be changed.

The construction phase Caltrans RUSLE2 analysis is an iterative process that refines BMPs for controlling the erosion rate during construction activities. The steps involved to model the construction condition are described below and shown in Figure 4-2.

Step 1: Set up the construction Caltrans RUSLE2 analysis for program input variables that do not change with management practices: climate, soil, and topography.

Step 2: Caltrans RUSLE2 Run 1 with bare soil with no management practices. Resulting erosion rate is used to determine the MAER for construction comparisons (MAER = Erosion Rate * 0.02).

Step 3: Caltrans RUSLE2 Run 2 with minimal management practices (i.e., silt fence at toe of slope + hydraulic mulch.) Compare resulting erosion rate to MAER from Step 2. If result is still greater than the MAER, move to Step 4. If result is less than the MAER, construction runs are complete; move on to Step 5.

Step 4: Caltrans RUSLE2 Run 3 with revised management measures (i.e., silt fence at toe of slope, hydraulic mulch, and fiber rolls every 20 feet along the slope.) Compare resulting erosion rate to MAER from Step 2, if result is still greater than the MAER, repeat runs with revised management practices until the result is less than the MAER. If result is less than the MAER, construction runs are complete; move to Step 5.

Step 5: When the user has completed the construction Caltrans RUSLE2 analysis (Step 4), print the output results and move to post-construction analysis (Section 4.4.5).

4.4.5 Post-construction Phase Caltrans RUSLE2 Analysis

The post-construction phase Caltrans RUSLE2 analysis is an iterative process that refines BMPs for controlling the erosion rate during site establishment and ultimately defines the post-construction condition of the site. The steps involved to model the post-construction condition are described below and shown in Figure 4-3.

Step 1: Set up the post-construction Caltrans RUSLE2 analysis for program input variables that do not change with management practices: climate, soil, and topography.

Step 2: Caltrans RUSLE2 Run 1 with minimal management practices. Compare resulting erosion rate to MAER from the pre-construction phase (Section 4.4.3). If result is still greater than the MAER, move to Step 3. If result is less than the MAER, post-construction runs are complete.

Step 3: Caltrans RUSLE2 Run 2 with revised management practices. Compare resulting erosion rate to MAER from the pre-construction phase (Section 4.4.3). If result is still greater than the MAER, repeat runs with revised management practices until the result is less than the MAER. If result is less than the MAER, post-construction runs are complete; move to Step 4.

Step 4: When the user has completed the post-construction Caltrans RUSLE2 analysis (Step 3), print the output results and begin the EC Report (Section 4.4.6).

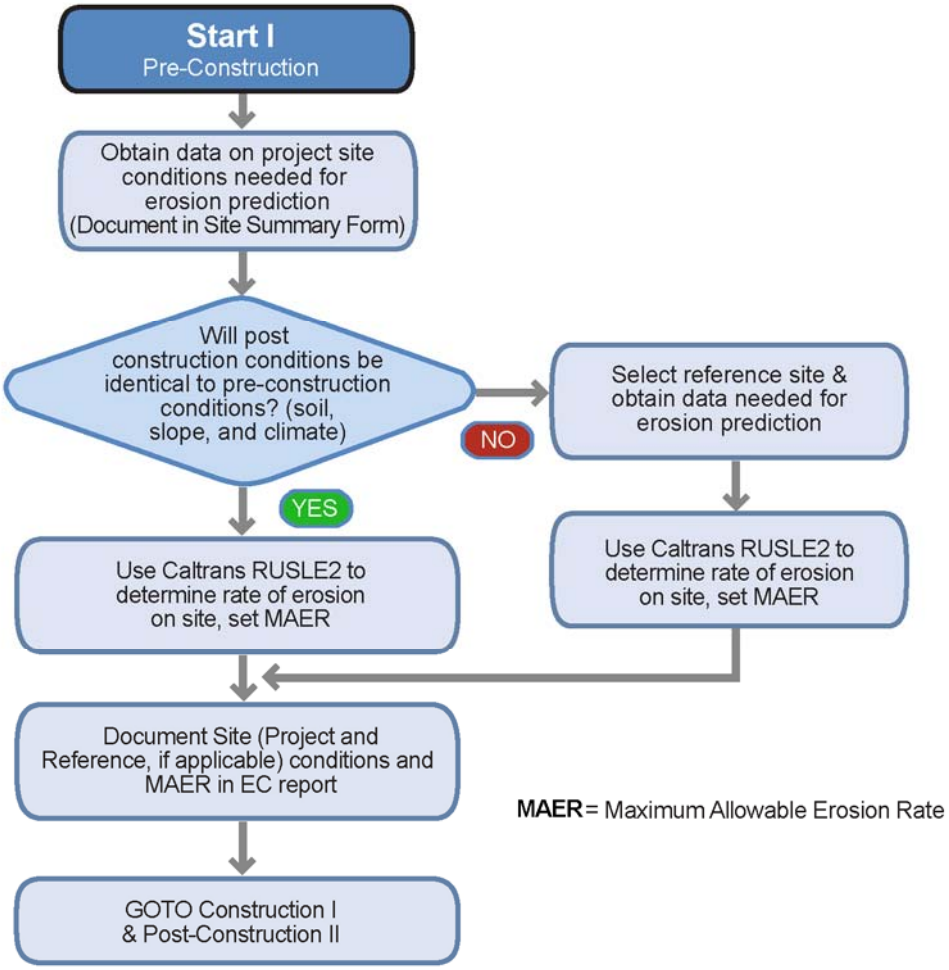

Figure 4-1 Pre-Construction Flow Chart

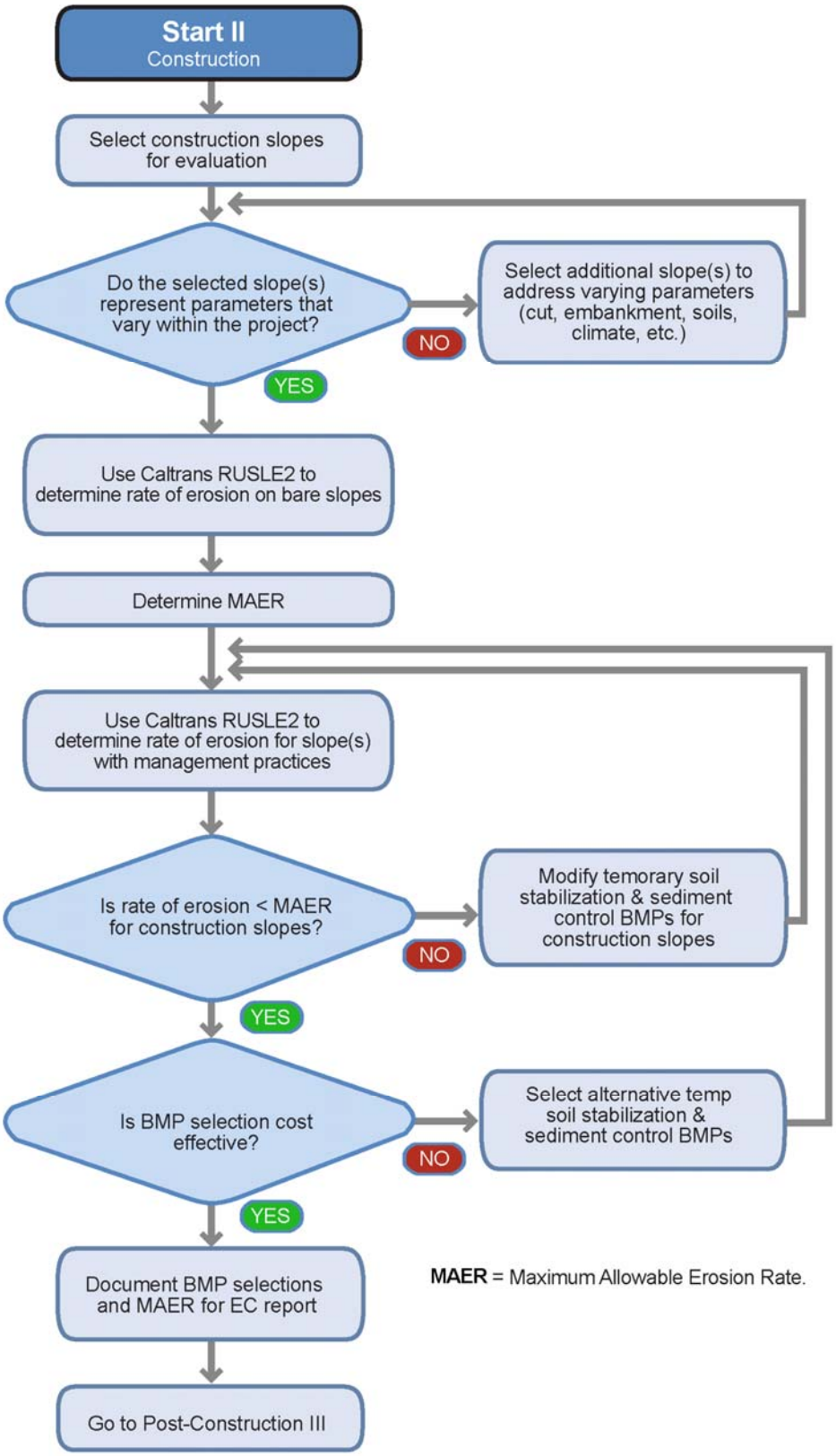

Figure 4-2 Construction Flow Chart

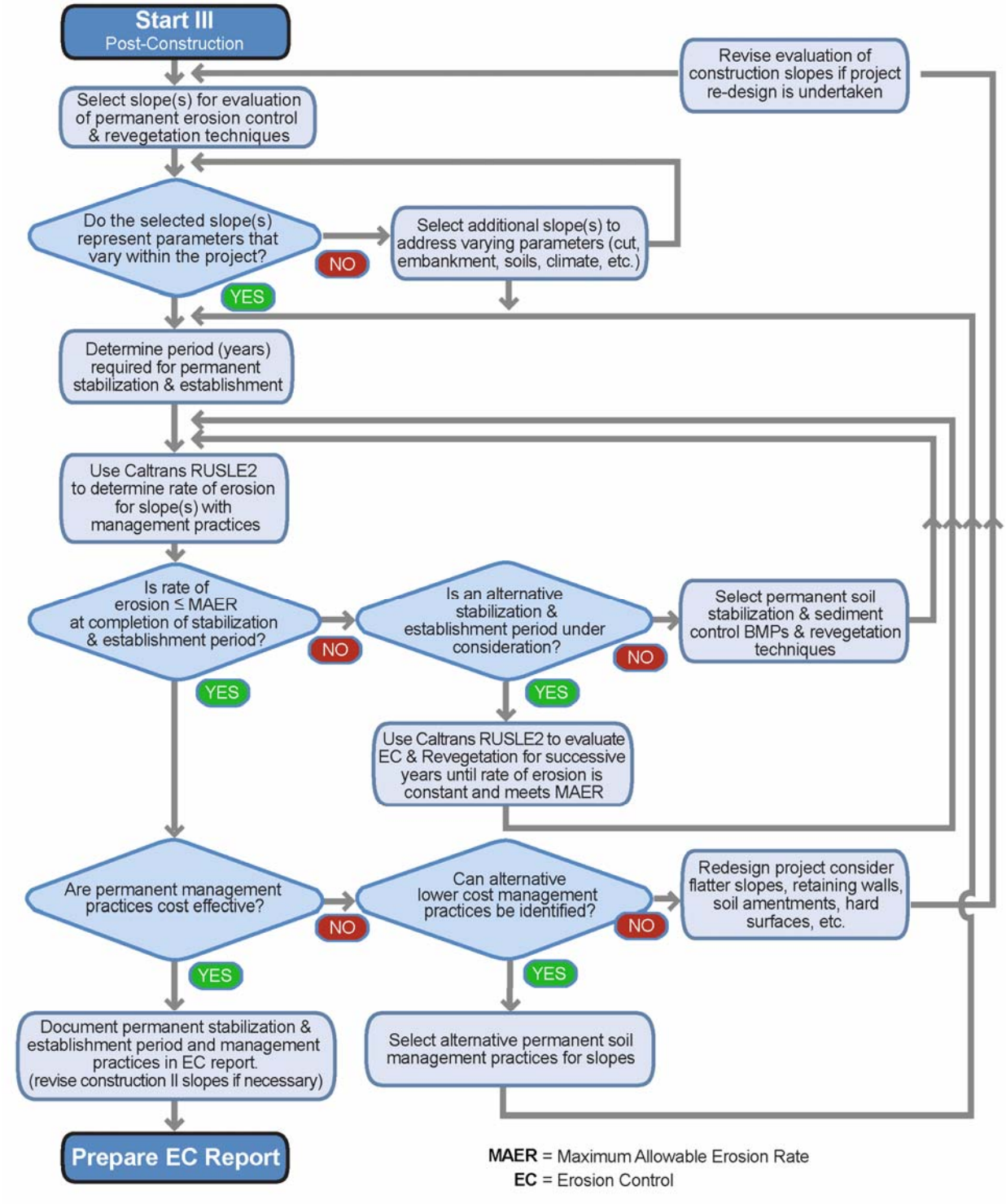

Figure 4-3 Post-Construction Flow Chart

4.5 Model Inputs

When first starting Caltrans RUSLE2, there are two working interfaces: the "worksheet" and the "profile." The worksheet is the collection of profiles on one screen and it is useful to compare one segment with different management options. The profile represents different segments on one sheet and it has graphic representation; hence a profile is suggested for roadway projects to represent both embankments and the road. At this point, the user should input details of the project from the Site Summary Form (such as the project name, route number, KP/PM) and a brief description in the "info box." The project details will print on the Caltrans RUSLE2 outputs. Generic summaries of the input data are provided below. A specific application of each is demonstrated in the sample project run through included in Appendix E.

4.5.1 Location - Climate/Rainfall Erosivity 'R'

The project location will determine the climate that will be used for the project site. The climate is determined by the R value. R is the product of storm energy times the maximum 30-minute rainfall intensity. The R value is an average annual sum of these individual storm intensity 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. The project area rainfall intensity is selected from the Caltrans RUSLE2 database by choosing the county or local region and the intensity range in the drop-down menu.

Caltrans RUSLE2 will calculate the R factor based on the monthly erosivity corresponding to the rainfall. This erosivity equates to the erosivity of the existing project site, without any construction disturbance. The Caltrans RUSLE2 climate data use 10-year 24-hour rainfalls and average monthly temperatures to develop this corresponding erosivity factor and erosivity density. The monthly rainfall has a direct effect on the erosivity factor and the temperature has an indirect effect on decomposition.

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. Should the climate need to be altered, the database can be changed by choosing "enter monthly R values" in the erosivity distribution drop-down menu and entering temperature and rainfall, and obtaining the corresponding R value.

Figure 4-1 shows a sample graphical result from the monthly erosivity factor values over a standard 12-month period.

The erosivity values should be considered for project scheduling to minimize the erosion during construction. Construction activity and exposed soil surfaces should be avoided in high erosivity periods from November to March for the sample project shown in Figure 4-4.

The rainfall intensity for the project site location and 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.

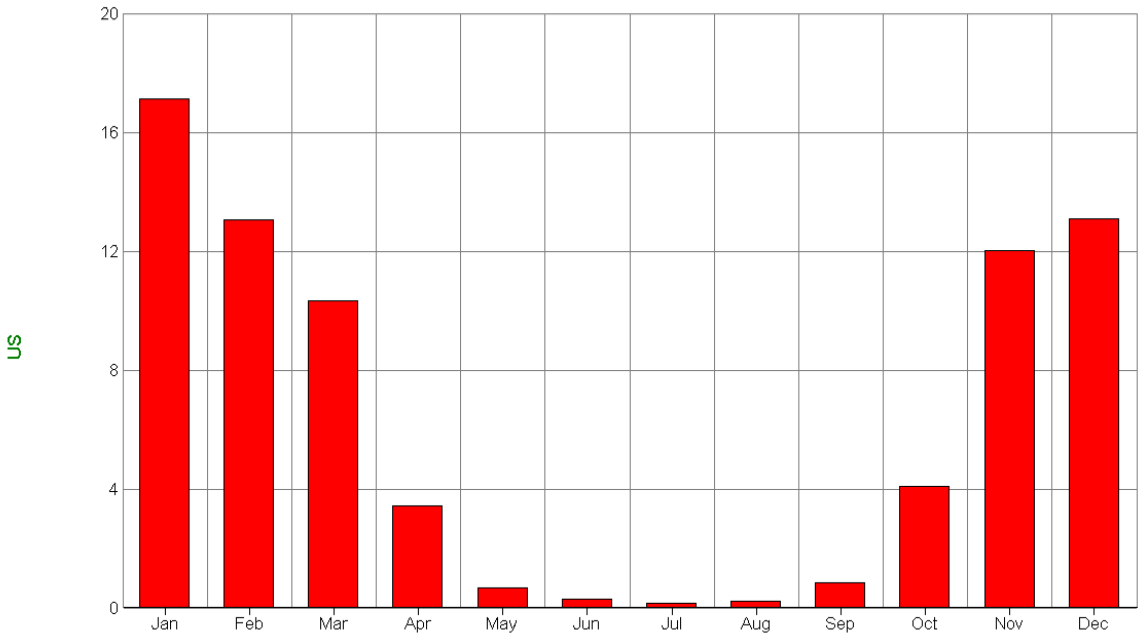

Figure 4-4 Graphic Representation of Monthly Erosivity Values

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 different 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 included NRCS RUSLE2 database by choosing the county and soil number in the drop-down menu. This selection method will not produce accurate results if the top layers of soil on the project site are already disturbed in the pre-construction phase.

- Inputting the soil texture and properties is the preferred method for soil erodibility. The user will need to select the soil values from the geotechnical report as discussed in Section 2.

- 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, by selecting the soil texture from the pulldown, or using the soil nomograph pulldown.

The rock cover percentage is entered in the upper right input box. This is the value obtained in the Site Summary Form. 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, much like residue and plant litter. Rock cover reduces soil loss, and Caltrans RUSLE2 considers rock cover as part of the C (cover) 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 will be developed and input in Caltrans RUSLE2. Because soils in construction areas are disturbed, the NRCS databases based on the soil survey number are not applicable for use in the construction phase analysis. Usually in cut and fill areas for road embankments, the aggregate base class 2 or engineering fill is used as a top layer. Hence the texture of cover soil material input in Caltrans RUSLE2 should be reflective of that base material.

4.5.2.2 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 completion of construction.

4.5.3 Topography

In Caltrans RUSLE2, slope length and gradient are combined into a single topographic factor (LS).

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 topographic condition factor combination represents. The total soil loss in the project area is obtained by adding up these different segments. This pre-construction value represents the baseline of pre-construction soil erosion for the project site.

For most projects, the user can measure the horizontal distance and elevation drop, 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, off the project mapping. 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 will have been developed as part of the Site Summary Form as described in Section 3.

4.5.3.2 Construction

The construction phase topography is usually much 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 nonuniform 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 is entered into the database 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 reference site identified in the Site Summary Form 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 are used independently or in combination.

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 list typical cover vegetation types as 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 the visual estimation of density and categorization into minimal, medium, and dense cover.

4.5.4.2 Construction -Temporary BMPs

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

In construction projects, reducing 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 during construction to achieve the 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. The user may need to run several model iterations based on the final project site conditions and the proposed BMPs to account for changes in vegetation over time, as the vegetation matures and ages. Model runs for 1, 2, 3, 5, 10, and 15 years after construction should be performed and tabulated.

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 MAER (where post-construction phase MAER option 1 applies) may require permanent sediment control systems, which must be modeled outside of the Caltrans RUSLE2.

4.5.5 Analyze and Validate Pre-Construction Inputs and Results

For quality assurance, the Caltrans RUSLE2-computed pre-construction erosion rate should be compared to the NRCS soil tolerance, which can be obtained from the NRCS soil surveys. It should be noted that the NRCS values are very general in nature, especially in rural non-agricultural areas. If the output erosion rate is outside of the NRCS values, usually 2 t/ac/yr to 5 t/ac/yr, then the model inputs need to be verified to ensure that there were no order-of-magnitude errors in the calculation of erosion rate values for the pre-construction baseline case.

Erosion rates in Caltrans RUSLE2 were derived from NRCS soil surveys and are slope independent, as far as Caltrans RUSLE2 is concerned. Caltrans RUSLE2 chooses the erosion value for a specific project from the project database based on soil type for the pre- and post-construction phases.

Construction and post-construction management practices are compared to the established MAER values for each phase, as described in the steps outlined Section 4.4 and in detail in Section 2.2.

4.6 Report Template

When the user has the pre-construction, construction, and post-construction results from the Caltrans RUSLE2 model runs for the project site and has reviewed those results for accuracy and completeness, the user can prepare the EC Report for the proposed project. The user should use the template provided on the attached CD and follow the steps and example outlined in Appendix E as a guide to create the EC Report.

4.7 Program Limitations

The Caltrans RUSLE2 program incorporates modifications that improve its applicability to California ecosystems and construction activities; however, there are certain limitations of the program that the user should be aware of when using it to achieve optimal model results.

Caltrans RUSLE2 program limitations that the user should be aware of 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 will 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 (i.e., greater than 3 years) permanent vegetation conditions.

- California vegetation (e.g. California Brome) produces results that behave as expected; however, nonnative vegetation does not produce as accurate or realistic results.

- Grasses and Forbs and their corresponding ARS database vegetation produce reasonable results in Caltrans RUSLE2 model runs in general; however, shrub vegetation does not generally produce reasonable results, particularly for time periods beyond the 3-year period. It is recommended that Table 4-2 be used to help characterize post-construction vegetation types to produce more accurate model results.

Table 4-2
Vegetation Characterization for Caltrans RUSLE2 Options

Post-Construction Vegetation	Percentage Grasses/Forbs(1)	User to Select:
Grasses/Forbs and Shrubs	≥ 60%	Grasses/Forbs
Grasses/Forbs and Shrubs	< 60%	Grasses/Forbs and Shrubs
Grasses/Forbs, Shrubs and Trees	≥ 60%	Grasses/Forbs
Grasses/Forbs, Shrubs and Trees	< 60%	Grasses/Forbs, Shrubs and Trees

(1) The percentage of cover represented by grasses/forbs determined during the site characterization phase of the EPP.

- To achieve the most accurate results when using Grasses/Forbs and Shrubs or Grasses/Forbs, Shrubs, and Trees, it is suggested that Caltrans RUSLE2 calculations be limited to 3 years. Due to the current computational limitations of the ARS RUSLE2 the program shows increasing erosion over time. Long-term erosion rates, however, are generally expected to decrease over time to at or below 3-year levels; therefore, by using the 3-year erosion rate, the impact of this limitation should be minimal. Table 4-3 illustrates changes in erosion rates over time based on the current program.

Table 4-3
Post-Construction Vegetation Erosion Rates Over Time

Post-Construction Vegetation	ARS Vegetation	Erosion Rate (tons/acre/year)				
		Year 1	Year 3	Year 5	Year 10	Year 15
Grasses/Forbs, medium	Brome	5.7	3	2.1	1.4	1.1
Grasses/Forbs and Shrubs, medium	Blueberry	4	15	20	22	23
Grasses/Forbs, Shrubs and Trees, medium	Citrus	19	20	20	20	20

- 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 analyzed with caution and compared with expected values and empirical evidence to the extent feasible.

Caltrans RUSLE2 can provide a useful tool for meeting requirements set forth by both the Caltrans individual statewide NPDES storm water permit (Order No. 99-06 DWQ) and the SWRCB Draft Construction General Permit (CGP, March 2008). However, the user should be aware of certain program limitations, as well as how to most effectively use Caltrans RUSLE2 to help meet permit requirements.

This EPP and the Caltrans RUSLE2 program can be used to facilitate characterization of highway construction project site vegetation types, vegetative cover, topography, soil classification, and erodibility potential. The EPP and Caltrans RUSLE2 can subsequently be applied to calculate construction and post-construction soil loss for the project site. By doing so, the user can then assess which BMPs would provide the most effective erosion prevention and minimization at the project site to the Maximum Extent Practicable (MEP) or those which are the Best Available Technology Economically Achievable/Best Conventional Pollutant Control Technology (BAT/BCT), as required by the Draft CGP.

Per the Draft CGP, to file a Notice of Intent (NOT), soil loss predicted by RUSLE must be at or below pre-project levels. The EPP and Caltrans RUSLE2 can be used directly to assess this requirement. Resulting construction and post-construction Caltrans RUSLE2 erosion rates can be used to assess risk levels outlined in the Draft CGP and determine whether erosion rates are at or below calculated pre-construction conditions. However, using the EPP and program to meet Draft CGP requirements has its caveats and limitations, as follows.

- The Draft CGP includes numeric action levels (NALs) and numeric effluent limits (NELs) for turbidity, with NAL exceedances triggering a need for additional BMPs. NEL exceedances are a violation and must be reported to the SWRCB. The CGP relates sediment loss directly to turbidity at a 1:1 ratio. RUSLE2 calculates soil loss in t/acre/yr. Thus, the MAERs outlined in this EPP are not directly applicable to the sediment loss/turbidity exceedance triggers outlined in the Draft CGP.

- The Draft CGP requires the use of both C and P factors when characterizing a project site and calculating sediment loss. The RUSLE2 program, however,

combines the two factors in management practices, therefore the use of C or P factors as decision-making criteria per the CGP would not be feasible through Caltrans RUSLE2.

- The Draft CGP outlines a numeric C value goal of 0.003 in order to file a NOT. As stated above, this is not directly applicable to Caltrans RUSLE2, which combines both the C and P factors in management practices. It also does not follow the Caltrans EPP process, which outlines the use of MAERs, or, when applicable, other numeric WQOs or TMDLs as project soil loss goals.

For additional information on program computational errors, limitations, and applicability to regulatory requirements see the technical memoranda in Appendix F.

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Wisconsin Department of Commerce. 2007. Website: http://commerce.wi.gov/SBdocs/SB-CodeDevComm602025AdoptDrft1006.pdf. Accessed August.

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CLIMATE DATABASE

The climate database loaded in the Caltrans RUSLE2 is as follows.

CAclimate120303.gdb	2.21 MB	GDB File	12/4/2003 12:00 AM

SOIL DATABASE

The soil database loaded in the Caltrans RUSLE2 is as follows, including a list of revision dates for individual California counties:

Alameda Area, California.gdb	422 KB	GDB File	2/28/2005 10:56 PM
Alameda County, California, Western Part.gdb	272 KB	GDB File	2/28/2005 10:58 PM
Amador Area, Ca.gdb	558 KB	GDB File	9/3/2004 12:00 AM
Angeles National Forest Area, Ca.gdb	511 KB	GDB File	2/14/2005 7:55 PM
Antelope Valley, Ca.gdb	484 KB	GDB File	8/21/2004 12:00 AM
Benton Owens Valley Area Parts of Inyo and Mono Counties, Ca.gdb	1.21 MB	GDB File	3/22/2005 9:28 PM
Butte Area, Ca, Parts of Butte and Plumas Counties.gdb	1.59 MB	GDB File	3/30/2005 6:13 PM
Butte Valley-Tule Lake Area, Parts of Siskiyou and Modoc Counties, Ca.gdb	443 KB	GDB File	2/14/2005 7:55 PM
California.zip	1.90 MB	WinZip File	3/30/2005 6:16 PM
Colorado River Indian Reservation, Ca.gdb	223 KB	GDB File	9/3/2004 12:00 AM
Colusa County, Ca.gdb	542 KB	GDB File	3/30/2005 6:13 PM
Contra Costa, Ca.gdb	409 KB	GDB File	8/4/2004 12:00 AM
El Dorado Area, Ca.gdb	405 KB	GDB File	9/2/2004 12:00 AM
Fresno County, Eastern Part, Ca.gdb	1.08 MB	GDB File	3/14/2005 3:58 PM
Fresno County, Western Part, Ca.gdb	634 KB	GDB File	2/14/2005 7:55 PM
Glenn County, Ca.gdb	1.05 MB	GDB File	9/2/2004 12:00 AM
Imperial, Ca.gdb	196 KB	GDB File	8/4/2004 12:00 AM
Intermountain Area, Parts of Lassen, Modoc, Shasta, and Siskiyou counties, Ca.gdb	968 KB	GDB File	3/14/2005 3:58 PM
Kern County, Nothwest Part, Ca.gdb	539 KB	GDB File	3/14/2005 3:58 PM
Kern County, Southeast Part, Ca.gdb	381 KB	GDB File	3/14/2005 3:58 PM
Kings County, Ca.gdb	281 KB	GDB File	3/22/2005 9:28 PM
Lake County, Ca.gdb	848 KB	GDB File	3/14/2005 3:58 PM
Lassen National Forest, Ca.gdb	1.14 MB	GDB File	3/22/2005 9:28 PM
Los Angeles Co, W. San Fernando Valley Area, Ca.gdb	235 KB	GDB File	9/3/2004 12:00 AM
Los Padres National Forest South Area, Ca.gdb	562 KB	GDB File	9/3/2004 12:00 AM
Madera, Ca.gdb	888 KB	GDB File	8/4/2004 12:00 AM
Marin, CA.gdb	458 KB	GDB File	8/4/2004 12:00 AM
Marine Corps Air Ground Combat Center at Twentynine Palms, Ca.gdb	438 KB	GDB File	2/14/2005 7:55 PM
Mariposa Area.gdb	295 KB	GDB File	9/3/2004 12:00 AM
Mendocino County, Eastern Part, and Southwestern Part of Trinity County, Ca.gdb	791 KB	GDB File	3/14/2005 3:58 PM
Mendocino County, Western Part, Ca.gdb	697 KB	GDB File	9/3/2004 12:00 AM
Merced County, Eastern Part, Ca.gdb	795 KB	GDB File	9/2/2004 12:00 AM
Merced County, Western Part, Ca.gdb	654 KB	GDB File	9/2/2004 12:00 AM
Modoc County, Alturas Area, Ca.gdb	436 KB	GDB File	2/14/2005 7:55 PM
Monterey, Ca.gdb	707 KB	GDB File	8/4/2004 12:00 AM
Napa County, Ca.gdb	533 KB	GDB File	2/14/2005 7:55 PM
Nevada County Area, Ca.gdb	355 KB	GDB File	9/2/2004 12:00 AM
Orange County and Western Part of Riverside County, Ca.gdb	396 KB	GDB File	3/14/2005 3:58 PM

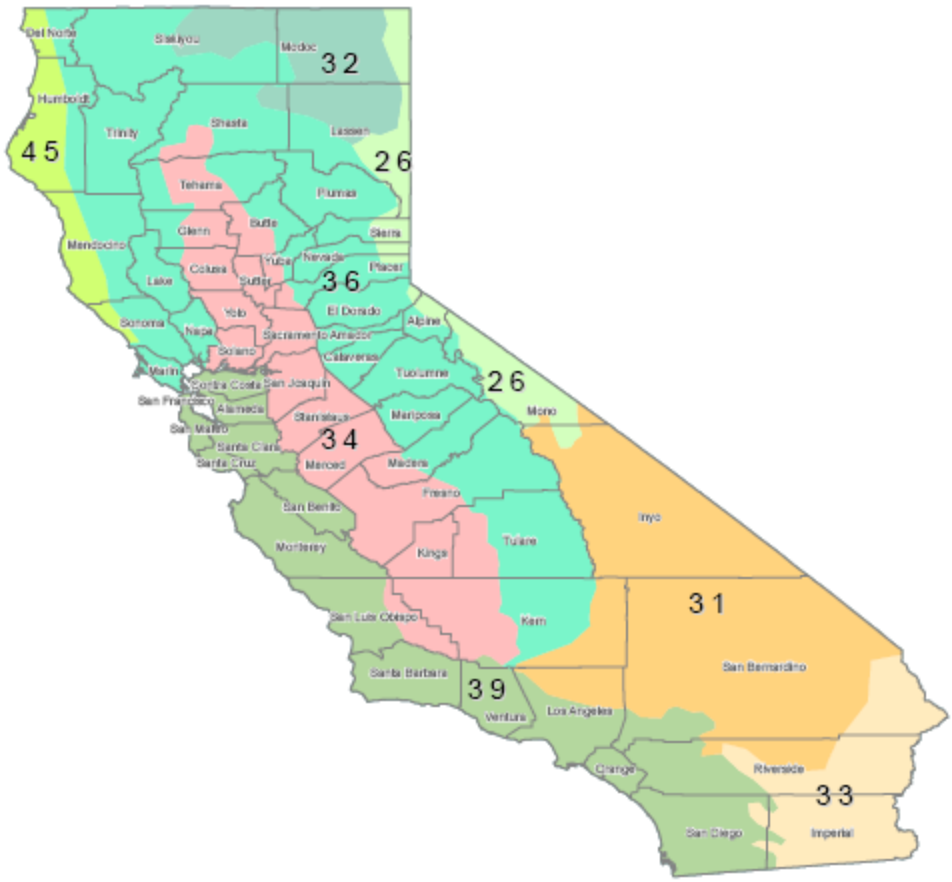
Palo Verde, Ca.gdb	164 KB	GDB File	3/22/2005 9:28 PM
Placer County, Western Part, Ca.gdb	424 KB	GDB File	9/2/2004 12:00 AM
Riverside County, Coachella Valley Area, Ca.gdb	203 KB	GDB File	2/14/2005 7:55 PM
Riverside Western Part, Ca.gdb	905 KB	GDB File	9/3/2004 12:00 AM
Sacramento County, Ca.gdb	451 KB	GDB File	9/2/2004 12:00 AM
San Benito, Ca.gdb	521 KB	GDB File	8/21/2004 12:00 AM
San Bernardino County, Mojave River Area, Ca.gdb	274 KB	GDB File	3/14/2005 3:58 PM
San Bernardino County, Southwest Part, Ca.gdb	217 KB	GDB File	3/14/2005 3:58 PM
San Bernardino National Forest Area, Ca.gdb	459 KB	GDB File	9/3/2004 12:00 AM
San Diego Area, Ca.gdb	738 KB	GDB File	9/3/2004 12:00 AM
San Joaquin County, Ca.gdb	604 KB	GDB File	2/14/2005 7:55 PM
San Luis Obispo Co., Carrizo Plain Area, Ca.gdb	568 KB	GDB File	9/3/2004 12:00 AM
San Luis Obispo Co., Coastal Area, Ca.gdb	441 KB	GDB File	9/3/2004 12:00 AM
San Luis Obispo Co., Paso Robles Area, Ca.gdb	465 KB	GDB File	9/3/2004 12:00 AM
San Mateo Area, Ca.gdb	725 KB	GDB File	9/3/2004 12:00 AM
San Mateo County, Eastern Part, and San Francisco County, Ca.gdb	164 KB	GDB File	2/14/2005 7:55 PM
Santa Barbara Northern Part, Ca.gdb	646 KB	GDB File	8/21/2004 12:00 AM
Santa Barbara South Coastal Area, Ca.gdb	349 KB	GDB File	8/21/2004 12:00 AM
Santa Clara Eastern Part, Ca.gdb	530 KB	GDB File	9/3/2004 12:00 AM
Santa Cruz County, Ca.gdb	326 KB	GDB File	9/3/2004 12:00 AM
Santa Monica Mountains National Recreation Area, Ca.gdb	335 KB	GDB File	3/22/2005 9:28 PM
Shasta Area, Ca.gdb	732 KB	GDB File	9/2/2004 12:00 AM
Sierra Valley Area, Parts of Sierra, Plumas, and Lassen Counties, Ca.gdb	374 KB	GDB File	2/14/2005 7:55 PM
Siskiyou County, Ca, Central Part.gdb	562 KB	GDB File	2/14/2005 7:55 PM
Solano County, Ca.gdb	376 KB	GDB File	9/2/2004 12:00 AM
Sonoma County, Ca.gdb	785 KB	GDB File	9/2/2004 12:00 AM
Stanislaus County, Western Part, Ca.gdb	476 KB	GDB File	2/14/2005 7:55 PM
Stanislaus Eastern Part, Ca.gdb	666 KB	GDB File	9/3/2004 12:00 AM
Susanville Area, Ca.gdb	1.31 MB	GDB File	9/2/2004 12:00 AM
Sutter County, Ca.gdb	317 KB	GDB File	9/2/2004 12:00 AM
Tehama County, Ca.gdb	1.06 MB	GDB File	9/3/2004 12:00 AM
Trinity County, Weaverville Area, Ca.gdb	526 KB	GDB File	3/14/2005 3:58 PM
Tulare County, Central Part, Ca.gdb	256 KB	GDB File	3/14/2005 3:58 PM
Tulare County, Western Part, Ca.gdb	198 KB	GDB File	2/14/2005 7:55 PM
Ventura Area, Ca.gdb	559 KB	GDB File	9/3/2004 12:00 AM
Yolo County, Ca.gdb	445 KB	GDB File	9/2/2004 12:00 AM
Yuba County, Ca.gdb	584 KB	GDB File	3/22/2005 9:28 PM
Yuma-Wellton Area, Ca.gdb	171 KB	GDB File	9/3/2004 12:00 AM

CROP MANAGEMENT DATABASE

The Crop Management Database, Crop Management Zone (CMZ) files and index (Figure 1) loaded in the Caltrans RUSLE2, including a list of revision dates, are as follows.

CMZ 01.gdb	3.27 MB	GDB File	10/7/2004 12:00 AM
CMZ 02.gdb	482 KB	GDB File	6/1/2004 12:00 AM
CMZ 03.gdb	578 KB	GDB File	7/9/2004 12:00 AM
CMZ 04.1.gdb	9.28 MB	GDB File	3/16/2005 11:03 PM
CMZ 04.gdb	4.49 MB	GDB File	4/28/2005 1:45 PM
CMZ 05.gdb	1.79 MB	GDB File	10/17/2004 12:00 AM
CMZ 06.gdb	277 KB	GDB File	6/1/2004 12:00 AM
CMZ 07.gdb	614 KB	GDB File	8/28/2004 12:00 AM
CMZ 08.gdb	246 KB	GDB File	8/24/2004 12:00 AM
CMZ 09.gdb	526 KB	GDB File	8/28/2004 12:00 AM
CMZ 10.gdb	541 KB	GDB File	10/26/2004 12:00 AM
CMZ 11.gdb	488 KB	GDB File	3/22/2005 9:51 PM
CMZ 12.gdb	441 KB	GDB File	11/12/2004 9:30 PM
CMZ 13.gdb	766 KB	GDB File	3/9/2005 2:24 PM
CMZ 14.gdb	381 KB	GDB File	1/14/2005 2:01 PM
CMZ 15.1.gdb	331 KB	GDB File	10/17/2004 12:00 AM
CMZ 15.gdb	271 KB	GDB File	6/8/2004 12:00 AM
CMZ 16.gdb	1.83 MB	GDB File	12/15/2004 6:19 PM
CMZ 17.gdb	1.96 MB	GDB File	1/13/2005 10:35 PM
CMZ 18.gdb	248 KB	GDB File	6/1/2004 12:00 AM
CMZ 19.gdb	213 KB	GDB File	6/8/2004 12:00 AM
CMZ 20.gdb	152 KB	GDB File	7/12/2004 12:00 AM
CMZ 21.gdb	144 KB	GDB File	7/12/2004 12:00 AM
CMZ 22.gdb	170 KB	GDB File	7/12/2004 12:00 AM
CMZ 23.gdb	125 KB	GDB File	7/12/2004 12:00 AM
CMZ 24.gdb	693 KB	GDB File	7/13/2004 12:00 AM
CMZ 25.gdb	310 KB	GDB File	3/18/2005 2:22 PM
CMZ 26.gdb	375 KB	GDB File	8/24/2004 12:00 AM
CMZ 27.gdb	214 KB	GDB File	3/9/2005 2:25 PM
CMZ 28.gdb	888 KB	GDB File	3/9/2005 2:25 PM
CMZ 29.gdb	112 KB	GDB File	5/7/2004 12:00 AM
CMZ 30.gdb	216 KB	GDB File	1/14/2005 2:00 PM

CMZ 31.gdb	99.0 KB	GDB File	7/9/2004 12:00 AM
CMZ 32.gdb	377 KB	GDB File	3/22/2005 9:51 PM
CMZ 33.gdb	420 KB	GDB File	9/13/2004 12:00 AM
CMZ 34.gdb	225 KB	GDB File	2/25/2005 10:11 PM
CMZ 35.gdb	491 KB	GDB File	3/9/2005 2:25 PM
CMZ 36.gdb	6.86 MB	GDB File	3/22/2005 10:00 PM
CMZ 36_Important_Notice.htm	1.36 KB	HTML Document	9/13/2004 12:00 AM
CMZ 37.1.gdb	296 KB	GDB File	8/29/2003 12:00 AM
CMZ 37.gdb	303 KB	GDB File	7/9/2004 12:00 AM
CMZ 38.1.gdb	99.0 KB	GDB File	6/9/2003 12:00 AM
CMZ 38.gdb	226 KB	GDB File	7/9/2004 12:00 AM
CMZ 39.gdb	6.82 MB	GDB File	4/22/2005 7:05 PM
CMZ 39_Important_Notice.htm	1.45 KB	HTML Document	4/28/2003 12:00 AM
CMZ 40.gdb	286 KB	GDB File	5/24/2004 12:00 AM
CMZ 41.gdb	340 KB	GDB File	8/29/2003 12:00 AM
CMZ 42.gdb	261 KB	GDB File	8/24/2004 12:00 AM
CMZ 43.gdb	173 KB	GDB File	7/9/2004 12:00 AM
CMZ 44.gdb	304 KB	GDB File	8/29/2003 12:00 AM
CMZ 45.gdb	191 KB	GDB File	3/22/2005 9:52 PM
CMZ 46.gdb	359 KB	GDB File	4/13/2005 5:56 PM
CMZ 47.gdb	414 KB	GDB File	1/4/2005 6:11 PM
CMZ 48.gdb	246 KB	GDB File	5/25/2004 12:00 AM
CMZ 49.gdb	285 KB	GDB File	3/22/2005 9:52 PM
CMZ 50.gdb	391 KB	GDB File	3/22/2005 9:53 PM
CMZ 51.gdb	168 KB	GDB File	3/22/2005 9:53 PM
CMZ 52.gdb	193 KB	GDB File	12/7/2004 2:45 PM
CMZ 53.gdb	498 KB	GDB File	4/1/2005 5:32 PM
CMZ 54.gdb	122 KB	GDB File	12/7/2004 2:22 PM
CMZ 55.gdb	340 KB	GDB File	3/22/2005 9:54 PM
CMZ 56.gdb	135 KB	GDB File	12/7/2004 2:17 PM
CMZ 57.gdb	315 KB	GDB File	7/9/2004 12:00 AM
CMZ 58.gdb	239 KB	GDB File	8/29/2003 12:00 AM
CMZ 59.gdb	518 KB	GDB File	7/9/2004 12:00 AM
CMZ 60.gdb	4.24 MB	GDB File	2/20/2005 9:38 PM
CMZ 62.gdb	7.42 MB	GDB File	9/16/2004 12:00 AM
CMZ 63.gdb	947 KB	GDB File	5/6/2005 8:50 PM
CMZ 64.gdb	520 KB	GDB File	10/8/2003 12:00 AM
CMZ 65.gdb	7.48 MB	GDB File	2/9/2005 5:37 AM
CMZ 66.gdb	615 KB	GDB File	11/3/2003 12:00 AM
CMZ 67.gdb	1.29 MB	GDB File	4/20/2005 9:02 PM
CMZ 68.gdb	189 KB	GDB File	10/26/2004 12:00 AM
CMZ 69.gdb	856 KB	GDB File	12/1/2004 9:03 PM
CMZ 70.gdb	205 KB	GDB File	7/9/2004 12:00 AM
CMZ 71.gdb	184 KB	GDB File	3/22/2005 9:55 PM
CMZ 72 AK.gdb	107 KB	GDB File	7/9/2004 12:00 AM
CMZ 73 HI.gdb	457 KB	GDB File	4/8/2005 10:25 PM
CMZ 74 PB.gdb	288 KB	GDB File	7/17/2004 12:00 AM
CMZ 75 PR.gdb	390 KB	GDB File	9/13/2004 12:00 AM



Source: Natural Resource Conservation Service (NRCS) 2003

NO SCALE

Figure 1
California Crop Management Zones

Caltrans RUSLE2 EPP

Path: P:\2007\07050307 Caltrans TO34 EPP RUSLE2 Refinement\GIS\MXD\CMZ_overview.mxd 11/06/07, kej

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Since published descriptions of soil characteristics, especially soil erodibility (K) factor, do not exist for highly disturbed lands typical of construction sites, landfill, and reclaimed mined land, soil character must be developed from a soil test. The modified RUSLE2 nomograph should be used to estimate K factors for soils associated with highly disturbed lands such as construction sites. The nomograph is a mathematical algorithm, which uses values supplied for soil characteristics such as permeability, structure, texture, and organic content to provide a K factor.

Reference the USDA-NRCS Soil Survey Manual for a description of the terms used in the soil erodibility nomograph and procedures for determining values for the nomograph variables. This manual is available on the NRCS website at www.nrcs.usda.gov.

Creating a soil data file for each of the construction site soils can be best accomplished by modifying an existing soil file found in the "Disturbed Land Examples" folder. Information can then be entered based upon field observation and laboratory soil test. 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 the following table.

Table B-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 Clay loam Loam Loamy sand Sand Sandy clay Sandy loam Sandy clay loam Silt Silt loam Silty clay Silty clay loam Unknown	Laboratory Test
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

Variable	Comment	Data Source
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 Judgement 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 Judgement
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)

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 utilized. 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 RUSLE2 but they can determine the distribution of the various sized particles. Request California Test 202 to do 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.

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_rbs.xls" found on the RUSLE2 CD. 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.

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 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.

Soil Texture and Permeability

Since infiltration correlates to soil texture, once the soil texture is known, the permeability can be determined. Use the provided 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 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 (Table B-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.

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.

Example Report

The following pages show an example of a Caltrans Soil Analysis Report.

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	

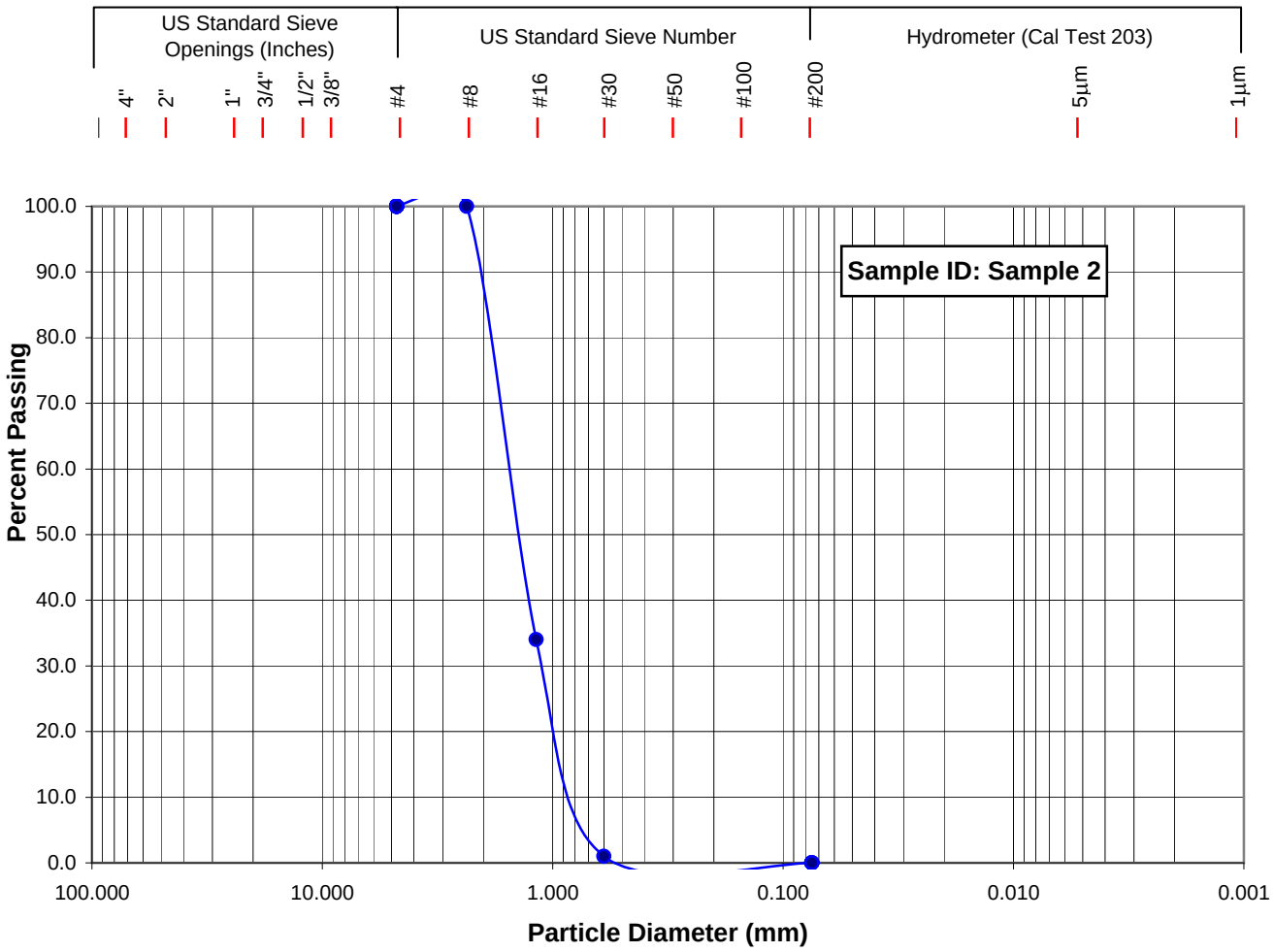
Project Information

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



GRAVEL			SAND					SILT	CLAY
Coarse	Medium	Fine	V.C	Co.	Med.	Fine	V.Fin		

USDA Soil Texture Classification

GRAVELS		SANDS			SILT	CLAY
Coarse	Fine	Coarse	Medium	Fine		

Unified Soil Classification System

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**

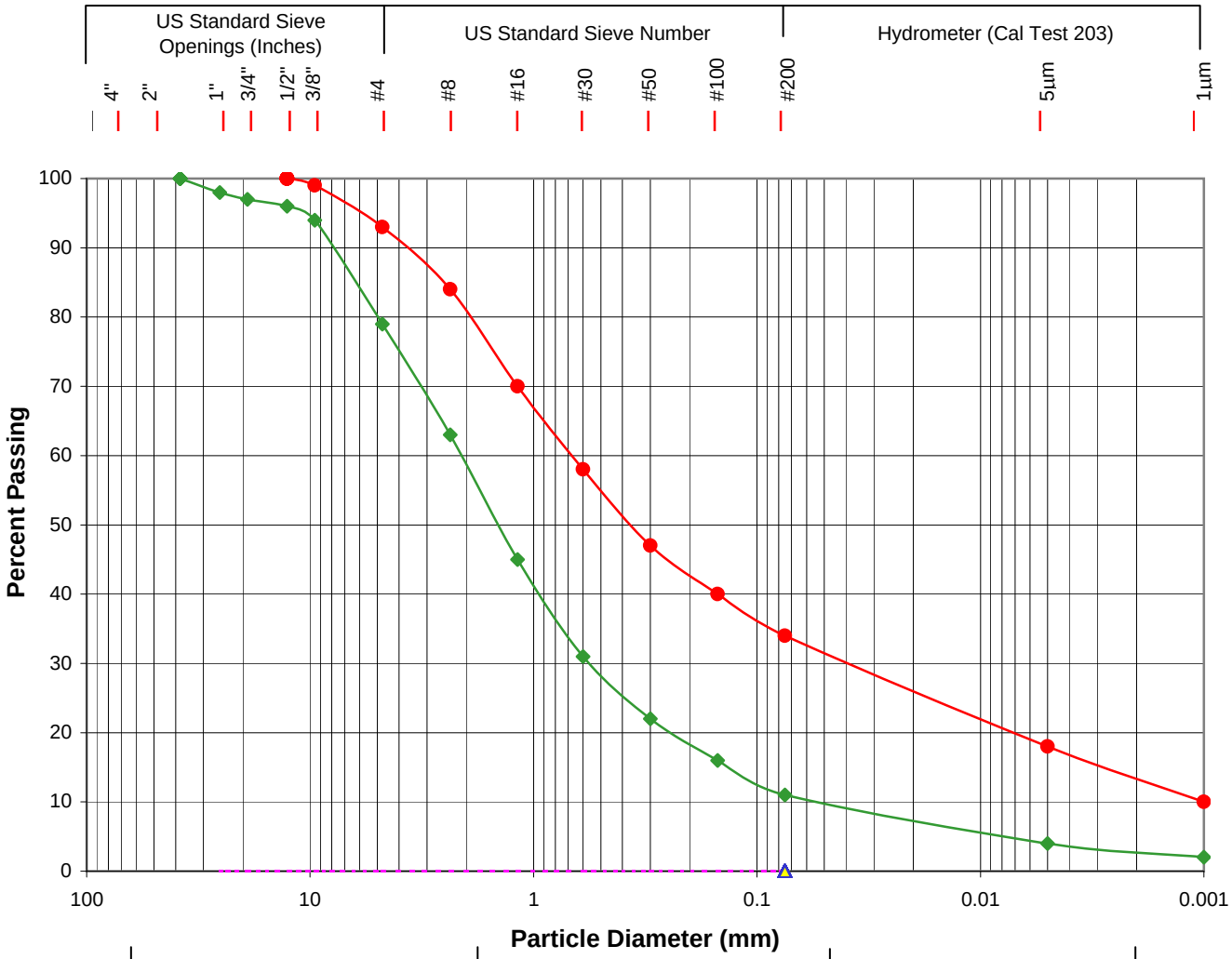
EA: **04-1123C1**

D-Co-Rt-KP: **04-SM-1-**

Sample Information

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

Gradation Analysis Test Results



GRAVEL			SAND					SILT	CLAY
Coarse	Medium	Fine	V.C	Co.	Med.	Fine	V.Fin		

USDA Soil Texture Classification

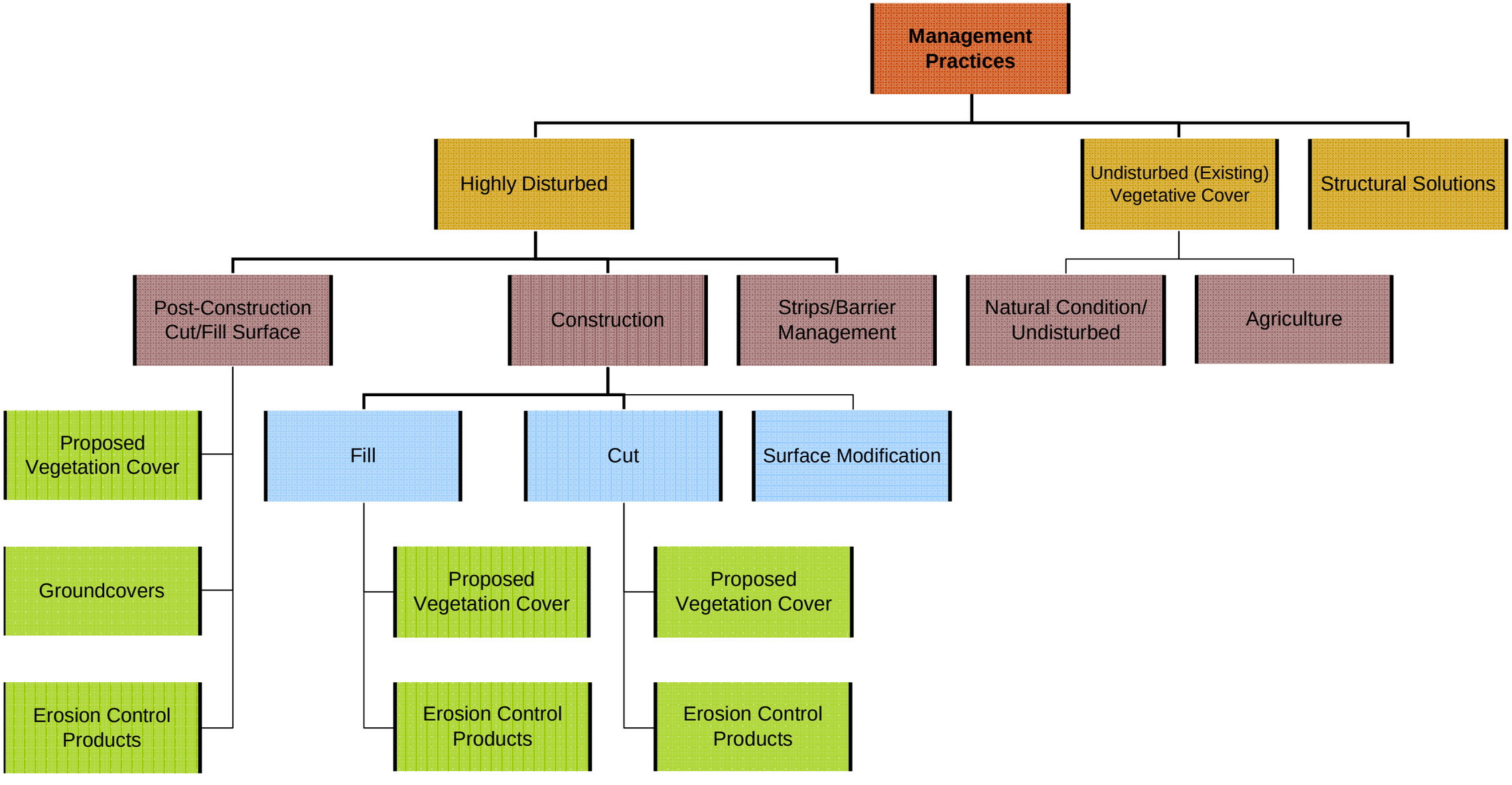
Sample ID: DS-1 DS-2

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

Plate No.:

FLOW CHART


Management Practices
Highly Disturbed
Undisturbed (Existing) Vegetative Cover
Structural Solutions
Post-Construction Cut/Fill Surface
Construction
Strips/Barrier Management
Natural Condition/ Undisturbed
Agriculture
Proposed Vegetation Cover
Fill
Cut
Surface Modification
Groundcovers
Proposed Vegetation Cover
Proposed Vegetation Cover
Erosion Control Products
Erosion Control Products
Erosion Control Products

LAYOUT

Undisturbed (Existing) Vegetative Cover		Structural Solutions	Highly Disturbed				
Natural Condition/Undisturbed	*Agriculture*		*Construction*			*Post-Construction Cut/Fill Surface*	*Strips/Barrier Management*
Bare Ground	CMZ 31	Asphalt	***Surface Modification***	***Cut***	***Fill***		Silt Fence (SC-1)
Bare Ground, Rough	CMZ 32	Concrete	bare rough	bare cut, smooth	bare fill material	bare cut, smooth	Fiber Roll (SC-5)
Grass & Forbs - Minimal	CMZ 34	Rock Slope Protection	ripping/ridging 6 in high				Straw Bale Barrier (SC-9)
Grass & Forbs - Medium	CMZ 36	Gravel	ripping/ridging 12 in high	***Proposed Vegetation Cover***	***Proposed Vegetation Cover***	***Proposed Vegetation Cover***	
Grass & Forbs-Dense	CMZ 39		track walking	Hydroseeding	Hydroseeding	Grass & Forbs - Medium	
Grasses/Forbs & Shrubs - Minimal	CMZ 45					Grass & Forbs-Dense	
Grasses/Forbs & Shrubs - Medium				***Erosion Control Product***	***Erosion Control Product***		
Grasses/Forbs & Shrubs - Dense				Combination Blanket (SS-7)	Combination Blanket (SS-7)	Grasses/Forbs & Shrubs - Medium	
Grasses/Forbs, Shrubs & Trees - Minimal				Seed + Combination Blanket (SS-4 + SS-7)	Seed + Combination Blanket (SS-4 + SS-7)	Grasses/Forbs, Shrubs & Trees - Medium	
Grasses/Forbs, Shrubs & Trees - Medium				Hydraulic Mulch/Bonded Fiber Matrix (SS-3)	Hydraulic Mulch/Bonded Fiber Matrix (SS-3)	Grasses/Forbs, Shrubs & Trees - Dense	
Grasses/Forbs, Shrubs & Trees - Dense				Hydroseeding w/ Hydraulic Mulch/Bonded Fiber Matrix (SS-4 + SS-3)	Hydroseeding w/ Hydraulic Mulch/Bonded Fiber Matrix (SS-4 + SS-3)	Shrubs - Medium	
Shrubs - Minimal				Hydroseeding w/Straw Mulch (SS-4 + SS-6)	Hydroseeding w/Straw Mulch (SS-4 + SS-6)	Shrubs - Dense	
Shrubs - Medium				Hydroseeding w/Wood Mulching (SS-4 + SS-8)	Hydroseeding w/Wood Mulching (SS-4 + SS-8)		
Shrubs - Dense				Straw Blanket (SS-7)	Straw Blanket (SS-7)	***Groundcover***	
				Seed + Straw Blanket (SS-4 + SS-7)	Seed + Straw Blanket (SS-4 + SS-7)	Wood Mulching (SS-8)	
				Jute Netting (SS-7)	Jute Netting (SS-7)	Compost	
				Seed + Jute Netting (SS-4 + SS-7)	Seed + Jute Netting (SS-4 + SS-7)	Rock	
				Coconut/Coir Blanket	Coconut/Coir Blanket	Pine Needles	
				Seed + Coconut/Coir Blanket (SS-4 + SS-7)	Seed + Coconut/Coir Blanket (SS-4 + SS-7)	Hydraulic Mulch (SS-3)	
				Straw Mulch (SS-6)	Straw Mulch (SS-6)	Straw Mulch (SS-6)	
				Wood Mulching (SS-8)	Wood Mulching (SS-8)	***Erosion Control Product***	
				Compost	Compost	Non-biodegradable Blanket - Permanent (SS-7)	
						Non-biodegradable Blanket - Permanent + Grasses and Forbs - Medium	
						Non-biodegradable Blanket - Permanent + Grasses and Forbs - Dense	
						Erosion Control (Type C)	
						Erosion Control (Type D)	

Appendix D Index

PRE-CONSTRUCTION PHASE BMP DATASHEETS

EROSION CONTROL

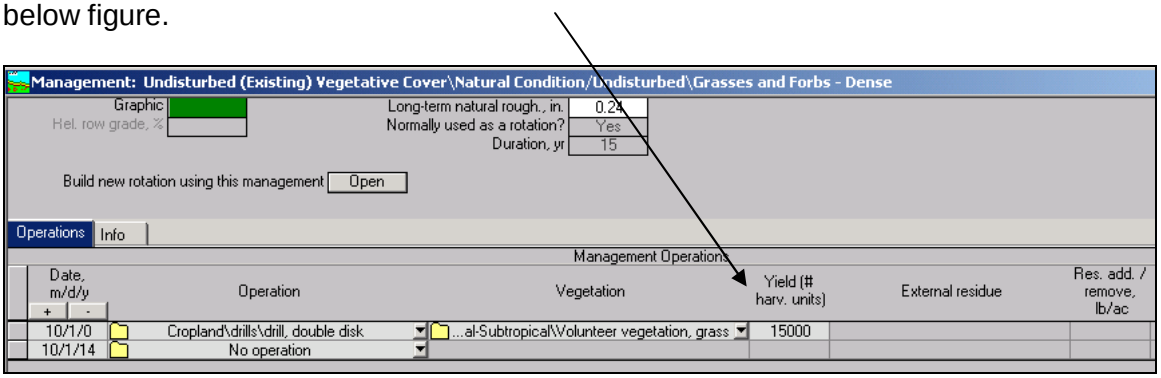
Vegetative Cover- Grasses and Forbs

Management Practice Options (found under "Management" tab):

- "Undisturbed (Existing) Vegetative cover / Natural condition / Undisturbed / Grasses and Forbs

In Caltrans RUSLE2 there are 3 options for Grasses and Forbs: Minimal (0 – 30% cover), Medium (30 – 50% cover), and Dense (greater than 70% cover).

Design Customization: The designer can modify the yield rates based on site conditions. The crop-yielding rate in terms of "harvest units" can be modified in the "yield" cell as shown in the below figure.



Assumptions:

- Grasses and Forbes in Caltrans RUSLE2 is comparable to "Tropical/Subtropical/Volunteer vegetation grass" in ARS-RUSLE2 (NRCS Database)
- Standard Caltrans limitations and specifications apply
- In Caltrans RUSLE2 the management options for Minimal, Medium, and Dense are based upon the following vegetation yields:

Minimal	6500 lb/ac
Medium	10,000 lb/ac
Dense	15,000 lb/ac.

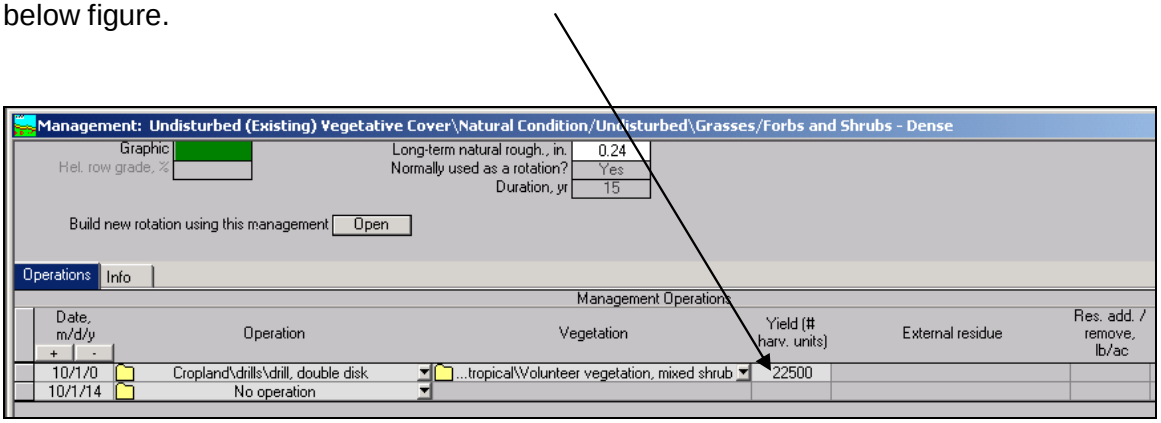
Vegetative Cover- Grasses/Forbs and Shrubs

Management Practice Options (found under "Management" tab):

- "Undisturbed (Existing) Vegetative Cover / Natural Condition / Undisturbed / Grasses/Forbs and Shrubs

In Caltrans RUSLE2 there are 3 options for Grasses/Forbs and Shrubs: Minimal (0 – 30% cover), Medium (30 – 50% cover), and Dense (greater than 70% cover).

Design Customization: The designer can modify the yield rates based on site conditions. The crop-yielding rate in terms of "harvest units" can be modified in the "yield" cell as shown in the below figure.



Assumptions:

- Grasses/Forbs and Shrubs in Caltrans RUSLE2 is comparable to "Tropical/Subtropical/Volunteer vegetation, mixed Shrub" in ARS-RUSLE2 (NRCS Database)

- Standard Caltrans limitations and specifications apply

- In Caltrans RUSLE2 the management options for Minimal, Medium, and Dense are based upon the following vegetation yields:

Minimal	9,000 lb/ac
Medium	15,000 lb/ac
Dense	22,500 lb/ac.

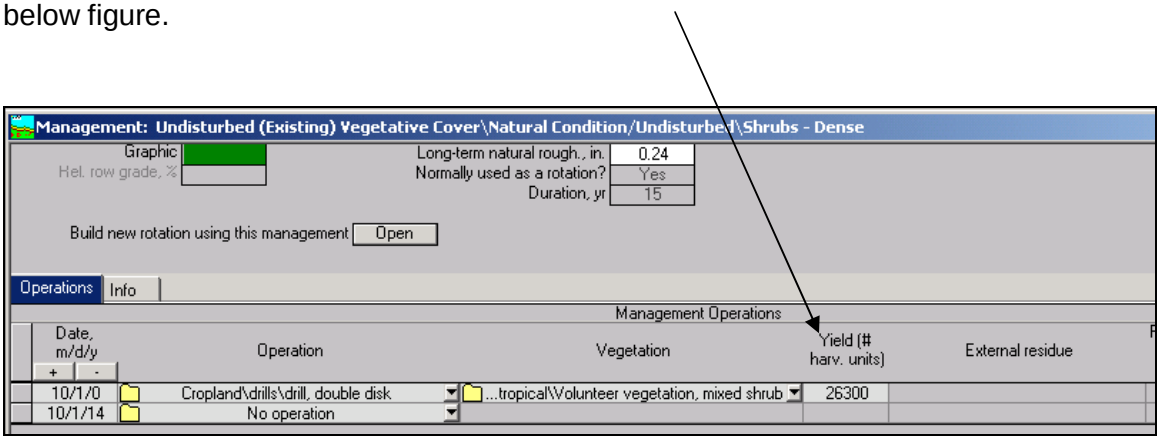
Vegetative Cover- Shrubs

Management Practice Options (found under "Management" tab):

- "Undisturbed (Existing) Vegetative Cover / Natural Condition / Undisturbed / Shrubs

In Caltrans RUSLE2 there are 3 options for Shrubs: Minimal (0 – 30% cover), Medium (30 – 50% cover), and Dense (greater than 70% cover).

Design Customization: The designer can modify the yield rates based on site conditions. The crop-yielding rate in terms of "harvest units" can be modified in the "yield" cell as shown in the below figure.



Assumptions:

- Shrubs in Caltrans RUSLE2 is comparable to "Tropical/Subtropical/Volunteer vegetation, mixed Shrub" in ARS-RUSLE2 (NRCS Database)
- Standard Caltrans limitations and specifications apply
- In Caltrans RUSLE2 the management options for Minimal, Medium, and Dense are based upon the following vegetation yields:

Minimal	10,500 lb/ac
Medium	17,500 lb/ac
Dense	26,300 lb/ac.

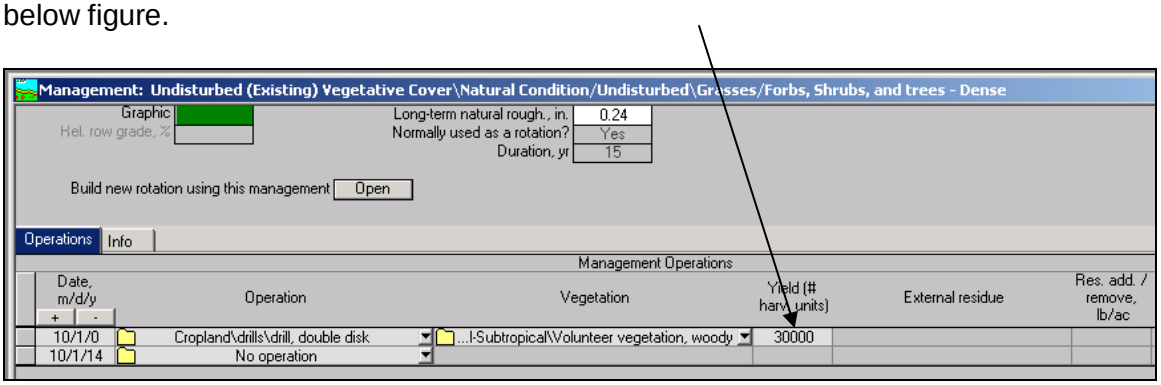
Vegetative Cover- Grasses/Forbs, Shrubs and Trees

Management Practice Options (found under "Management" tab):

- "Undisturbed (Existing) Vegetative Cover / Natural Condition / Undisturbed / Grasses/Forbs, Shrubs and Trees

In Caltrans RUSLE2 there are 3 options for Grasses/Forbs, Shrubs and Trees: Minimal (0 – 30% cover), Medium (30 – 50% cover), and Dense (greater than 70% cover).

Design Customization: The designer can modify the yield rates based on site conditions. The crop-yielding rate in terms of "harvest units" can be modified in the "yield" cell as shown in the below figure.



Assumptions:

- Grasses/Forbs, Shrubs and Trees in Caltrans RUSLE2 is comparable to "Tropical/Subtropical/Volunteer vegetation, Woody" in ARS-RUSLE2 (NRCS Database)
- Standard Caltrans limitations and specifications apply
- In Caltrans RUSLE2 the management options for Minimal, Medium, and Dense are based upon the following vegetation yields:

Minimal	12,000 lb/ac
Medium	20,000 lb/ac
Dense	30,000 lb/ac

CONSTRUCTION PHASE BMP DATASHEETS

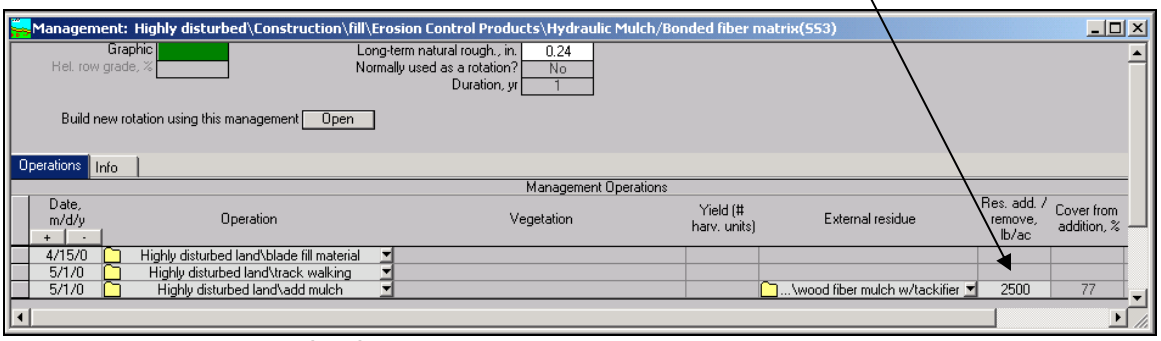
EROSION CONTROL

Hydraulic Mulch/Bonded Fiber Matrix (SS-3)

Management Practice Options (found under "Management" tab):

- "Highly Disturbed / Construction / Cut /Erosion Control Products/ Hydraulic Mulch/Bonded fiber matrix (SS-3)"
- "Highly Disturbed / Construction / Fill /Erosion Control Products/ Hydraulic Mulch/Bonded fiber matrix (SS-3)"

Design Customization: The designer can modify mulch application rates based on site conditions and "percentage of cover from addition" as shown in the figure. The required mulch rate can be input into the "Res. add/remove, (lb/ac)" cell.



Source: NRCS & ARS database

Assumptions:

- Rate of wood fiber mulch application is 2500 lb/ac
- Applied mulch is considered a residue on the soil surface
- Standard Caltrans limitations and specifications apply
- Caltrans RUSLE2 considers wood fiber to be comparable to Hydraulic Mulch/Bonded fiber matrix, which adds material to soil surface without disturbing soil (NRCS & ARS Database)

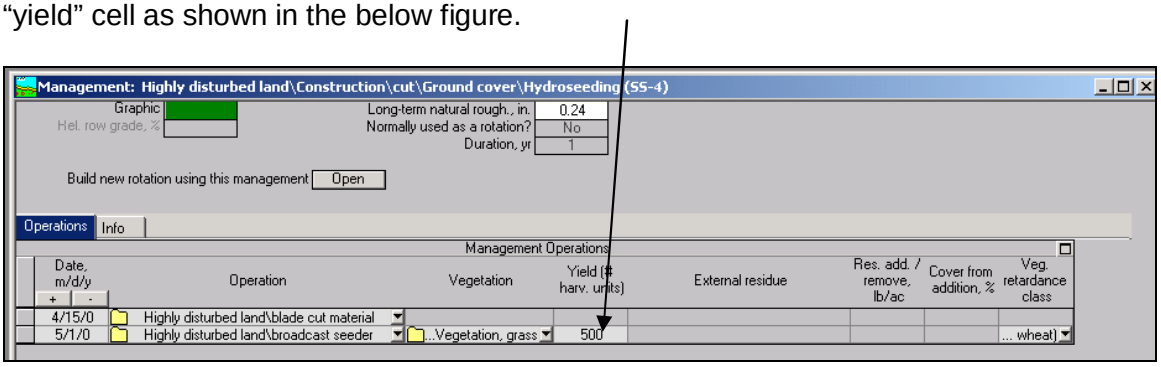
Hydroseeding (SS-4)

Management Practice Options (found under "Management" tab)

- "Highly Disturbed / Construction / Cut / Proposed Vegetation Cover / Hydroseeding (SS-4)"
- "Highly Disturbed / Construction / Fill / Proposed vegetation Cover / Hydroseeding (SS-4)"

Modifications from RUSLE2: Caltrans RUSLE2 does not specify seed application rates but gives the most common crops. In Caltrans RUSLE2, wood fiber can be added as mulch to "fill" and "cut" managements. This is equivalent to Caltrans hydroseeding standards.

Design Customization: The designer can modify vegetation and yield rates based on site conditions. The crop-yielding rate, given in terms of "harvest units", can be modified in the "yield" cell as shown in the below figure.



Source: ARS database

Assumptions:

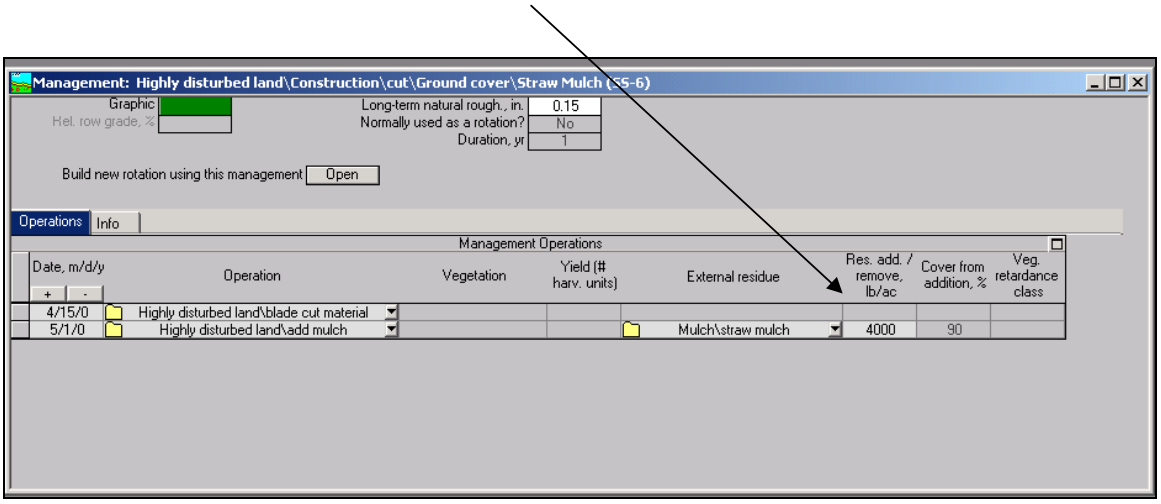
- Vegetation yield is 500 lb/ac
- Seed application rates are per Caltrans Standards and the California State Seed law
- Standard Caltrans limitations and specifications apply

Straw Mulch (SS-6)

Management Practice Options (found under "Management" tab):

- "Highly Disturbed / Construction / Cut / Erosion control products / Straw Mulch (SS-6)"
- "Highly Disturbed / Construction / Fill / Erosion control products / Straw Mulch (SS-6)"

Design Customization: The designer can modify straw mulch application rates based on site conditions and the percentage of "cover from addition" as shown in the below figure. The required mulch rate can be input into the "Res. add/remove, (lb/ac)" cell.



Assumptions:

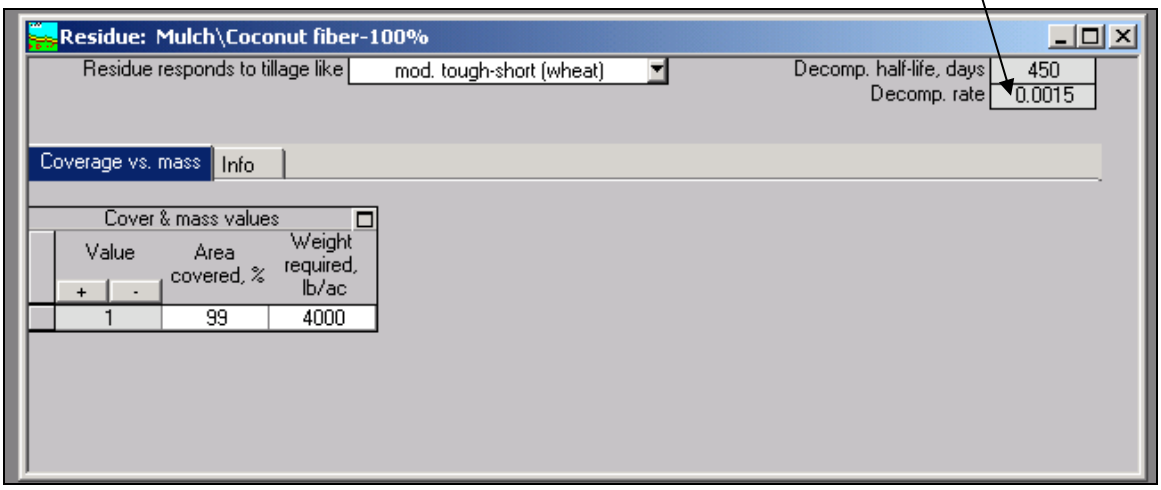
- Rate of straw mulch application is 4000 lb/ac
- Standard Caltrans limitations and specifications apply
- Straw mulch in Caltrans RUSLE2 is comparable to "wheat, rice or barley" in RUSLE2, which involves adding material to the soil surface without disturbing the soil (ARS database)

Geotextiles, Mats, Plastic Covers and Erosion Control Blankets (SS-7)

Management Practice Options (found under "Management" tab):

- "Highly Disturbed / Construction / Cut/ Erosion Control Product / Coconut/Coir blanket (SS-7)"
- "Highly Disturbed / Construction / Cut / Erosion Control Product / Straw blanket (SS-7)"
- "Highly Disturbed / Construction / Cut / Erosion Control Product / Jute blanket (SS-7)"
- "Highly Disturbed / Construction / Cut / Erosion Control Product / Combination blanket (SS-7)"
- "Highly Disturbed / Construction/ Fill / Erosion Control Product / Coconut / Coir blanket (SS-7)"
- "Highly Disturbed / Construction / Fill / Erosion Control Product / Straw blanket (SS-7)"
- "Highly Disturbed / Construction / Fill / Erosion Control Product /Jute blanket (SS-7)"
- "Highly Disturbed / Construction / Fill / Erosion Control Product / Combination blanket (SS-7)"

Design Customization: The designer can modify the life of the blanket by selecting the "Residue" tab, "Mulch" option, then selecting your mulch type. The life can be modified in the "Decomp. half-life, days" cell as shown in the below figure. The decomposition half-life is the length of time that the material takes to decompose by 50%.



Source: ARS database

Assumptions:

- Caltrans RUSLE2 distinguishes between blankets based on the life of material (see table below)

Caltrans RUSLE2 Product	Life	Comparable Product
Jute Netting	365 days (12 months)	Curlex-II Fiber Net
Straw Blanket	180 days (6 months)	AEC Premier Straw Blanket
Coconut/Coir Blanket	900 days (30 months)	AEC Premier Coconut Blanket
Combination Blanket	1080 days (36 months)	Curlex- High Velocity Heavy duty

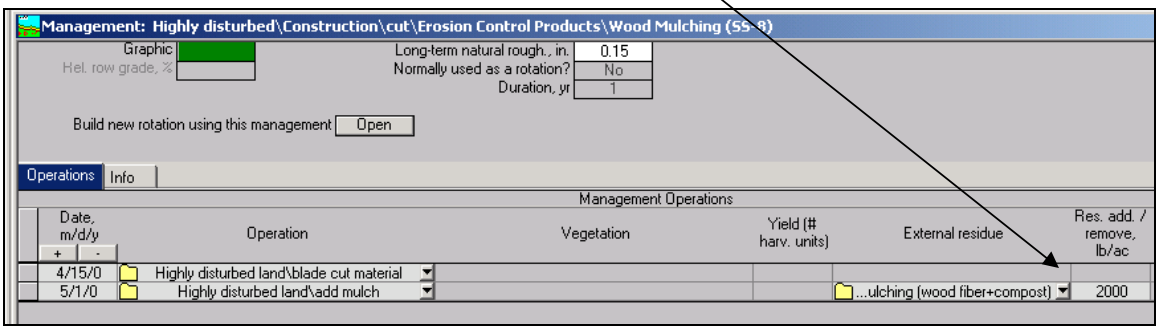
- Rate of blanket application is 2000 lb/ac
- The Caltrans RUSLE2 Combination Blanket option is based on Excelsior (Wood fibers with Plastic netting)
- Standard Caltrans limitations and specifications apply

Wood Mulching (SS-8)

Management Practice Options (found under "Management" tab):

- "Highly Disturbed / Construction / Cut / Erosion Control Products / Wood Mulching (SS-8)"
- "Highly Disturbed / Construction/ Fill / Erosion Control Products / Wood Straw Mulching (SS-8)"

Design Customization: The designer can modify straw mulch application rates based on site conditions as shown in the below figure. The required mulch rate can be input into the "Res. add/remove, (lb/ac)" cell.



Source: NRCS database

The above screen reflects a modification to the operation "Highly disturbed land\ add mulch" as reflected by the addition of "Mulching (Wood fiber + compost)" under the External Residue column. For a combination (wood/straw), this requires modification of the "Decomposition half life" to 100 days.

Assumptions:

- Rate of wood mulching application is 2000 lb/ac
- Standard Caltrans limitations and specifications apply
- Caltrans RUSLE2 considers a mixture of wood fiber and compost equivalent to Wood mulch, which adds material to the soil surface without disturbing the soil

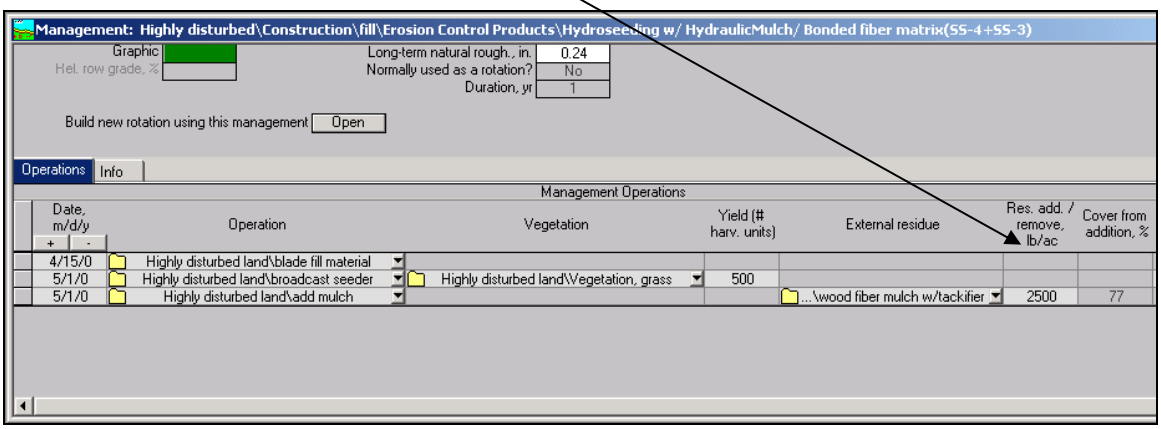
Hydroseeding (SS-4) + Hydraulic Mulch/Bonded Fiber Matrix (SS-3)

Management Practice Options (found under "Management" tab):

- "Highly Disturbed / Construction / Cut / Erosion Control Products / Hydroseeding (SS-4) w/ Hydraulic Mulch/Bonded fiber matrix (SS-3)"
- "Highly Disturbed / Construction / Fill / Erosion Control Products / Hydroseeding (SS-4) w/ Hydraulic Mulch/Bonded Fiber Matrix (SS-3)"

Design Customization: The designer can modify vegetation and yield rates based on site conditions. The crop-yielding rate is given in terms of "harvest units".

The designer can modify mulch application rates based on site conditions and the percentage of "Cover from addition" as shown in the below figure. The required mulch rate can be input into the "Res. add/remove, (lb/ac)" cell.



Assumptions:

- Rate of application of wood fiber mulch with tackifier is 2500 lb/ac
- Standard Caltrans limitations and specifications apply
- Vegetation yield is 500 lb/ac
- Caltrans RUSLE2 does not specify seed application rates but gives the most common crops
- Caltrans RUSLE2 considers wood fiber equivalent to Hydraulic Mulch/Bonded Fiber Matrix, which adds material to soil surface without disturbing soil

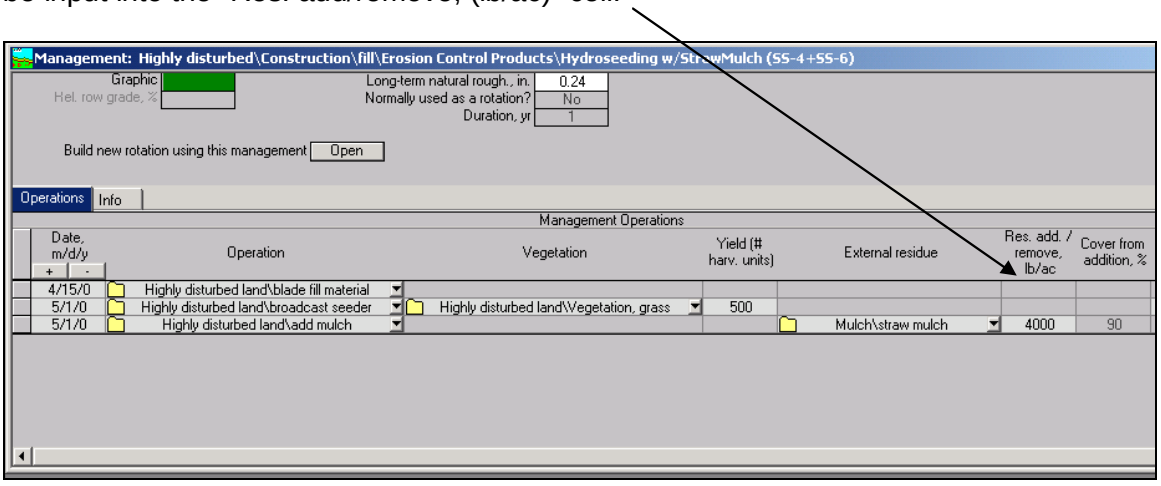
Hydroseeding (SS-4) + Straw Mulch (SS-6)

Management Practice Options (found under "Management" tab):

- "Highly Disturbed / Construction / cut / Erosion Control Products / Hydroseeding (SS-4) w/ Straw Mulch (SS-6)"
- "Highly Disturbed / Construction / fill / Erosion Control Products / Hydroseeding (SS-4) w/ Straw Mulch (SS-6)"

Design Customization: The designer can modify vegetation and yield rates based on site conditions. The crop-yielding rate is given in terms of "harvest units".

The designer can modify straw mulch application rates based on site conditions and the percentage of "Cover from addition" as shown in the below figure. The required mulch rate can be input into the "Res. add/remove, (lb/ac)" cell.



Assumptions:

- Rate of Straw mulch application is 4000 lb/ac
- Vegetation yield is 500 lb/ac
- Caltrans RUSLE2 does not specify seed application rates but gives the most common crops
- Caltrans RUSLE2 considers wheat, rice or barley equivalent to straw mulch, which adds material to the soil surface without disturbing the soil
- Standard Caltrans limitations and specifications apply

Hydroseeding (SS-4) + Geotextiles, Mats, Plastic Covers, and Erosion Control Blankets (SS-7)

Management Practice Options (found under "Management" tab):

- "Highly Disturbed / Construction / Cut / Erosion Control Product / seed (SS-4) w/ Coconut/Coir blanket (SS-7)"
- "Highly Disturbed / Construction / Cut / Erosion Control Product / seed (SS-4) w/ Straw blanket (SS-7)"
- "Highly Disturbed / Construction / Cut / Erosion Control Product / seed (SS-4) w/ Jute blanket (SS-7)"
- "Highly Disturbed / Construction / Cut / Erosion Control Product / seed (SS-4) w/ Combination blanket (SS-7)"
- "Highly Disturbed / Construction / Fill / Erosion Control Product / seed (SS-4) w/ Coconut/Coir blanket (SS-7)"
- "Highly Disturbed / Construction / Fill / Erosion Control Product / seed (SS-4) w/ Straw blanket (SS-7)"
- "Highly Disturbed / Construction / Fill / Erosion Control Product / seed (SS-4) w/ Jute blanket (SS-7)"
- "Highly Disturbed / Construction / Fill / Erosion Control Product / seed (SS-4) w/ Combination blanket (SS-7)"

Assumptions:

- Rate of blanket application is 2000 lb/ac
- Vegetation yield is 500 lb/ac
- Standard Caltrans limitations and specifications apply
- Caltrans RUSLE2 distinguishes between blankets based on the life of material (see table below)

Caltrans RUSLE2 Product	Life	Comparable Product
Jute Netting	365 days (12 months)	Curlex-II Fiber Net
Straw Blanket	180 days (6 months)	AEC Premier Straw Blanket
Coconut/Coir Blanket	900 days (30 months)	AEC Premier Coconut Blanket
Combination Blanket	1080 days (36 months)	Curlex- High Velocity Heavy duty

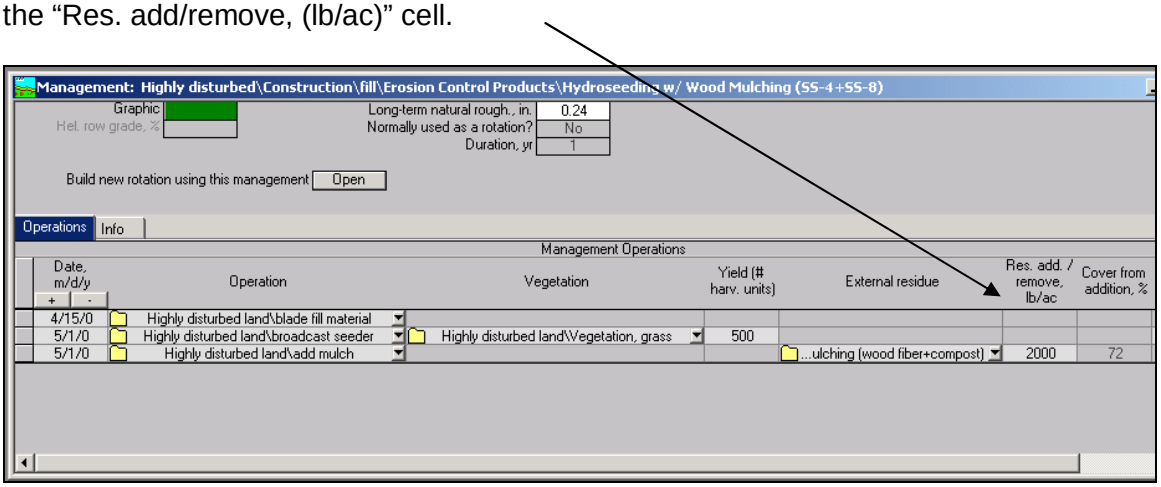
Hydroseeding (SS-4) + Wood Mulching (SS-8)

Management Practice Options (found under "Management" tab):

- "Highly Disturbed / Construction / cut / Erosion Control Products / Hydroseeding (SS-4) w/ Wood Mulching (SS-8)"
- "Highly Disturbed / Construction / fill / Erosion Control Products / Hydroseeding (SS-4) w/ Wood Straw Mulching (SS-8)"

Design Customization: The designer can modify vegetation and yield rates based on site conditions. The crop-yielding rate is given in terms of "harvest units".

The designer can modify straw mulch application rates based on site conditions and percentage of "Cover from addition" as shown in the below figure. The required mulch rate can be input into the "Res. add/remove, (lb/ac)" cell.



Assumptions:

- The rate of Wood mulch application is 2000 lb/ac
- Vegetation yield is 500 lb/ac
- Caltrans RUSLE2 considers the mixture of wood fiber and compost equivalent to Wood mulch, which adds material to the soil surface without disturbing the soil
- Standard Caltrans limitations and specifications apply

Compost

Management Practice Options (found under "Management" tab):

"Highly Disturbed / Construction / cut / Erosion Control Products / Compost"
"Highly Disturbed / Construction / fill / Erosion Control Products / Compost"

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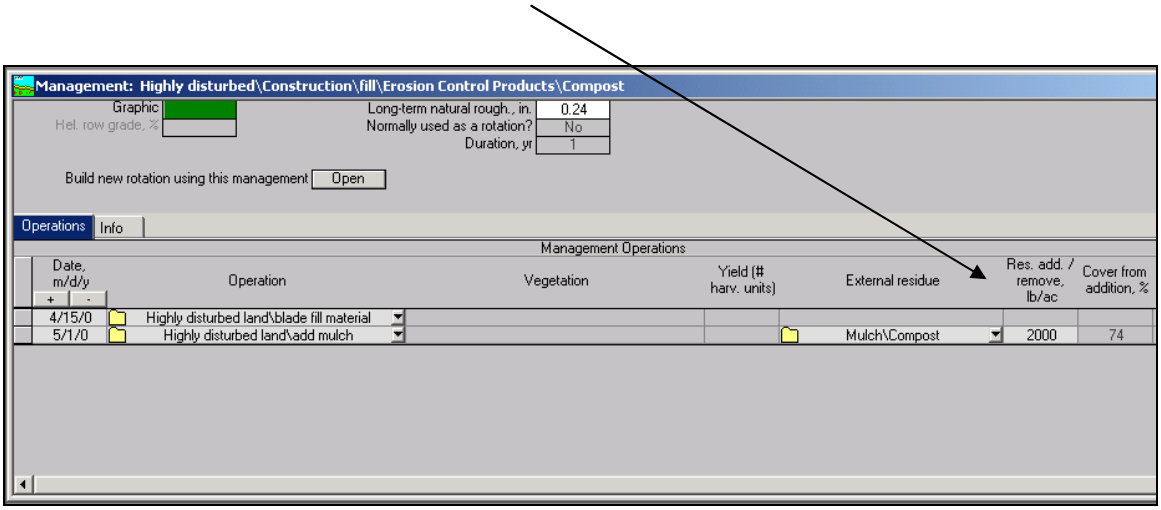
Design Customization: The designer can modify mulch application rates based on site conditions and the percentage of "Cover from addition" as shown in the below figure. The required mulch rate can be input into the "Res. add/remove, (lb/ac)" cell.



Source: NRCS database

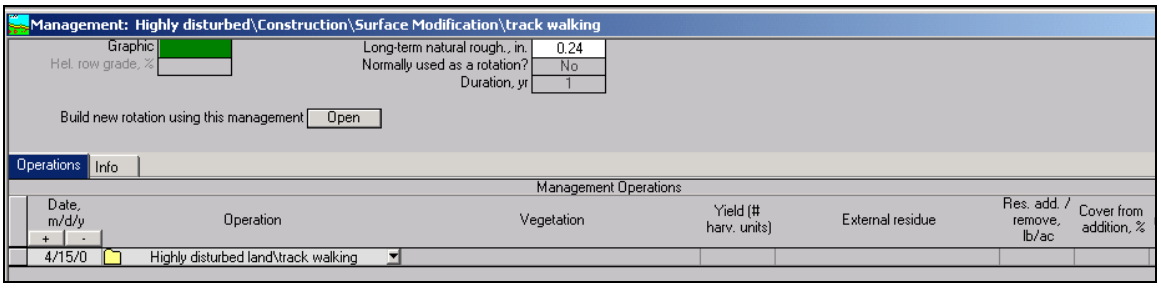
Assumptions:

- Rate of Compost application is 2000 lb/ac
- Caltrans RUSLE2 assumes that Compost adds material to soil surface without disturbing soil
- Standard Caltrans limitations and specifications apply

Track walking

Management Practice Option (found under "Management" tab):

- "Highly Disturbed / Construction / Surface Modification / Track Walking"



Source: ARS database

Assumptions:

- In Caltrans RUSLE2, the above BMP represents "6 inch ridges" left by a bulldozer running up and down a slope
- Standard Caltrans limitations and specifications apply

POST-CONSTRUCTION PHASE BMP DATASHEETS

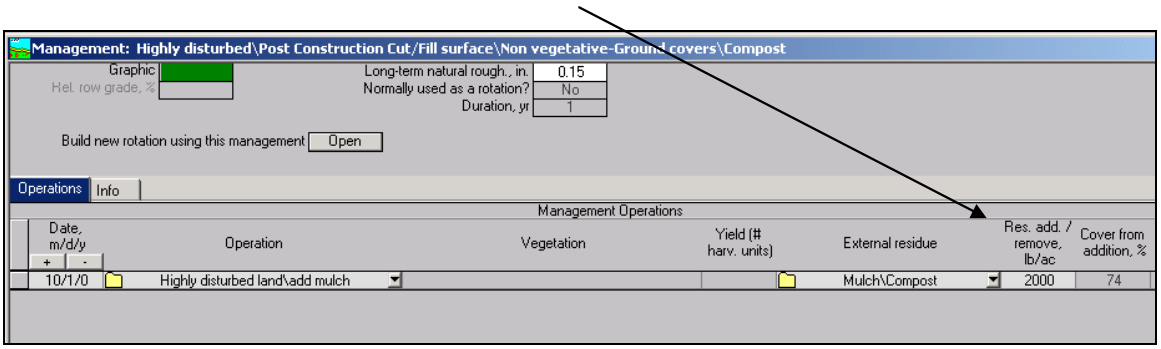
EROSION CONTROL

Compost

Management Practice Option (found under "Management" tab):

- "Highly Disturbed / Post Construction Cut/Fill surface / Non-Vegetative Groundcovers / Compost"

Design Customization: The designer can modify mulch application rates based on site conditions and the percentage of "Cover from addition" as shown in the below figure. The required mulch rate can be input into the "Res. add/remove, (lb/ac)" cell.



Source: NRCS database

Assumptions:

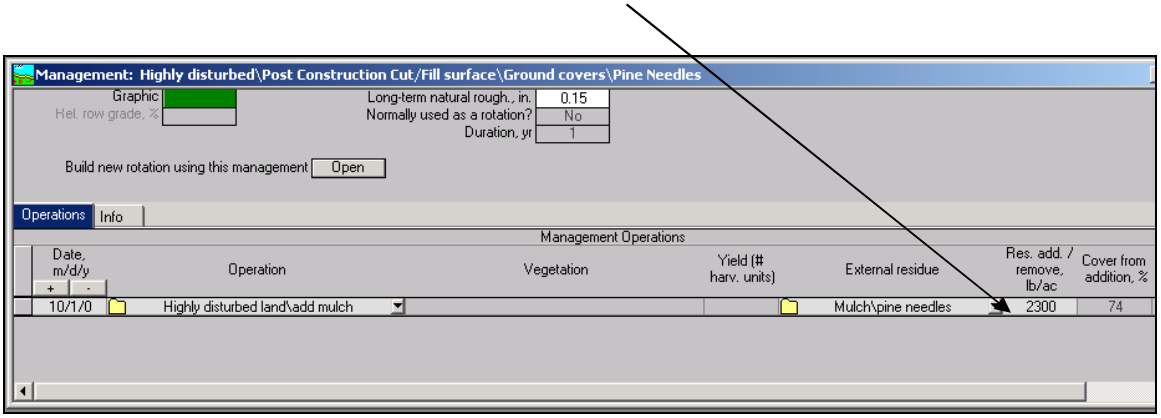
- The rate of compost application is 2000 lb/ac
- Compost is added to the soil surface without disturbing soil
- Standard Caltrans limitations and specifications apply

Pine Needles

Management Practice Option (found under "Management" tab):

- "Highly Disturbed / Post Construction Cut/Fill surface / Groundcovers / Pine Needles"

Design Customization: The designer can modify mulch application rates based on site conditions and the percentage of "cover from addition" as shown in the below figure. The required mulch rate can be input into the "Res. add/remove,(lb/ac)" cell.



Source: NRCS database

Assumptions:

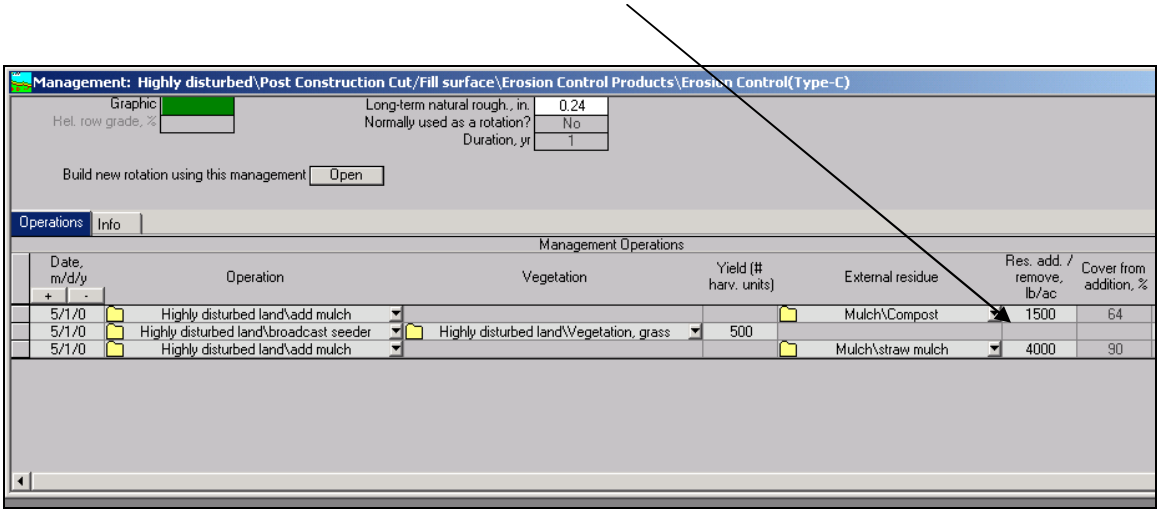
- Rate of Pine Needle application is 2300 lb/ac
- Pine Needles are added to the soil surface without disturbing the soil
- Standard Caltrans limitations and specifications apply

Caltrans Erosion Control (Type-C):

Management Practice Option (found under "Management" tab):

- "Highly Disturbed / Post Construction Cut/Fill surface\Erosion Control Products\Erosion control (Type-C)"

Design Customization: The designer can modify mulch application rates based on site conditions and the percentage of "cover from addition" as shown in the figure below. The required mulch rate can be input into the "Res. add/remove, (lb/ac)" cell.



Source: NRCS & ARS database

Assumptions:

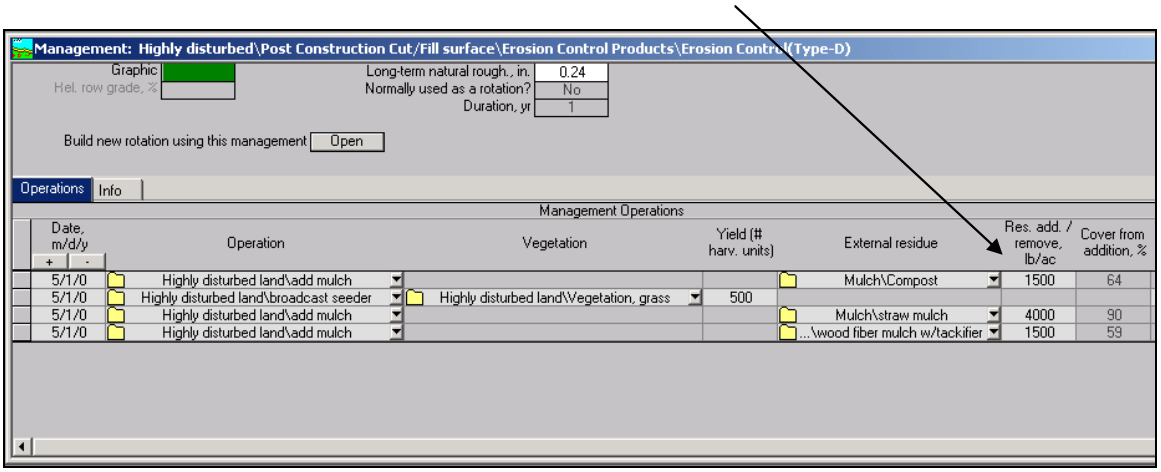
- The rate of compost application is 1500 lb/ac
- Vegetation yield is 500 lb/ac
- The rate of straw mulch application is 4000 lb/ac
- Compost & straw mulch are added to the soil surface without disturbing the soil
- Standard Caltrans limitations and specifications apply

Caltrans Erosion Control (Type-D):

Management Practice Option (found under "Management" tab):

- "Highly Disturbed / Post Construction Cut/Fill surface \Erosion Control Products\ Erosion control (Type-D)"

Design Customization: The designer can modify mulch application rates based on site conditions and the percentage of "Cover from addition" as shown in the below figure. The required mulch rate can be input into the "Res. add/remove, (lb/ac)" cell.



Source: NRCS & ARS database

Assumptions:

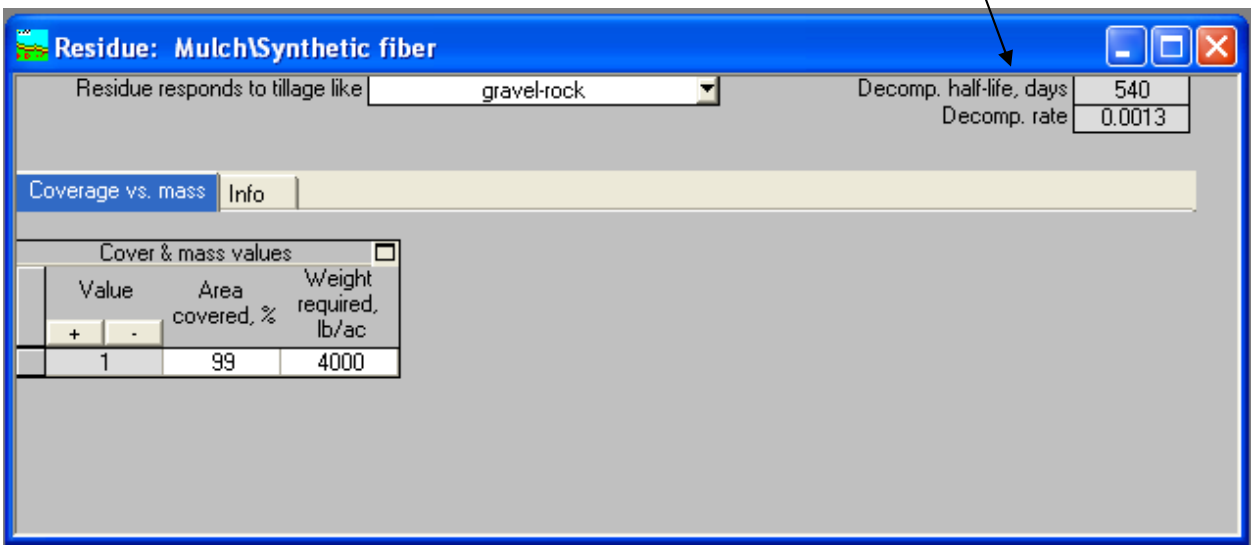
- Rate of Compost is 1500 lb/ac
- Vegetation yield is 500 lb/ac
- Straw mulch is 4000 lb/ac
- Hydraulic mulch is 1500 lb/ac
- Compost & straw mulch are added to the soil surface without disturbing the soil
- Standard Caltrans limitations and specifications apply

Non Biodegradable blanket - Permanent (SS-7)

Management Practice Options (found under "Management" tab):

- "Highly Disturbed / Post Construction Cut/Fill surface / Erosion Control Product / Non Biodegradable blanket-Permanent (SS-7)"

Design Customization: The designer can modify the life of the blanket by selecting the "Residue" tab, "Mulch" option, then selecting your mulch type. The life can be modified in the "Decomp. half-life, days" cell as shown in the below figure. The decomposition half-life is the length of time that the material takes to decompose by 50%.



Source: ARS database

Assumptions:

- Caltrans RUSLE2 distinguishes between blankets based on the life of material (see table below)

Caltrans RUSLE2 Product	Life	Comparable Product
Non-Biodegradable Blanket (SS-7)	1,080 days (36 months)	Tensar-TM3000

- Rate of blanket application is 2,000 lb/ac
- Standard Caltrans limitations and specifications apply

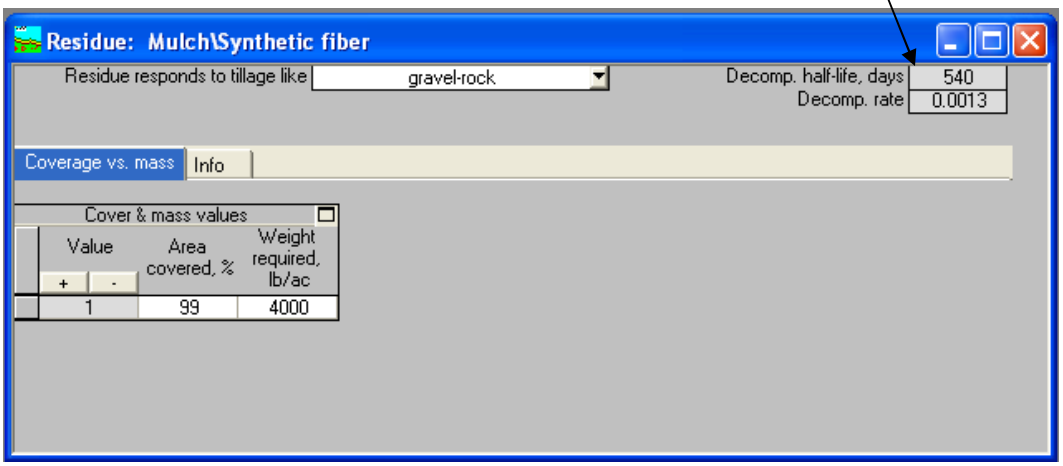
Non Biodegradable blanket - Permanent (SS-7) + Grasses and Forbs

Management Practice Options (found under "Management" tab):

- "Highly Disturbed / Post Construction Cut/Fill surface / Erosion Control Product / Non Biodegradable blanket-Permanent (SS-7) + Grasses and Forbs – Medium & Dense"

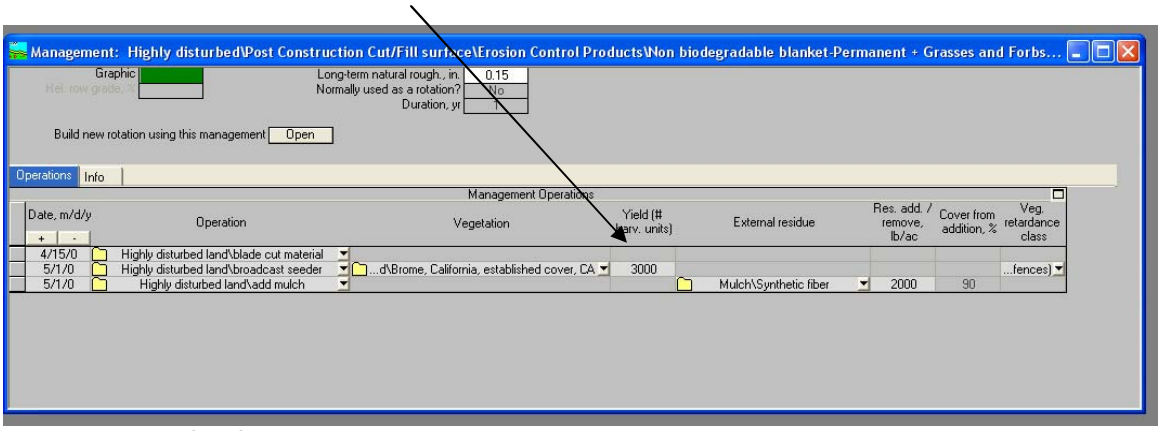
In Caltrans RUSLE2 there are 2 options for Non Biodegradable blanket - Permanent (SS-7) + Grasses and Forbs (post-construction): Medium (30 – 50% cover) and Dense (greater than 70% cover).

Design Customization: The designer can modify the life of the blanket by selecting the "Residue" tab, "Mulch" option, then selecting your mulch type. The life can be modified in the "Decomp. half-life, days" cell as shown in the below figure. The decomposition half-life is the length of time that the material takes to decompose by 50%.



Source: ARS database

The designer can modify the yield rates based on site conditions. The crop-yielding rate in terms of "harvest units" can be modified in the "yield" cell as shown in the below figure.



Source: ARS database

Assumptions:

- Caltrans RUSLE2 distinguishes between blankets based on the life of material (see table below)

Caltrans RUSLE2 Product	Life	Comparable Product
Non-Biodegradable Blanket (SS-7)	1,080 days (36 months)	Tensar-TM3000

- Rate of blanket application is 2,000 lb/ac
- Standard Caltrans limitations and specifications apply
- Grasses and Forbs in Caltrans RUSLE2 is comparable to “California Brome” in ARS-RUSLE2 (NRCS Database) perennial cover.
- The NRCS Database vegetation file begins in mid April and includes summer dormancy through day 200 and fall regrowth in mid October. Annual root sloughing is accounted for in May.
- Vegetation yield:

  Medium 3,000 lb/ac
  Dense 4,500 lb/ac

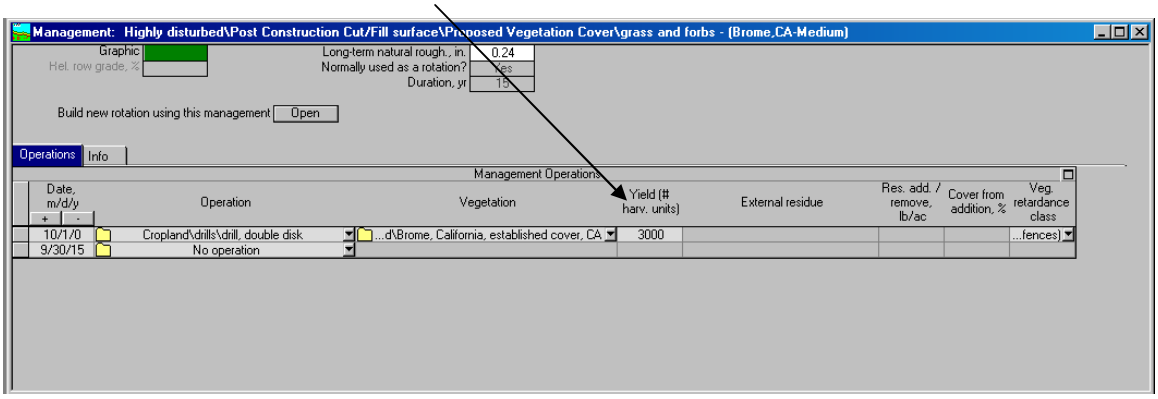
Vegetative Cover - Grasses and Forbs

Management Practice Options (found under "Management" tab):

- "Highly Disturbed / Post Construction Cut/Fill surface / Proposed Vegetation Cover/ Grasses and Forbs – Medium & Dense

In Caltrans RUSLE2 there are two options for Grasses and Forbs (post-construction): Medium (30 – 50% cover) and Dense (greater than 70% cover).

Design Customization: The designer can modify the yield rates based on site conditions. The crop-yielding rate in terms of "harvest units" can be modified in the "yield" cell as shown in the figure below.



Assumptions:

- Grasses and Forbs in Caltrans RUSLE2 is comparable to "California Brome" in ARS-RUSLE2 (NRCS Database) perennial cover.
- The NRCS Database file begins in mid-April and includes summer dormancy through day 200 and fall regrowth in mid-October. Annual root sloughing is accounted for in May.
- Standard Caltrans limitations and specifications apply.
- Vegetation yield:

Medium	3,000 lb/ac
Dense	4,500 lb/ac

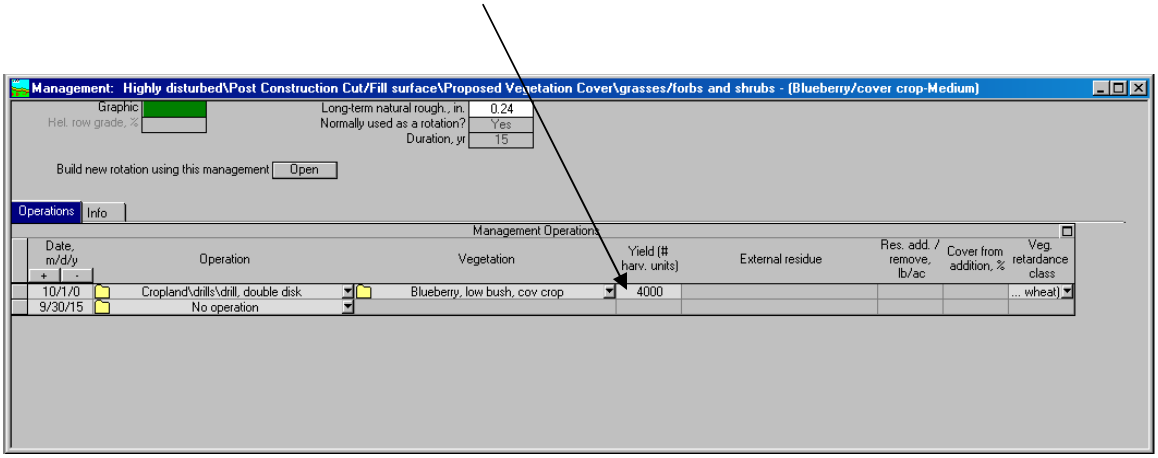
Vegetative Cover - Grasses/Forbs and Shrubs

Management Practice Options (found under "Management" tab):

- "Highly Disturbed / Post Construction Cut/Fill surface / Proposed Vegetation Cover/ Grasses/Forbs and Shrubs"

In Caltrans RUSLE2 there are two options for Grasses/Forbs and Shrubs (post-construction): Medium (30 – 50% cover) and Dense (greater than 70% cover).

Design Customization: The designer can modify the yield rates based on site conditions. The crop-yielding rate in terms of "harvest units" can be modified in the "yield" cell as shown in the figure below.



Assumptions:

- Grasses/Forbs and Shrubs in Caltrans RUSLE2 is comparable to "Blueberry, Low bush Cover crop" in ARS-RUSLE2 (NRCS Database).
- Based on low-growing blueberries with 9 ft. spacing and 1200 plants/ac. Blueberries were established with grass cover crop between bushes. Cover was mowed during the growing season, accounting for fluctuations in canopy. Type location: western Oregon.
- Standard Caltrans limitations and specifications apply.
- Vegetation yield:

Medium	4,000 lb/ac
Dense	6,000 lb/ac

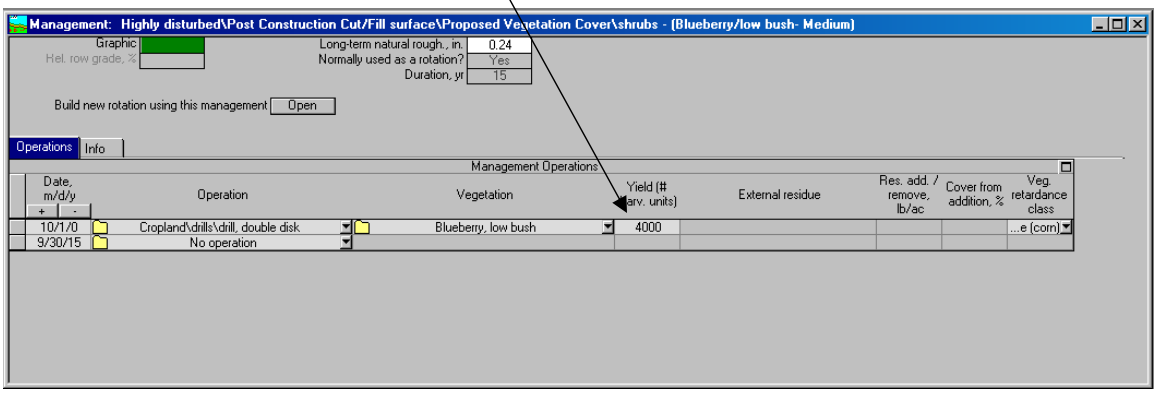
Vegetative Cover - Shrubs

Management Practice Options (found under "Management" tab):

- "Highly Disturbed / Post Construction Cut/Fill surface / Proposed Vegetation Cover / Shrubs"

In Caltrans RUSLE2 there are two options for Shrubs (post-construction): Medium (30 – 50% cover) and Dense (greater than 70% cover).

Design Customization: The designer can modify the yield rates based on site conditions. The crop-yielding rate in terms of "harvest units" can be modified in the "yield" cell as shown in the figure below.



Assumptions:

- Shrubs in Caltrans RUSLE2 is comparable to "Blueberry, low bush" in ARS-RUSLE2 (NRCS Database).
- Based on low-growing blueberries with 9 ft. spacing and 1200 plants/ac. The NRCS Database file begins on Jan. 1. Weeds in interrow killed either mechanically or chemically on day 105 (Mar 15), day 165 (May 15), and day 225 (July 15), which accounts for the variation in root mass.
- Standard Caltrans limitations and specifications apply.
- Vegetation yield:

Medium	4,000 lb/ac
Dense	6,000 lb/ac

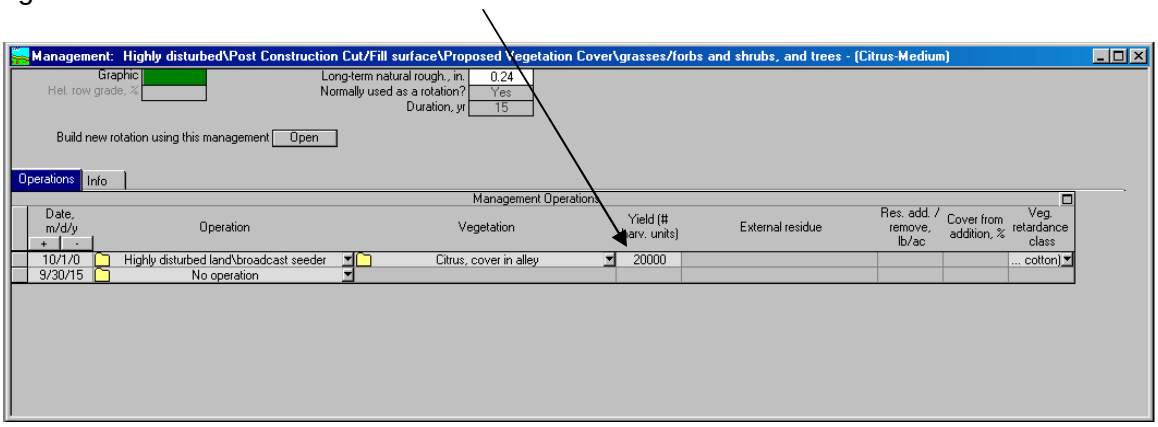
Vegetative Cover - Grasses/Forbs, Shrubs and Trees

Management Practice Options (found under "Management" tab):

- "Highly Disturbed / Post Construction Cut/Fill surface/ Proposed Vegetation Cover/ Grasses/Forbs, Shrubs and Trees"

In Caltrans RUSLE2 there are two options for Grasses/Forbs, Shrubs and Trees (post-construction): Medium (30 – 50% cover) and Dense (greater than 70% cover).

Design Customization: The designer can modify the yield rates based on site conditions. The crop-yielding rate in terms of "harvest units" can be modified in the "yield" cell as shown in the figure below.



Assumptions:

- Grasses/Forbs, Shrubs and Trees in Caltrans RUSLE2 is equivalent to "Citrus, Cover in alley" in ARS-RUSLE2 (NRCS Database).
- Based on citrus orchard; i.e. orange, grapefruit, lemon, and lime trees covering 75 to 85% of the area, grass cover in alleyways but not beneath trees, and residue at harvest is leaf drop.
- Standard Caltrans limitations and specifications apply.
- Vegetation yield:

Medium	20,000 lb/ac
Dense	30,000 lb/ac

SEDIMENT CONTROL

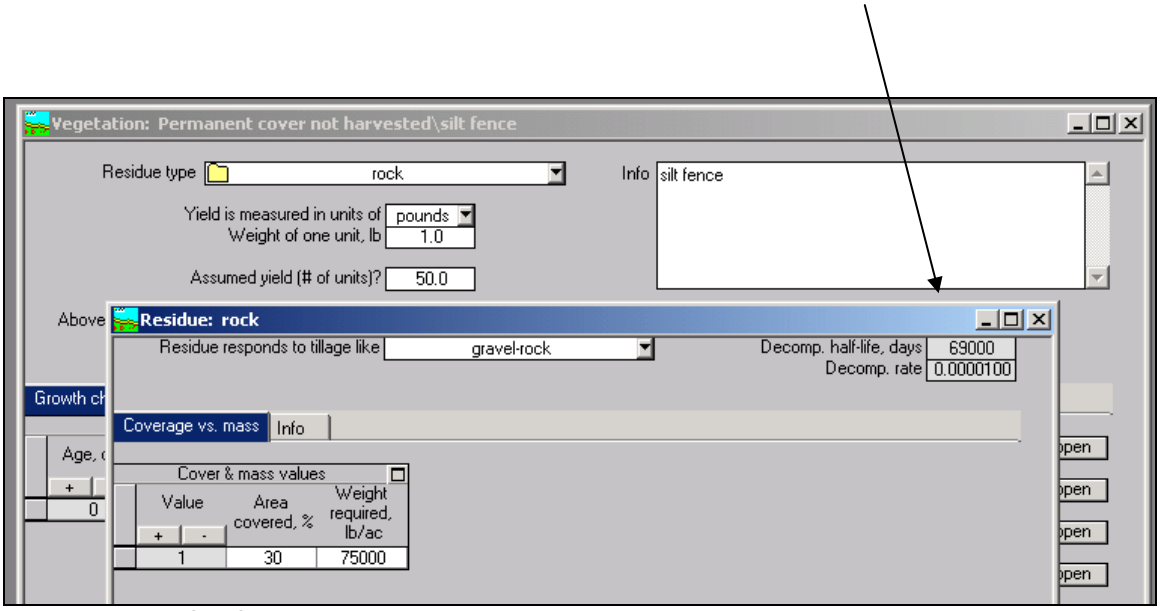
Silt Fence (SC-1)

Management Practice Options (found under "Management" tab):

- "Highly Disturbed / Strips/Barrier Managements / Silt Fence (SC-1)

Input: The width of silt fence can be entered in the "Horizontal segment length" cell of the "Management" tab in the profile.

Design Customization: Designer can modify the life of the fencing in the "Decomp. half life, days" cell under "Residue" as shown in the below figure. The decomposition half-life is the length of time it takes for the material to decompose 50 percent.



Source: ARS database

Operations: The operation column selection is "basic/general/ begin growth" and the vegetation column selection is "Highly disturbed land/silt fence full retardance".

Assumptions:

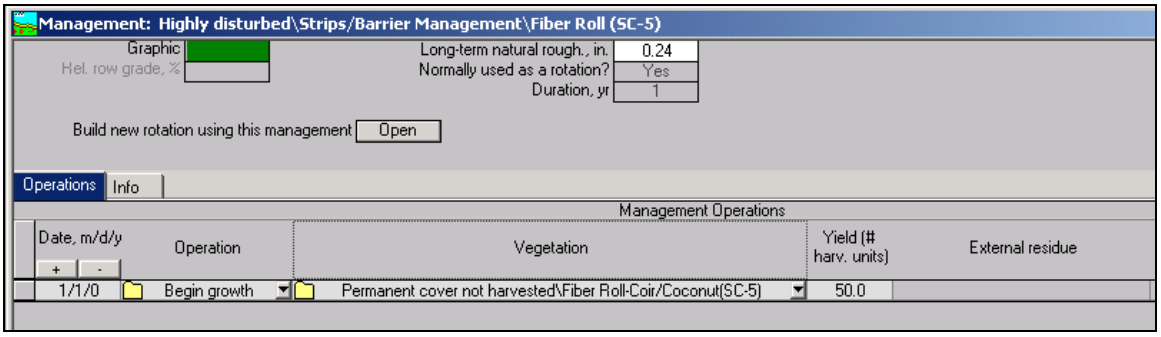
- Caltrans RUSLE2 does not account for a finite lifespan of silt fencing
- Silt fence in Caltrans RUSLE2 is based on a full retardance fabric fence
- Standard Caltrans limitations and specifications apply

Fiber Rolls (SC-5)

Management Practice Option (found under "Management" tab):

- "Highly Disturbed / Strips/Barrier Managements / Fiber Roll (SC-5)"

Input: The diameter of fiber roll can be entered into the "Horizontal segment length" cell of the "Management" tab in the profile. The diameter/width is based on design and usually ranges from 8 to 18 inches.



Operations: The selection in the Operation column is "Begin growth" and in the vegetation column is "Permanent cover not harvested\Fiber Roll-Coir/Coconut (SC-5)". In addition, the residue type is "roll material slow decay".

Assumptions:

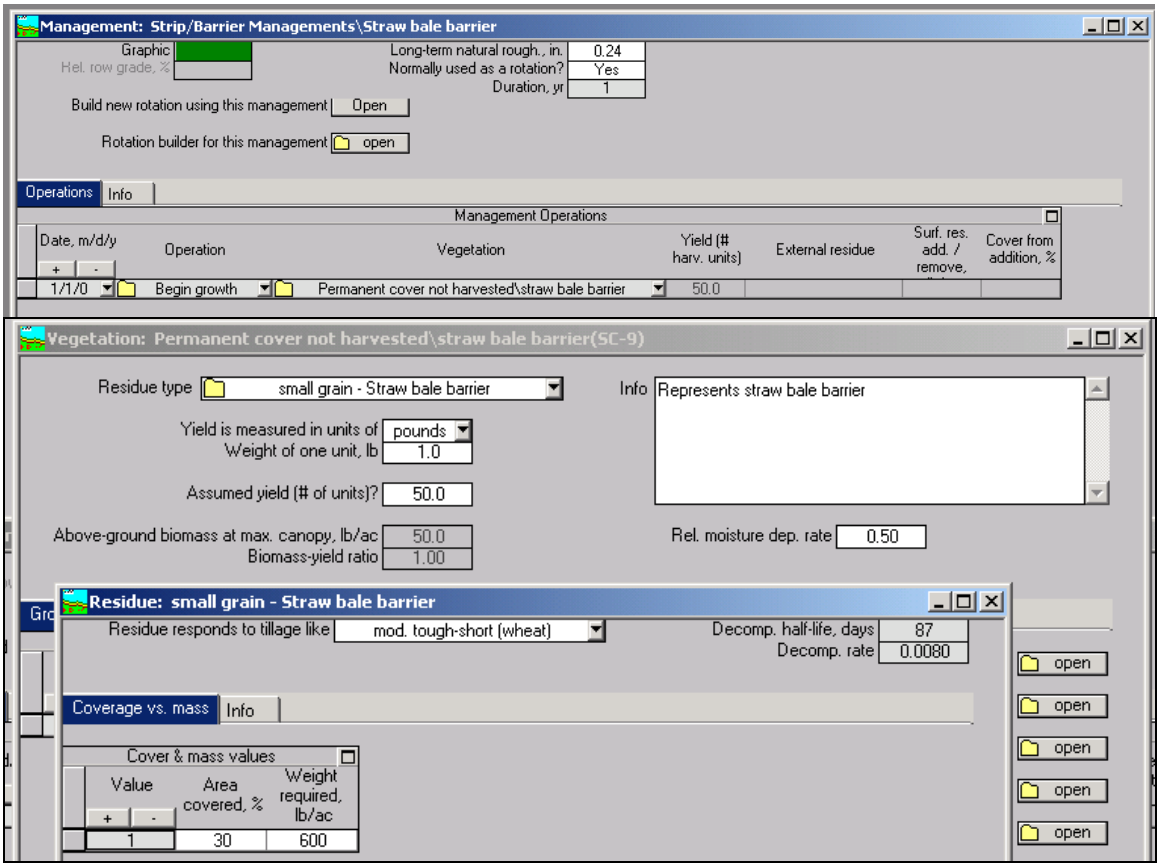
- Caltrans RUSLE2 differentiates between fiber roll options based on the decomposition life of material
- The fiber roll was derived from the straw bale barrier and erosion control blanket option in ARS-RUSLE2 (ARS Database)
- Standard Caltrans limitations and specifications apply

Straw Bale Barrier (SC-9)

Management Practice Option (found under "Management" tab):

- "Highly Disturbed / Strips/Barrier Managements / Straw bale barriers (SC-5)"

Input: The width of Straw bale barrier can be entered in the "Horizontal segment length" cell of the "Management" tab in the profile. The width varies based on design and the quantity of sediment to trap and usually ranges from 1 to 2 feet.



Source: NRCS database

Operations: The selection in the operations column is "Begin growth" and in the vegetation column is "Permanent cover not harvested\Straw bale barrier." In addition, the residue type is "small grain".

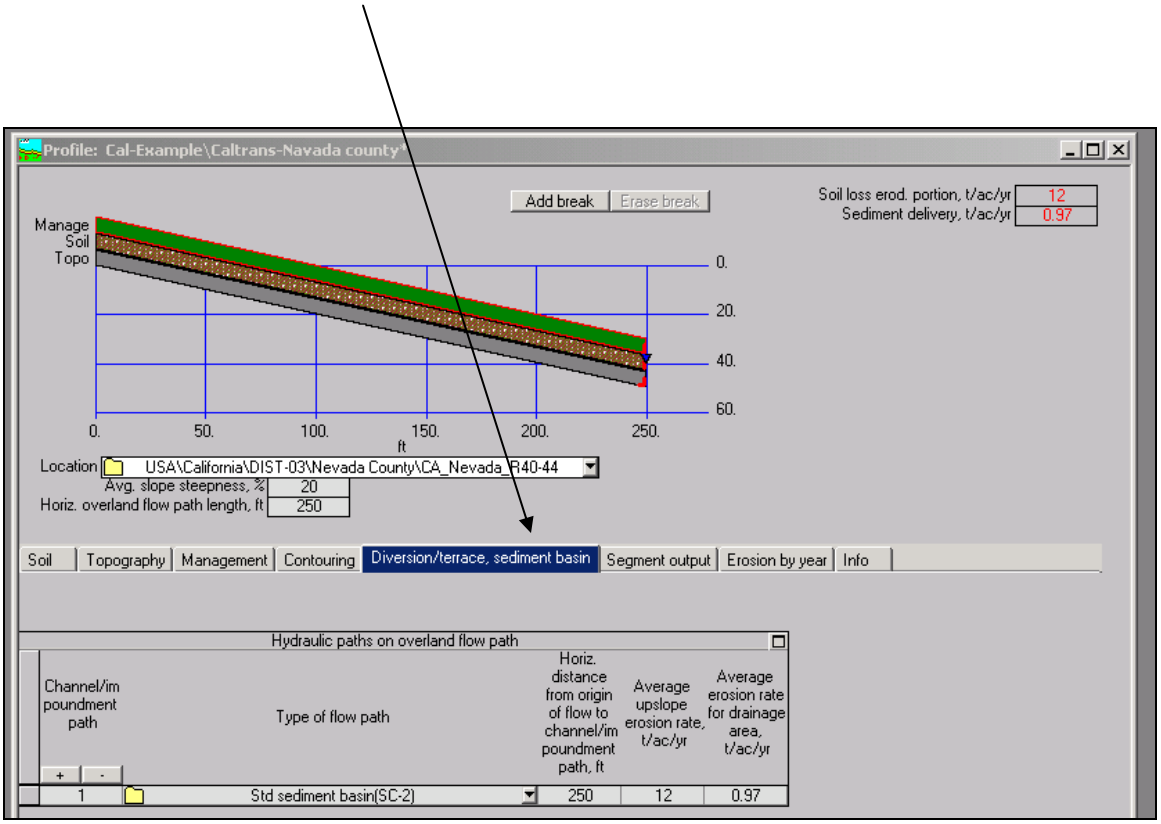
Assumptions:

- Standard Caltrans limitations and specifications apply

Sediment Basin (SC-2)

Found Under: "Diversion/terrace, Sediment Basin" Tab / Sediment basin (SC-2)

Input: The distance from origin of flow to sediment basin can be entered in the "Horizontal segment length" cell of the "Diversion/terrace, sediment basin" tab in the profile.



Source: ARS database

Assumptions:

- Caltrans RUSLE2 treats sediment basins as simple, small, well designed, well constructed, well maintained, optimally performing sediment basins typical of those used on construction sites

- Standard Caltrans limitations and specifications apply

OTHER BMPS

Typical Caltrans BMPs that could not be included in Caltrans RUSLE2 at this time and the reasoning behind each follows.

- Gravel Bag Berms: The RUSLE2 program is based on the assumption that all flow across a project site is sheet flow. According to Caltrans BMP Detail Sheet for SC-6, this BMP works best for concentrated flows, and is thus not appropriate for incorporation into Caltrans RUSLE2 as the program does not deal with concentrated flows.

- Turf Reinforcement Mats: This particular BMP is used for concentrated flows as well, and thus is not appropriate for use into the Caltrans RUSLE2 program.

- Crimped Straw: No comparable BMP or adequate scientific data on its erosion-reducing effects has been found to support incorporation of this BMP into the Caltrans RUSLE2 program at this time.

- Soil Additives and Tackifiers: No equivalent BMP or adequate scientific data on the erosion-reducing effects of soil additives and tackifiers has been found to support incorporation of this BMP into the Caltrans RUSLE2 program at this time.

- Compost/Mulch Berm: This particular BMP is used for concentrated flows and is thus not appropriate for use in the Caltrans RUSLE2 program.

- Grasses/Forbs & Trees (Minimal, Medium and Dense) and Shrubs & Trees: Both options were both found to be similar to Grasses/Forbs, Shrubs & Trees (soil loss output values were within ±10% of each other). Thus the three Vegetative Cover options were narrowed down to one option – Grasses/Forbs, Shrubs & Trees.

- Groundcover/Low-growing Shrubs: This option was not included as an option, as no comparable BMP or adequate scientific data on its erosion-reducing effects has been found to support incorporation of this BMP in the RUSLE2 program at this time. However, the “Blueberry, low bush-cover” crop is the closest equivalent to this management practice.

TRUCKEE BYPASS (Sample Project)

This appendix provides a sample run through of the EPP process and the Caltrans RUSLE2 model for the Truckee Bypass. The appendix is broken down in to a series of sections to outline the steps for analyzing a project using the EPP. The section is broken down as follows:

In addition to descriptions of the process, this example provides screenshots of the Caltrans RUSLE2 program screens. Below is a summary of the screenshots included in this appendix.

Section E-1 Site Summary Form

The data obtained from the various tasks performed as part of the Site Characterization (Section 3.0 of the EPP) for the Truckee Bypass Project was entered into the Site Summary Form shown below in Figure E-1. These values were then used as inputs into Caltrans RUSLE2 for the various project phases and BMP scenarios. Note, during site characterization, the data locations along 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, and/or cover.

CALTRANS EROSION PREDICTION PROCEDURE
RUSLE 2 - SITE SUMMARY

PROJECT NAME & NO : Truckee Bypass
CALTRANS DISTRICT : 3 **KP/PM:**
DETAILED LOCATION : On route 89 from Alder drive to Nevada county line on route 267
ESTIMATED PROJECT START DATE:
TYPE OF CONSTRUCTION: Four lane Highway
MAPPING/SURVEY SOURCE AND DATE:
GEOTECHNICAL REPORT SOURCE AND DATE:
REFERENCE SITE LOCATION:
REFERENCE SITE SUMMARY:

	3.3.1 Rainfall / Claimate			3.3.2: Soil Texture					3.3.1.1: Vegetation / Management		3.3.3: Topography		BMPs		Results		
Construction Phase	District #	County #	Rainfall Intensity	Texture	Clay	Silt	Sand	Hydrologic Class	Vegetation Classification	% RockCover (Veg+Canopy+ Rock)	Flow Length (%)	Steepness / (Slope)	Erosion Control	Sediment Control	Soil Loss	Sediment Delivery	Notes
Pre-Construction	3	Nevada	42"	Sandy Loam	30	6	64	moderate - Low runoff	Grass& Forbs - Medium	20%	50'	50%			5.6	5.6	
Construction	3	Nevada	42"	Sandy Clay Loam	27	14	59	moderate - high runoff		0	50'	50%	Hydraulic Mulch (SS-3)	Silt Fence (SC-1)	7.7	1.1	
Post-Construction	3	Nevada	42"	Sandy Clay Loam	27	14	59	moderate - high runoff	Grass&Forbs - Medium	0	50'	50%	Hydroseeding + Synthetic Fiber Blanket (SS-4+SS-7)	Silt Fence (SC-1)	5.1	1.0	

Section E-2 Caltrans RUSLE2 Program Initiation

The standard RUSLE2 program was modified by Caltrans for use on construction sites with highly disturbed soils, such as are typically found on roadway construction projects. The following steps demonstrate the inputs for the Caltrans RUSLE2 model for the Truckee Bypass project in Nevada County. The user should understand the basic parameters of the program, which are represented by the following mathematical equation:

A = R K LS C P
Where A = predicted soil loss
R = rainfall erosivity
K = soil erodibility
L = slope length
S = slope percent
C = cover
P = practice

RUSLE2 Interface: The Caltrans RUSLE2 program was started by clicking on the Caltrans RUSLE2 icon on the computer desktop or by selecting the Caltrans RUSLE2 command in the program list. The Caltrans RUSLE2 screenshot is shown in Figure E-1. Note that this version is modified for Caltrans use and the program name and version number are at the top of the screen.

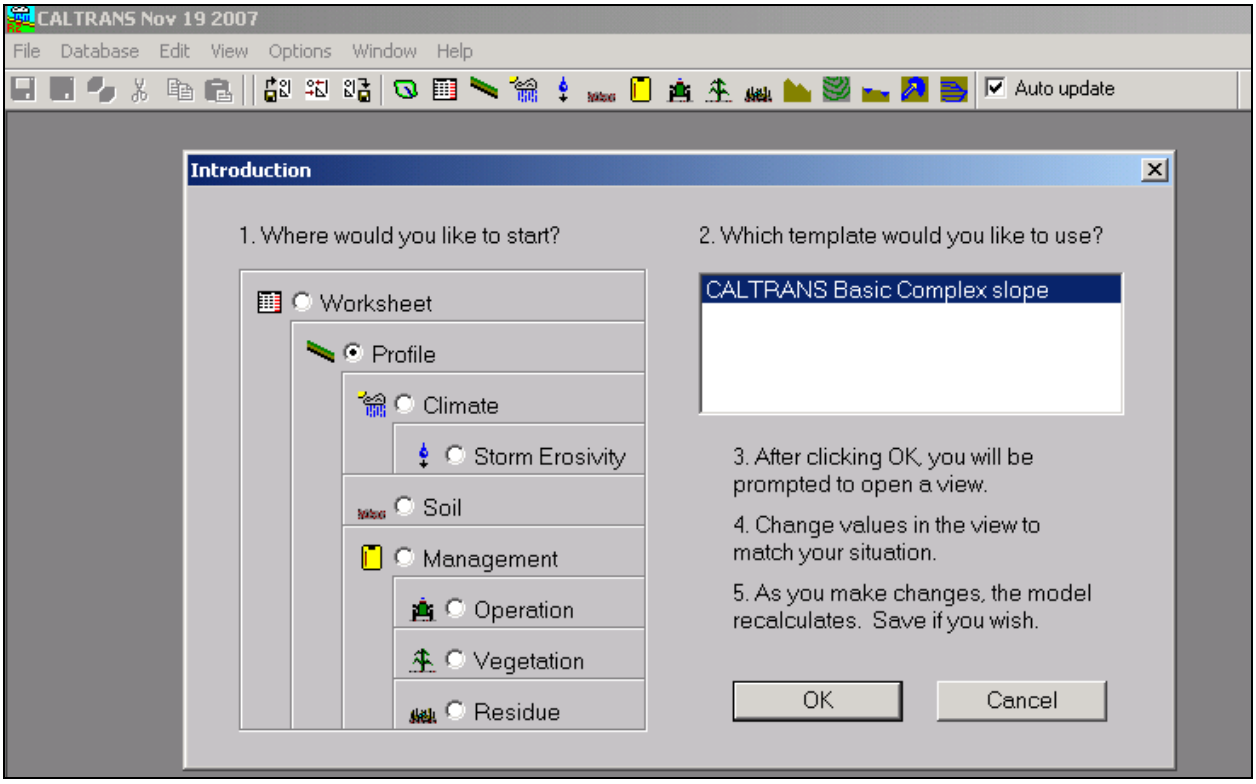


Figure E-1: Caltrans RUSLE2

Caltrans RUSLE2 has two working interfaces, which are the “worksheet” and “profile.” The user will be in the default sheet when the program is opened and the user will be able to replace various values and save the work as a new project file. Note that you cannot start with a blank sheet in Caltrans RUSLE2.

The worksheet is the collection of profiles on one screen and it is useful to compare one segment with different management options. The profile represents multiple segments on one sheet, which is more representative of roadway projects that include both embankments and the road.

User template: The Caltrans Basic Complex slope is suitable for simple uniform slopes and complex slopes, as shown in Figure E-2.

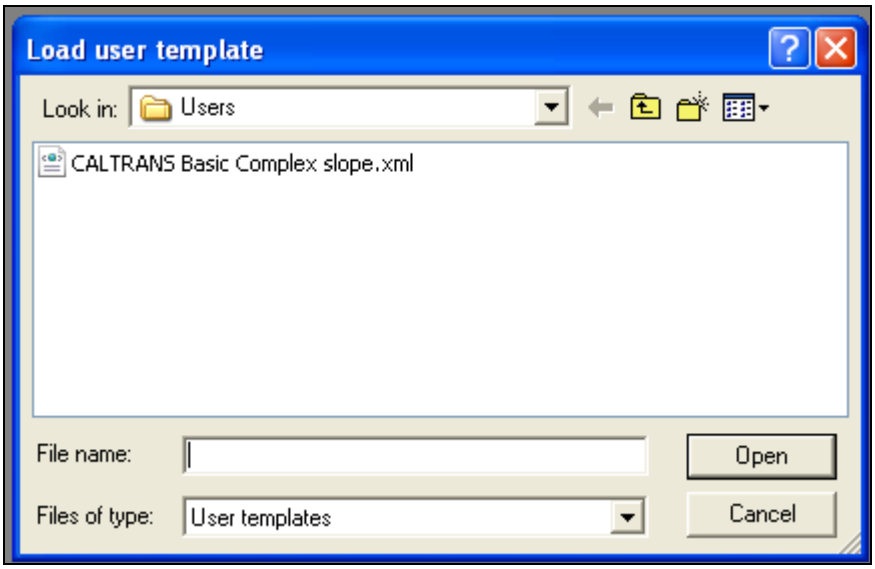


Figure E-2: User Template

The complex slope templates can be applied to mild convex slopes because erosion rates at the end of a convex slope can be much higher than the average erosion rate for the entire slope.

After the template selection is made, Caltrans RUSLE2 will ask the user to select a profile that has been previously generated or to choose a default profile as shown in Figure E-3.

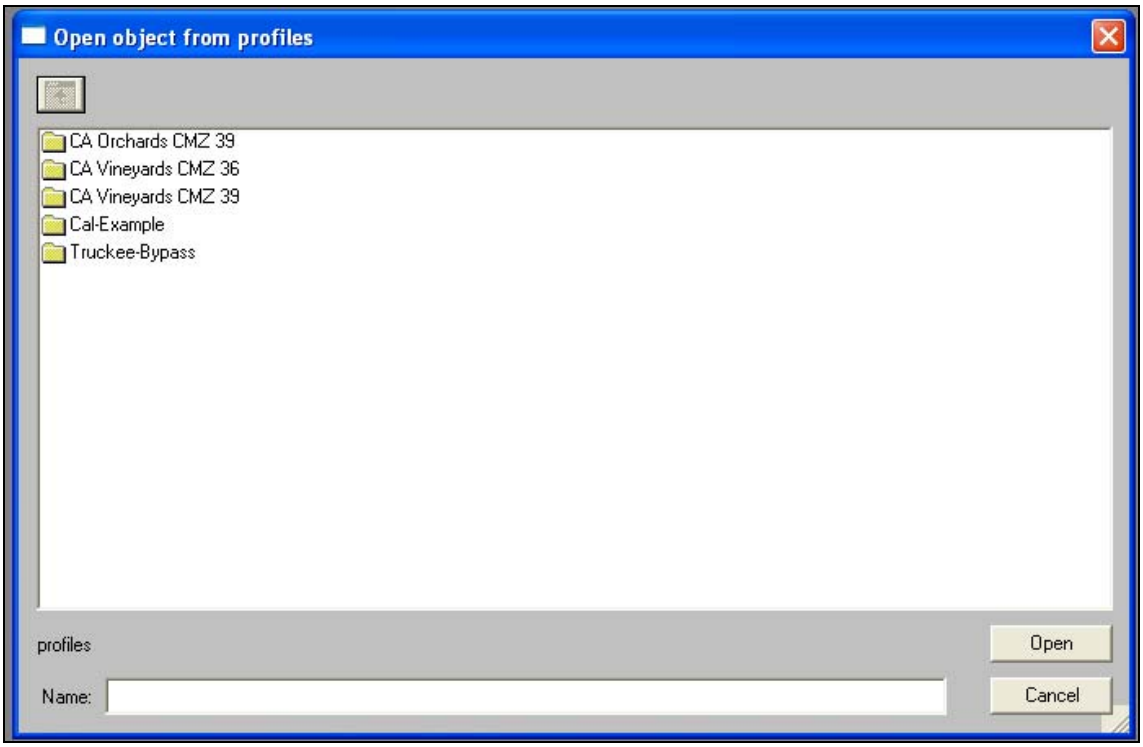


Figure E-3: Available Profiles

A new profile run can be created or a previously created profile run can be selected and saved under the project name or ID and phase such as pre / post-construction, etc.

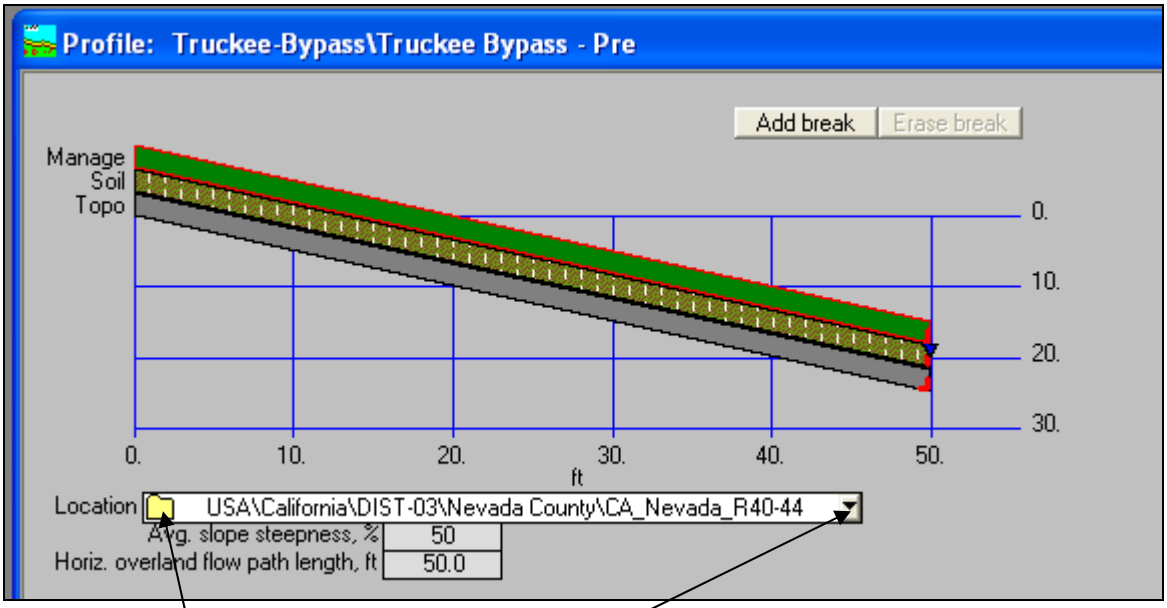


Figure E-4: Options in Profile Template

In each option there is a ▼ (black triangle) on the right side which indicates a menu of choices. Clicking on a choice inserts that selection as shown in Figure E-4.

A yellow folder on the left side indicates that the selection includes various data sets or type selections required by Caltrans RUSLE2. It is advisable to review the data in the yellow folder and make sure that it represents the specific project site conditions. These data values can be altered to represent specific individual project site situations and can be saved as a different name to the Caltrans RUSLE2 database for each project.

There are three phases for the Truckee Bypass project site: pre-construction, construction, and post-construction. All three phases are explained in the subsequent sample project sections with a brief description of appropriate inputs and corresponding screenshots.

Section E-3 Pre-Construction

The pre-construction data run is the baseline for the design and analysis of the Best Management Practices (BMPs) for the construction and post-construction phases of the project. The soil erosion rate is based on existing, pre-construction conditions on the project site. The primary pre-construction data required for the Caltrans RUSLE2 are rainfall intensity, soil texture, and vegetation. The steps for the pre-construction run are as follows:

Step 1: Setup the pre-construction Caltrans RUSLE2 analysis for program input variables: climate, soil, and topography.

Step 2: Caltrans RUSLE2 Run 1 with existing vegetation and no management practices. Resulting erosion rate is set as the MAER for post-construction comparisons for projects that do not discharge to ESAs.

Step 3: When the user is complete with the Caltrans RUSLE2 analysis (Step 2), print the output results and move to construction analysis.

STEP 1.1 – SET CLIMATE

Rainfall Erosivity, R: The product of storm energy times the maximum 30-minute rainfall intensity. The project site rainfall intensity can be based on a local isohyetal map. The climate details are based on monthly temperature, precipitation and erosivity factors and a 10-year storm, 24-hour rainfall period. Caltrans RUSLE2 utilizes average temperature and monthly precipitation in calculating the R factor.

The rainfall intensity corresponding to the sample project site location was selected by calling the local Natural Resources Conservation Service (NRCS) center. The NRCS-United States Department of Agriculture (USDA) provides details on rainfall intensity for any location in California. This rainfall intensity was then selected from the Caltrans RUSLE2 database by choosing Caltrans District 3, Nevada County and the intensity range (40 to 44 inches of rain annually) from the drop down menu. For this rainfall intensity, the erosivity values ranged from 0.27 in the month of July to 19.0 in the month of January, with the lowest values between April and October. The screenshot for the climate rainfall range selected for this sample site, including the graph for erosivity factor versus corresponding months, is shown in Figure E-5.

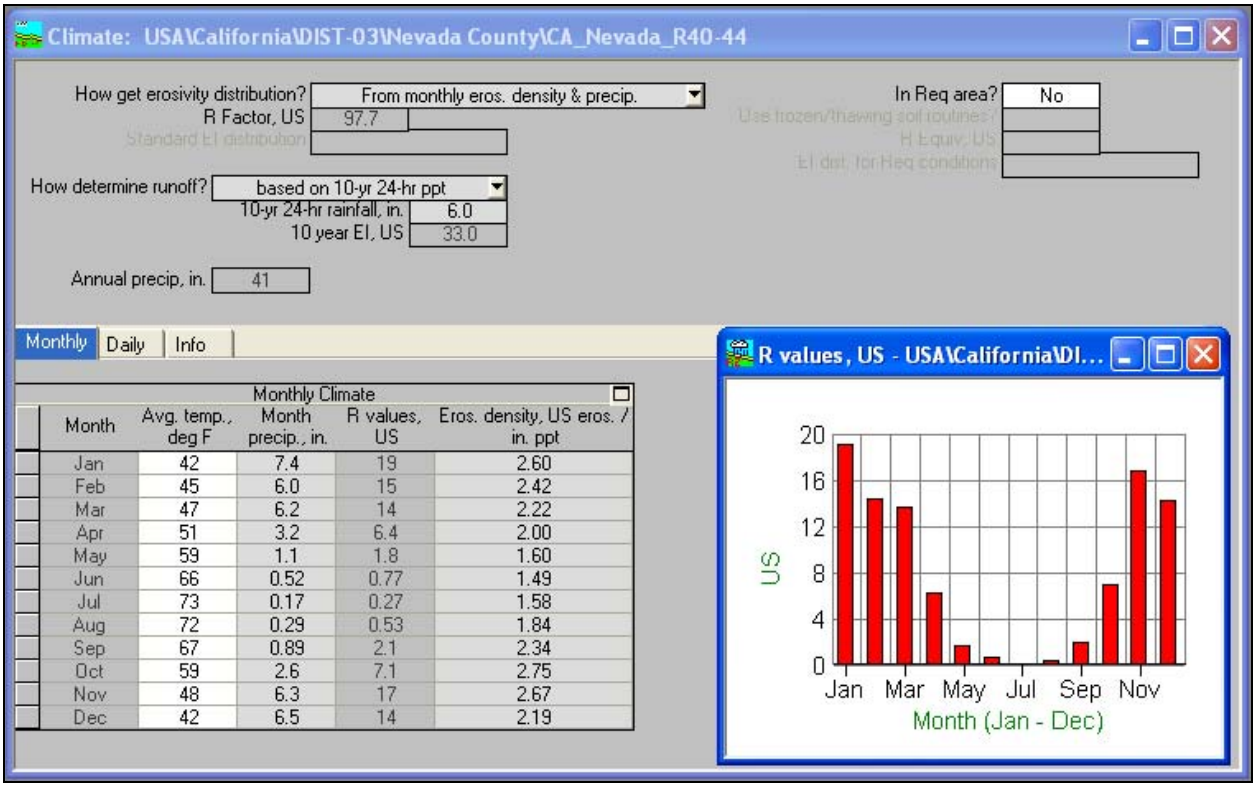


Figure E-5: Truckee Bypass - Pre-Construction Rainfall Data and Graphic Representation of Erosivity "R" vs. Duration (Months)

STEP 1.2 – CHOOSE SOIL TYPE

Soil Erodibility, K: Soil texture is a significant variable affecting soil loss. Soil structure, profile, permeability, and organic matter content influence inherent soil erodibility.

The appropriate soil type for the project site can be selected from the menu of choices. Open the yellow folder to compare clay, silt, and sand contents. While the United States Department of Agriculture (USDA) Soil Survey Classification can be used, the preferred method is to enter the project specific clay, silt, and sand values for the project site. The program will then calculate the erodibility of that soil.

For the Truckee Bypass project, the soil was obtained from a soil sample laboratory analysis and was defined as "Sandy Clay Loam" with 30% clay, 6% silt, and 64% sand and 20% rock cover based on the "Soil Gradation analysis". The project site had 35% to 40% vegetative cover, 10% to 15% canopy cover, and slope covered with organic materials. The erodibility, K is 0.12, as shown in Figure E-6.

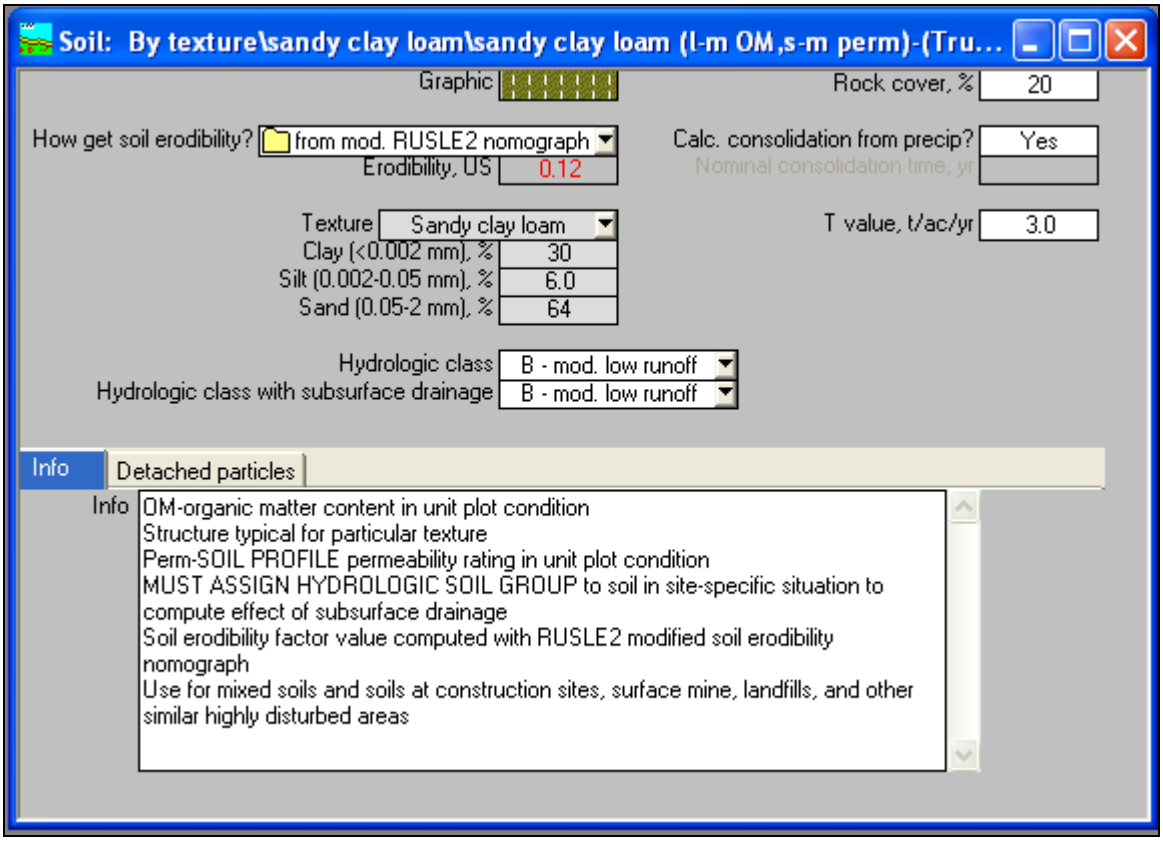


Figure E-6: Truckee Bypass - Pre-Construction Soil Texture & Rock Cover

STEP 1.3 – SET SLOPE TOPOGRAPHY

Slope Length and Steepness, LS: Erosion rates are sensitive to flow path length and steepness. The horizontal flow path length is measured from where the runoff originates in the project area to where it exits the site or enters a concentrated flow path. The flow path should be measured perpendicular to the contours. Because the standard United States Geological Survey (USGS) quadrangle topographic maps are unlikely to provide the desired level of accuracy, measuring the length and steepness of the slope to the nearest foot is typically sufficient for this model. The maximum slope length that can be used as an input for Caltrans RUSLE2 is 1,000 feet.

For this project site, the horizontal overland flow path length was 50 feet and the average slope steepness was 50%, as shown in Figure E-7.

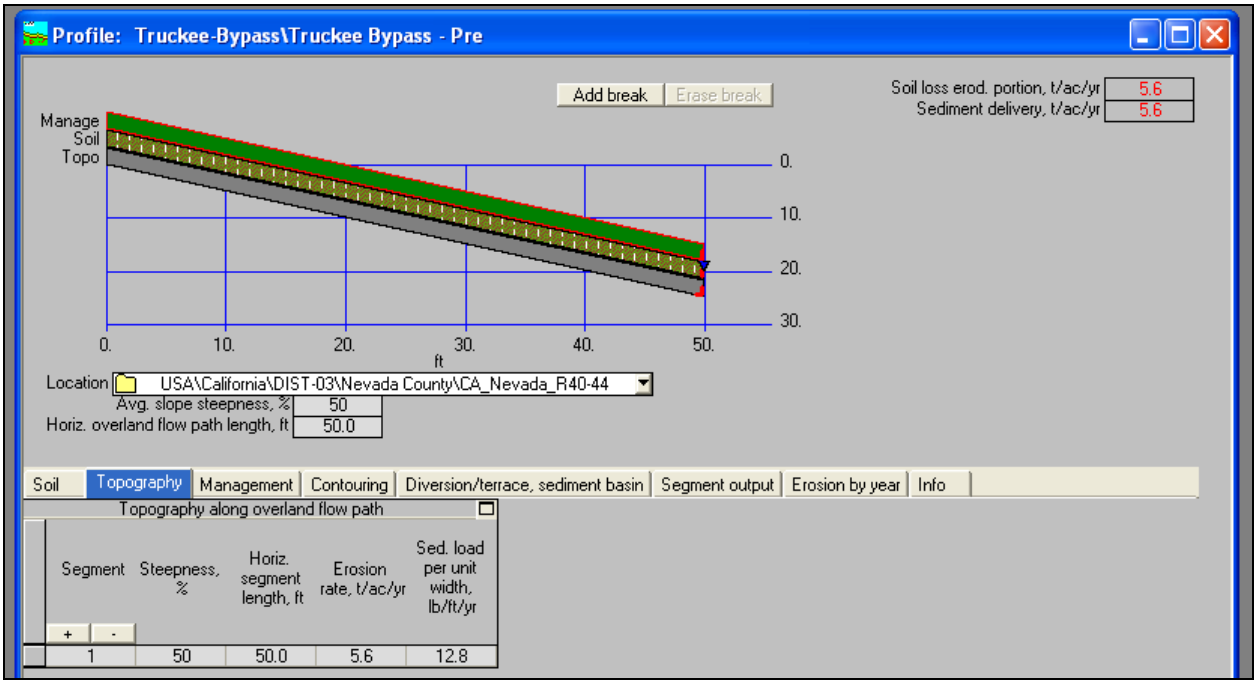


Figure E-7: Truckee Bypass - Pre-Construction Topography

STEP 2 – CALTRANS RUSLE2 ANALYSIS RUN 1

Management: The estimated cover for the pre-construction (site in native vegetation) state of a site should be determined during the site characterization process and recorded on the Site Summary Form. Based on the site visit, it was found that the project site contained grass/plants and a portion covered by shrubs and trees. The Caltrans RUSLE2 database has a vegetative cover option of "Grasses Forbs/Shrubs." This is representative of the existing native cover on the project site.

For the pre-construction phase, the sample project site had 35%to 40% vegetative cover, 10% to 15% canopy cover, slope covered with organic material. The screen shot for the pre-construction management, "Undisturbed (Existing) Vegetative Cover/ Natural condition/ Undisturbed/ Grasses and Forbs- Medium", is shown in Figure E-8.

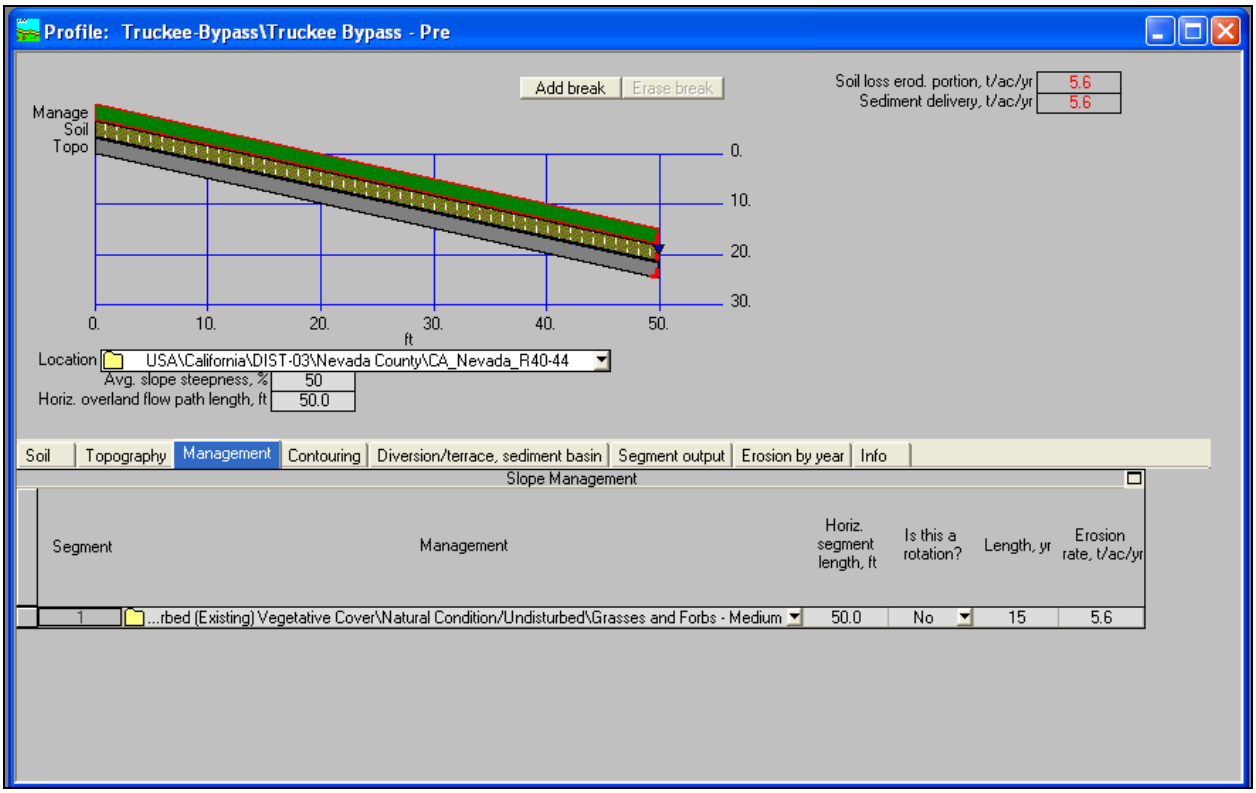


Figure E-8: Truckee Bypass - Base Management (Cover)

Contouring: For the pre-construction phase, the contouring was set to Up and Down slope. This represents the furrowing that occurs along the flow path in undisturbed areas. The screen shot for the contouring is shown in Figure E-9.

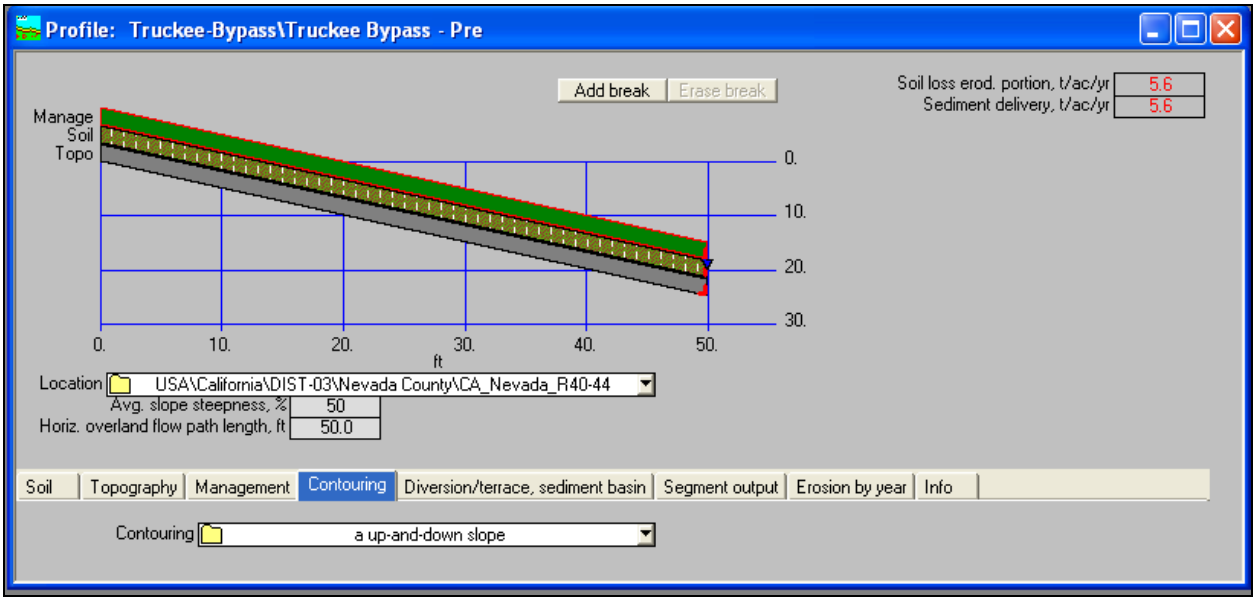


Figure E-9: Truckee Bypass - Contouring

STEP 3 – RESULTS

For this project site, the model results indicate that the erosion rate is 5.6 tons/acre/year (t/ac/yr) based on the native pre-construction phase of the site, as shown in Figure E-10. This erosion rate is the MAER that will drive the design of BMPs for the post-construction phase of the sample project.

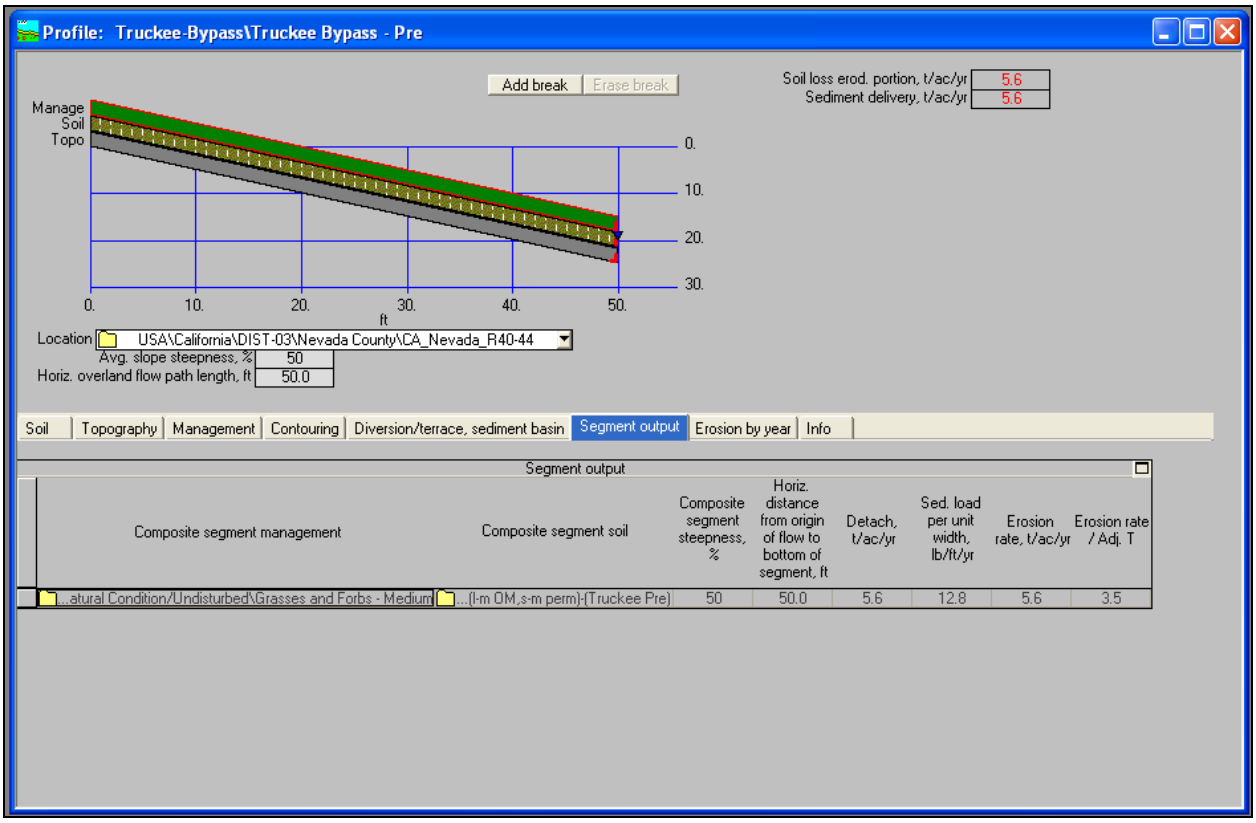


Figure E-10: Truckee Bypass - Pre-Construction Results

OUTPUT FILES

The output files for the pre-construction analysis are shown below.

RUSLE2 Profile Erosion Calculation Record

Info: Profile: **Pre Construction Phase**
Project Location : Truckee Bypass - Nevada county
Rainfall Intensity: 40"- 44 "
Soil: Sandy Clay Loam

File: profiles\Truckee-Bypass\Truckee Bypass - Pre

Inputs:
Location: DIST-03\Nevada County\CA_Nevada_R40-44
Soil: sandy clay loam (l-m OM,s-m perm)-(Truckee Pre)
Horiz. overland flow path length: 50.0 ft
Avg. slope steepness: 50 %

Management	*Vegetation*	*Yield units*	*Yield (# of units)*
Undisturbed (Existing) Vegetative Cover\Natural Condition/Undisturbed\Grasses and Forbs - Medium	Tropical-Subtropical\Volunteer vegetation, grass	lbs	10000

Contouring: a up-and-down slope
Strips/barriers: (none)
Diversion/terrace, sediment basin: (none)
Subsurface drainage: (none)
Adjust res. burial level: Normal res. burial

Outputs:
Soil loss erod. portion: 5.6 t/ac/yr
Detachment on slope: 5.6 t/ac/yr
Soil loss for cons. plan: 5.6 t/ac/yr
Sediment delivery: 5.6 t/ac/yr
Crit. slope length:
Surf. cover after planting: 0 %

Date	*Operation*	*Vegetation*	*Surf. res. cov. after op, %*
10/1/0	Cropland\drills\drill, double disk	Tropical-Subtropical\Volunteer vegetation, grass	0
10/1/14	No operation		0

Section E-4 Construction

The steps for the construction phase runs are as follows:

Step 1: Setup the construction Caltrans RUSLE2 analysis for program input variables that do not change with management practices: climate (Step 1.1), soil (Step 1.2), and topography (Step 1.3).

Step 2: Caltrans RUSLE2 Run 1 with bare soil with no management practices. Resulting erosion rate is used to determine the MAER for construction comparisons in non-ESAs (MAER = Erosion Rate * 0.02).

Step 3: Caltrans RUSLE2 Run 2 with minimal management practices: silt fence at toe of slope + hydraulic mulch. Compare resulting erosion rate to MAER from Step 2. IF result is still greater than the MAER, move to Step 4. IF result is less than the MAER, post-construction runs are complete. IF result is less than the MAER, construction runs are complete, move on to Step 5.

Step 4: Caltrans RUSLE2 Run 3 with revised management measures: silt fence at toe of slope, hydraulic mulch, and fiber rolls every 20 ft along the slope. Compare resulting erosion rate to MAER from Step 1, IF result is still greater than the MAER, repeat runs with revised management practices until the result is less than the MAER. IF result is less than the MAER, construction runs are complete, move to Step 5.

Step 5: When the user is complete with the construction Caltrans RUSLE2 analysis (Step 4), print the output results and move to post-construction analysis (Section E-5).

NOTE: Highly disturbed soils that are significantly different than soils in the native, undisturbed state; therefore, accurate estimation of the soil characteristics in the construction phase is essential for soil loss modeling.

STEP 1.1 – SET CLIMATE

Rainfall Erosivity, R: The rainfall intensity and erosivity factors are the same for the construction phase as for the pre-construction soil loss model run, as shown in Figure E-11.

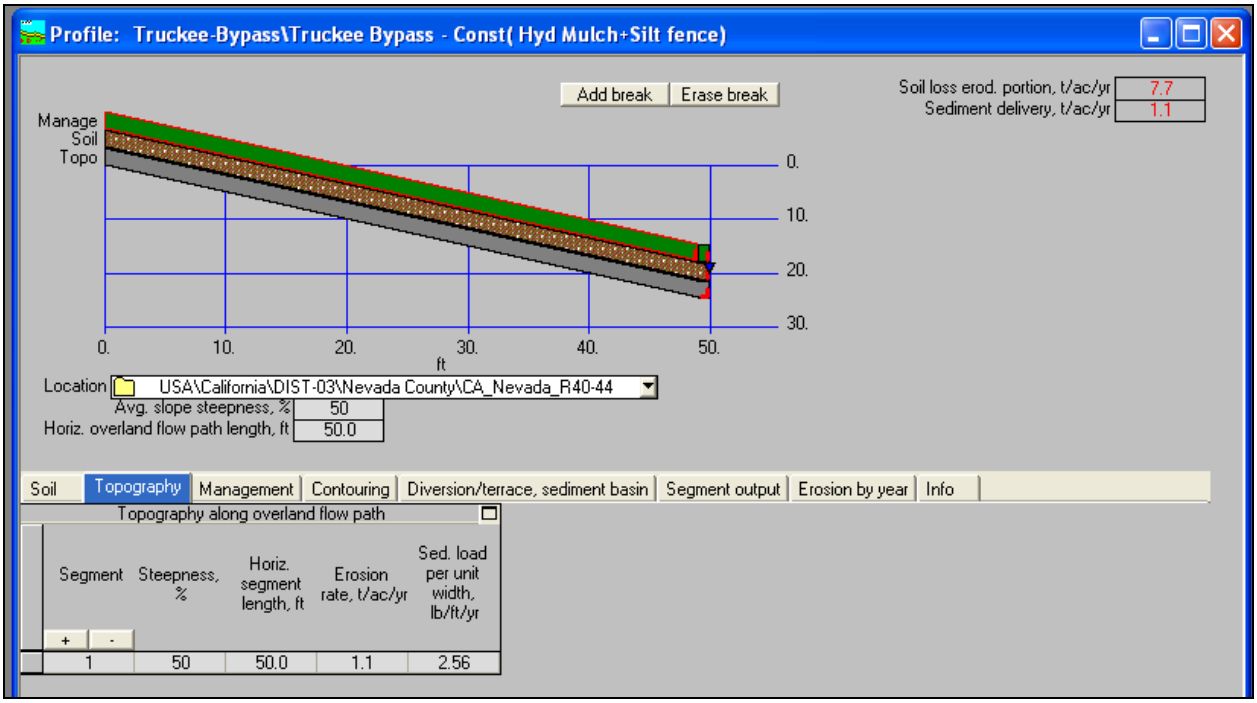


Figure E-11: Truckee Bypass - Construction Rainfall Data

STEP 1.2 – CHOOSE SOIL TYPE

Soil Erodibility, K: During construction, the soil-erodibility (K) value should represent the upper six inches of the final fill material, or in the case of multi-year projects, the state of grading at winterization. This version of the program includes a procedure for estimating soil erodibility for highly disturbed soils for construction sites based on the soil nomograph. For this project site, the soil texture was "Sandy Clay Loam," as shown in Figure E-12.

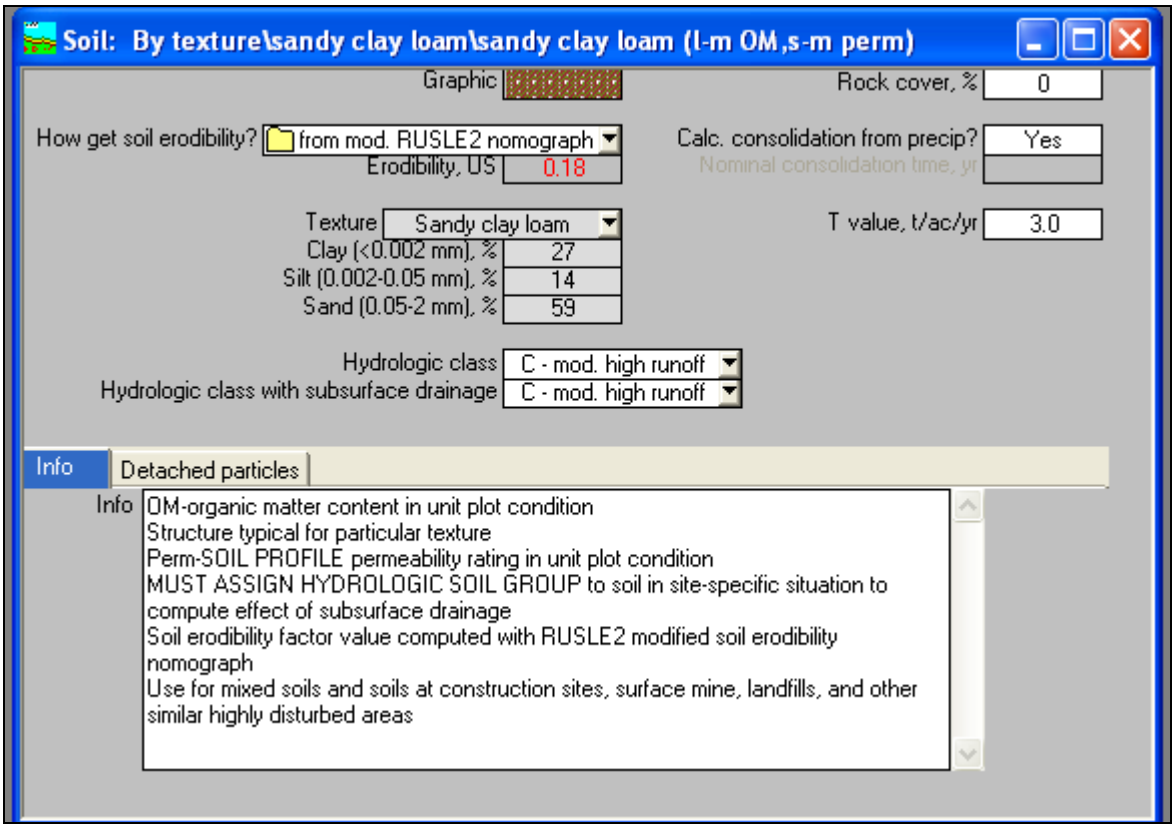


Figure E-12: Truckee Bypass - Construction Soil Texture

STEP 1.3 – SET SLOPE TOPOGRAPHY

Slope Length and Steepness, LS: The profile of the overland flow path can be divided into segments and the length and slope input into the model for each segment based on embankment slopes and lengths. These values can be taken from the final design profiles. If there are intermediate stages for the project such as temporary cut or fill slopes, these should be modeled as separate program runs to ensure appropriate BMPs are designed for these stages. Note that in Caltrans RUSLE2 the maximum slope is 100% (1:1) and maximum run is 1,000 feet.

For this project site, under the topography tab, the steepness selected was 50% and the path length selected was 50 feet. The slope is shown in Figure E-13.

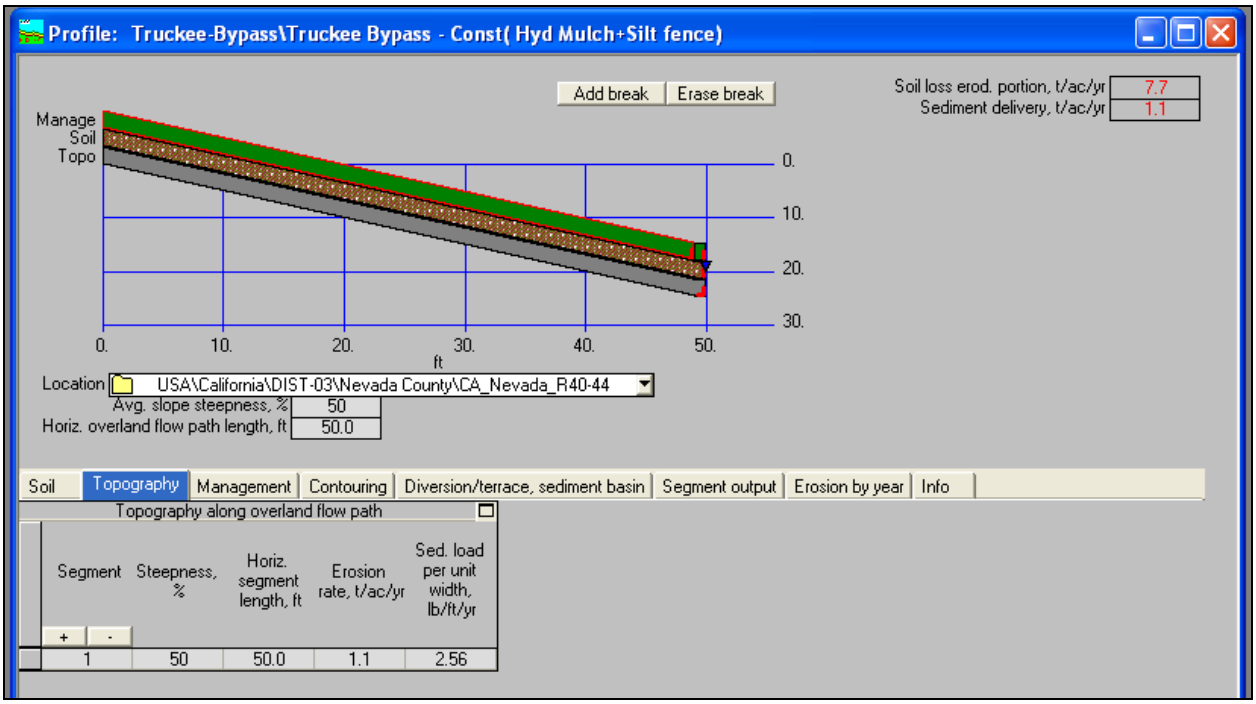


Figure E-13: Truckee Bypass - Construction Topography

STEP 2 – CALTRANS RUSLE2 RUN 1 (MAER)

The first Caltrans RUSLE2 analysis (Run 1) should be run with bare soil (bare cut, smooth or bare fill material) and no management practices to establish the base condition for calculation of the MAER. The MAER during construction shall be equal to or less than 20 percent of the calculated rate for bare cut /fill slopes.

For the Truckee Bypass project, the surface was a blade cut, smooth surface. Hence the MAER value for the construction phase needed to be equal to or less than 13.2 tons/acre/year (t/ac/yr) (20% of 66 t/ac/yr) for this project, as shown in Figure E-14.

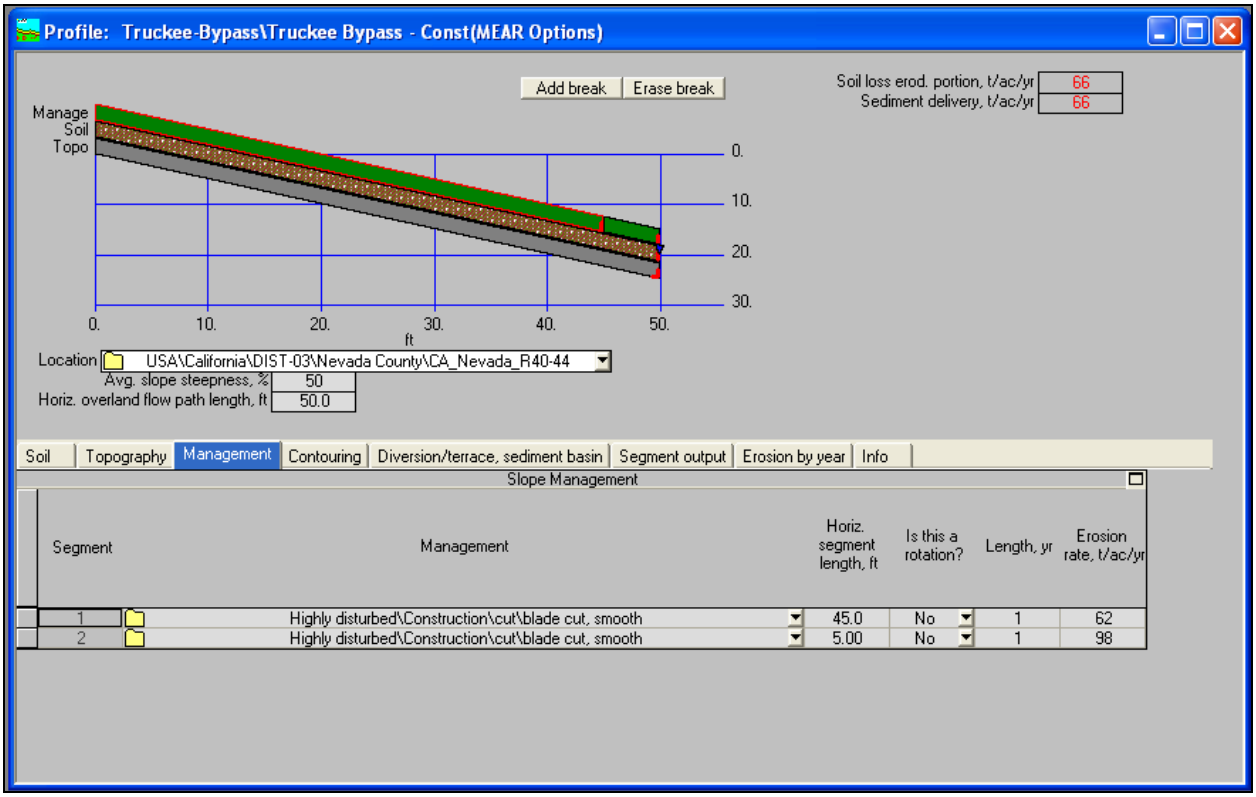


Figure E-14: Truckee Bypass- Construction – Run 1 MAER Determination

STEP 3 – CALTRANS RUSLE2 ANALYSIS RUN 2 (MINIMAL MANAGEMENT PRACTICES)

The second Caltrans RUSLE2 analysis (Run 2) should be run with minimal management practices to evaluate the BMP effectiveness. The Caltrans RUSLE2 management selection list has been modified to show standard construction operations typically found on Caltrans transportation projects. Mechanical disturbance for construction cut and fill surfaces increases the potential for erosion; therefore, the “highly disturbed” management folder option includes management practices for construction sites. Minimal management practices for this sample project are assumed to include silt fence at the toe of the slope and hydraulic mulch.

Management: The Caltrans RUSLE2 management options include both cover and support practices. A management practice is added by using "Add break" at the appropriate location on the profile, and the length of the practice was input into the "Horiz segment length, ft." cell, as shown in Figures E-15 & 16. The purpose of segmenting a slope when selecting management practices during the construction phase is to break up the slope length and thus reduce the predicted erosion rate.

The Truckee Bypass sample project Run 2 is based on two segments.

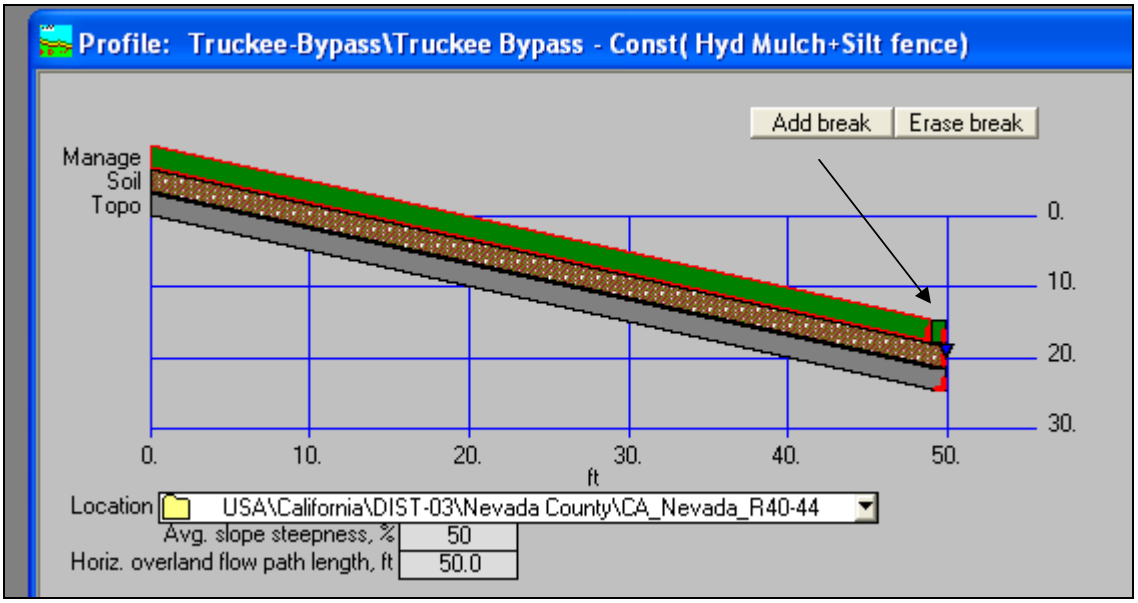


Figure E-15: Add Break – Erase Break

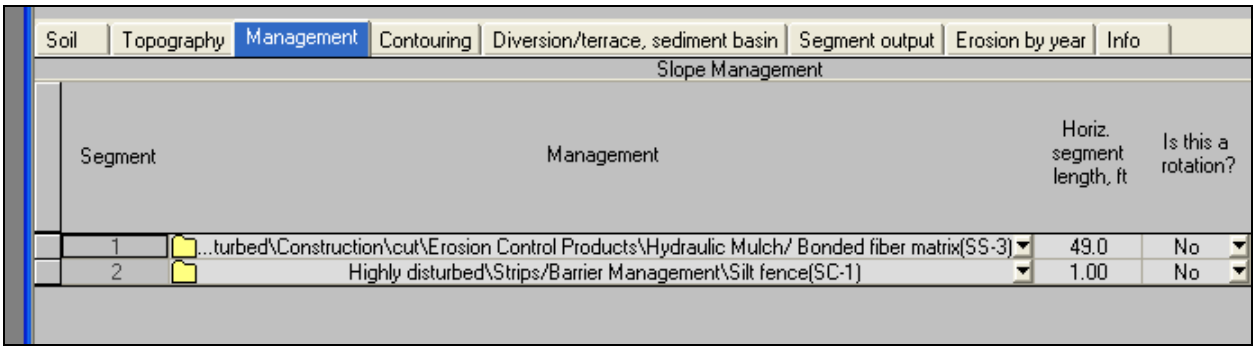


Figure E-16: Horizontal Segment Length with BMPs

Project site management was first evaluated with minimal management practices, including a cover practice for the entire slope (Segment 1) and a sediment control practice at the toe of the slope (Segment 2). The first segment is shown in Figure E-17.

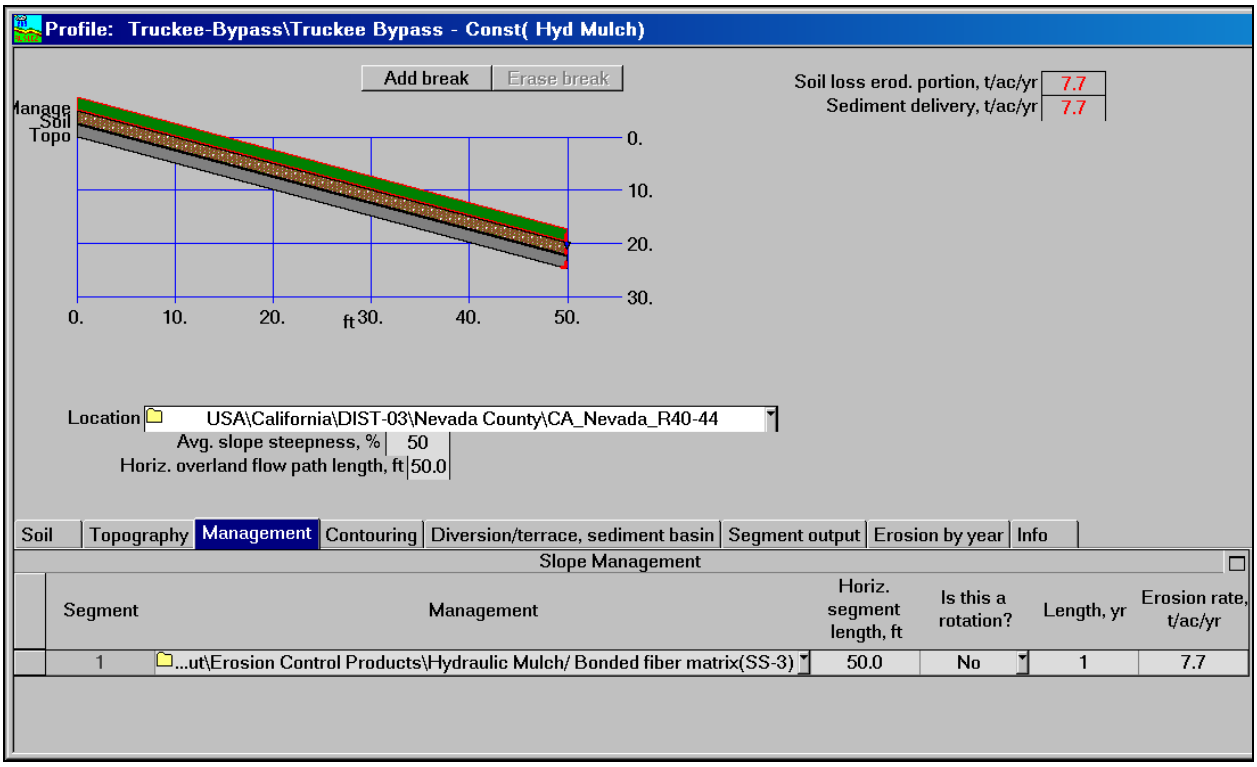


Figure E-17: Truckee Bypass - Construction Management

Segment 1 – Hydraulic Mulch/Bonded Fiber Matrix (BFM). Initially, the cover practice (Hydraulic Mulch/BFM) was selected for Segment 1 (located under the management tab: "Highly Disturbed / Construction / cut / Erosion Control Products / Hydraulic Mulch/Bonded fiber matrix [SS-3]".)

This management practice option consists of different activities and was assumed to start on April 15th. In this project, the management "Hydraulic Mulch/Bonded fiber matrix (SS-3)" has two activities: blade cut and adds mulch. For this scenario, Caltrans RUSLE2 calculates erosion based on the application of mulch during construction.

The "Operation" yellow folder options give details on how these operations can be performed, which should be followed at the project site to achieve the predicted soil loss rates.

The "Highly disturbed/ blade cut" option represents a bulldozer or road grader leaving a cut, undisturbed soil surface.

The "Highly disturbed/add mulch" operation represents material (such as mulch and erosion control blankets) added to the soil surface without disturbing the soil.

The external residue "wood fiber mulch" represents standard mulch blown on.

Segment 2 - Strip/Barrier Managements. A second segment and associated management practice was added at the toe of the slope to control sediment discharge. This management practice is located under the management tab in "Highly Disturbed / Strips/Barrier Management". The pull-down folder gives the types of barriers that can be selected to break up the slope length as shown in Figure E-18. A negative erosion rate in the last column indicates a deposition slope that may retain sediment. The predicted erosion rates are high during project construction due to disturbance of native soil. Note, strips/barriers are usually defined as a 1-foot segment length in the Caltrans RUSLE2 program.

For construction projects, reducing sediment delivery from the site is a primary objective and, in Run 2 for this example, straw bale barriers were provided in Segment 2 to slow runoff and induce sediment deposition. The offsite sediment delivery is 1.1 t/ac/yr, which is less than the pre-construction condition.

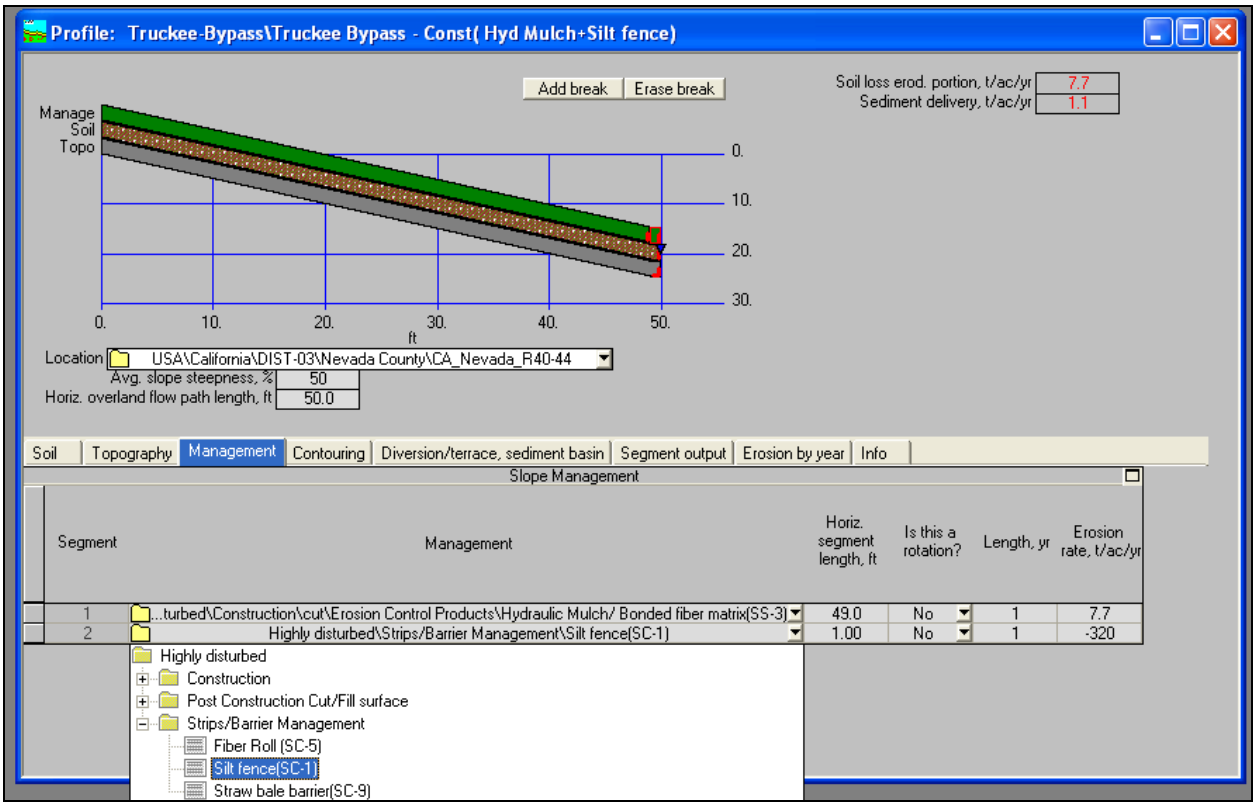


Figure E-18: Truckee Bypass - Construction Selection of Strips/Barrier Management Practices

Contouring: For the construction phase, the contouring is set to Up and Down slope.

Construction Phase Run 2 Results (Soil Loss Erod. Portion):

As can be seen in the upper right cell in Figure E-18, the predicted MAER during construction was 7.7 t/ac/yr, which was less than the established construction phase MAER of 13.2 t/ac/yr.

STEP 4 – CALTRANS RUSLE2 RUN 3 (REVISED MANAGEMENT PRACTICES)

This step was not required for this sample project because the Run 2 from Step 3 (Minimal Management Practices) resulted in achievement of the MAER performance goal. However, if the predicted MAER during the construction phase results in an erosion rate that is greater than MAER, the user should rerun the Caltrans RUSLE2 model with additional or revised management practices to achieve an erosion rate less than or equal to the established construction MAER. Additional runs may also be analyzed to evaluate comparable BMPs for maintenance requirements and cost-effectiveness. This section further demonstrates the results when selecting alternate management practices.

During Run 3, management practices were modified by adding additional sediment control BMPs along the slope. "Fiber rolls" were placed every 20 feet along the slope to reduce erosion and increase sediment control on the slope as opposed to controlling all of the sediment at "toe." Six segments were created for implementation of management practices in Run 3 including:

- **Cover Management:** "highly disturbed/ construction / cut / Erosion Control Products/ Hydraulic Mulch/Bonded fiber matrix (SS-3)" was selected for Segments 1, 3, & 5.
- **Strip/Barrier Managements:** Fiber rolls are installed at Segments 2 & 4 and silt fence is placed at the toe (Segment 6) to slow runoff and induce sediment deposition.

The above slope management plan resulted in a construction phase erosion rate of 7.5 t/ac/yr and sediment delivery of 1.1 t/ac/yr (Figure E-19), slightly less than the erosion rate for Run 2.

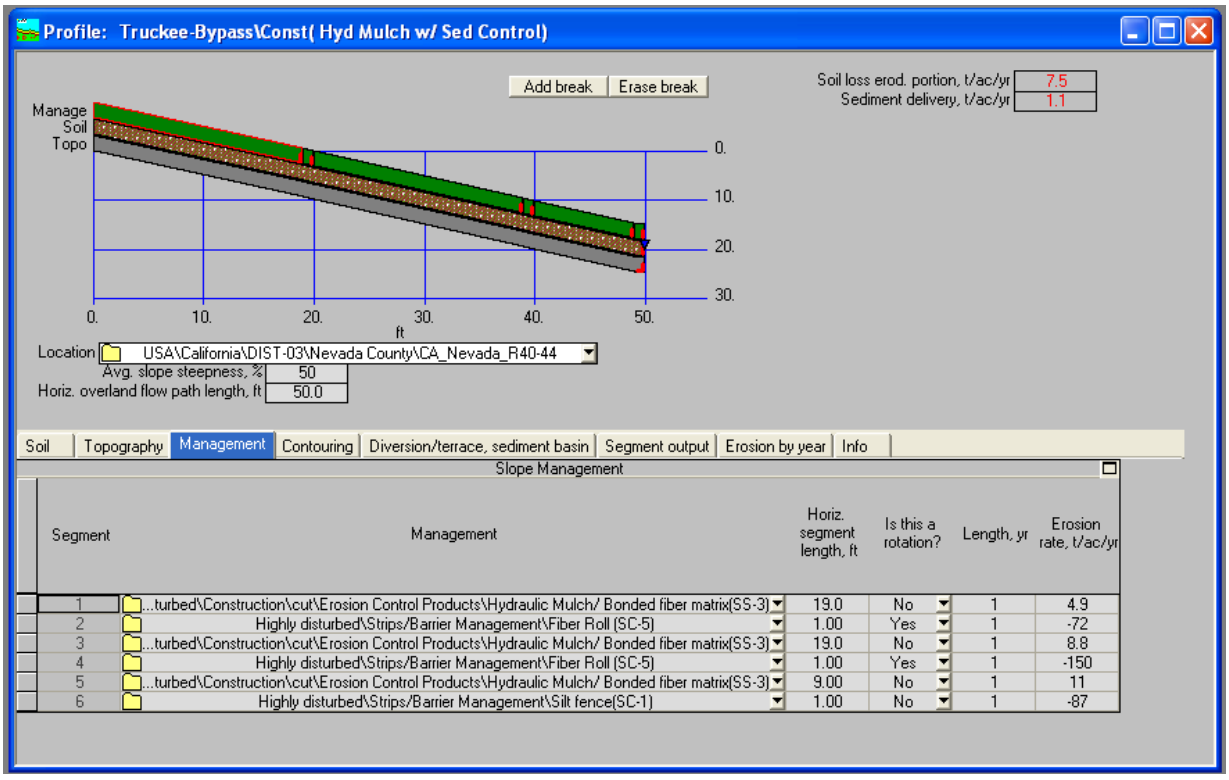


Figure E-19: Truckee Bypass - Construction Analysis Run 3

Erosion can be further controlled by providing hydroseeding in addition to the hydraulic mulch/BFM, which stabilizes the soil by root-mass before applying permanent management practices for the post-construction phase.

If seeding is added to the hydraulic mulch/BFM (located under the Management Tab in: "Highly Disturbed / Construction / cut / Erosion Control Products / Hydroseeding w/ Hydraulic Mulch/Bonded fiber matrix (SS-3)") at Segments 1, 3, and 5 to further control erosion, while maintaining fiber rolls at Segments 2 and 4, and silt fence at segment 6, the soil loss predicted during the construction phase is reduced further to 7.0 t/ac/yr. The results of this analysis are shown in Figure E-20.

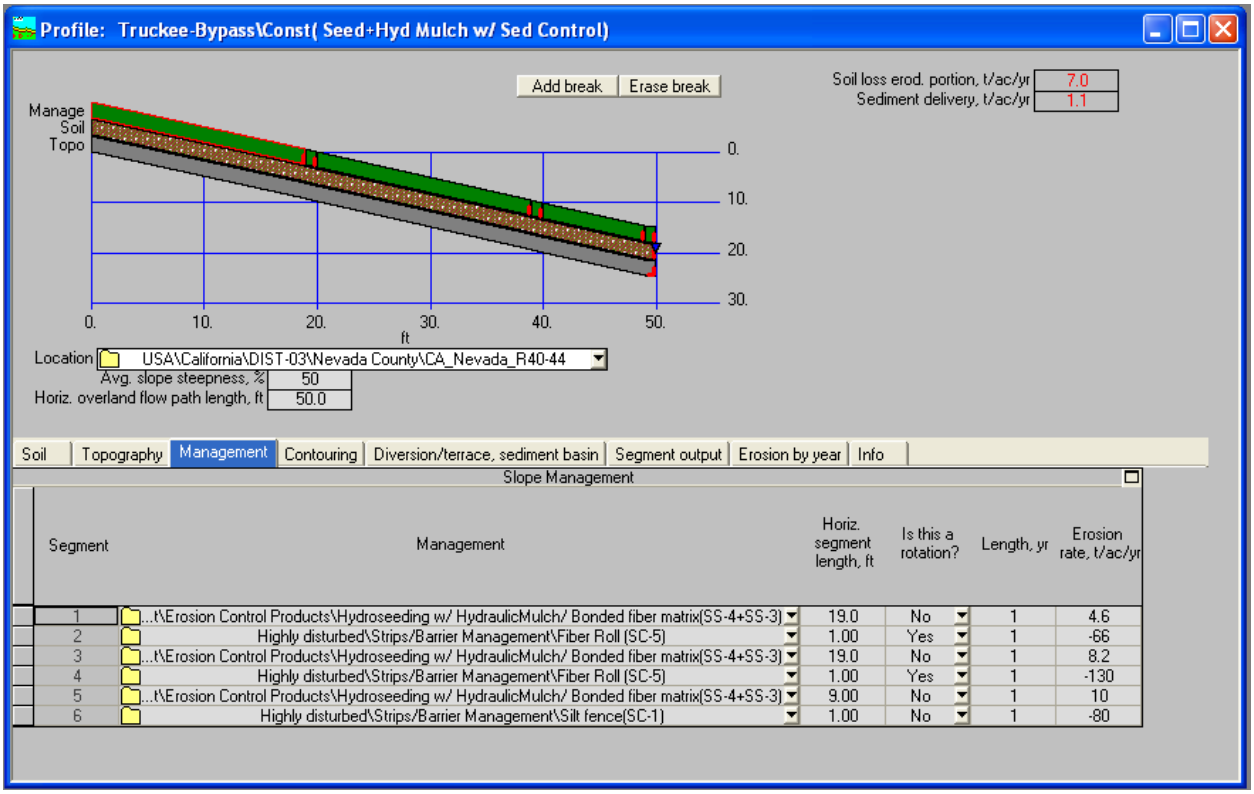


Figure E-20: Truckee Bypass - Construction Analysis Run 3 (with Seeding)

Construction Phase Run 3 Results (Soil Loss Erod. Portion):

As can be seen in the upper right cells in Figures E-19 and E-20, the predicted erosion rate during construction for Run 3 was 7.5 t/ac/yr for hydraulic mulch/BFM, fiber rolls, and silt fencing and 7.0 t/ac/yr with the addition of hydroseeding. Both of these options resulted in erosion rates that were less than the MAER of 13.2 t/ac/yr.

STEP 5 – RESULTS

Run 2 (Step 3) resulted in a predicted soil loss during the construction phase of 7.7 t/ac/yr and sediment delivery of 1.1 t/ac/yr, as can be seen in the upper right cell in Figure E-21. The established construction MAER (Step 2) was 13.2 t/ac/yr. The result of the construction analysis was that the project site attained the MAER performance goal with implementation of minimal management practices. Further analysis was not required for the construction phase of the Truckee Bypass project; however, alternative management practices were evaluated (Step 4) and resulted in additional reduction in erosion. The addition of fiber rolls, as analyzed in the Run 3 analysis, could provide a reduction in slope and sediment maintenance for the project without a substantial material cost increase and should therefore be considered for implemented during the construction phase of the Truckee Bypass project.

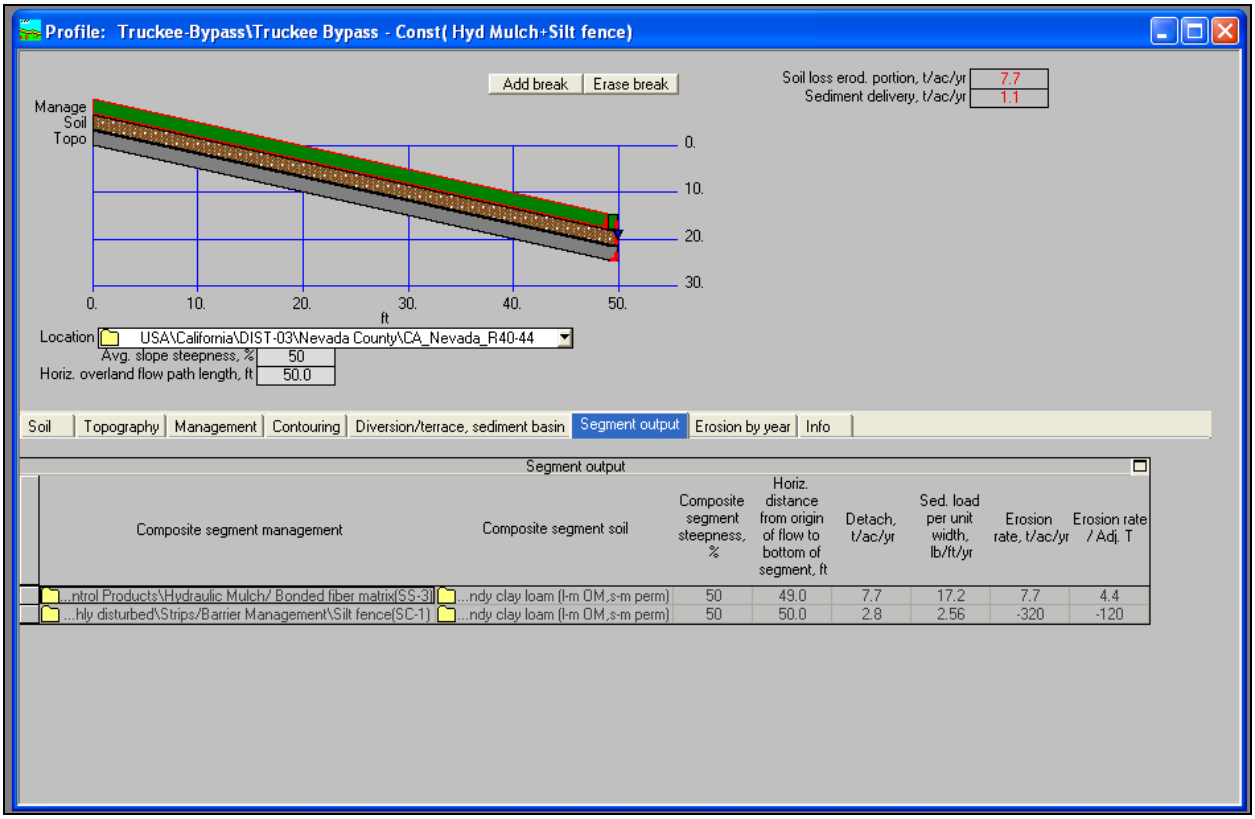


Figure E-21: Truckee Bypass - Construction Results

OUTPUT FILES

A summary output file for Run 3 is shown below.

RUSLE2 Profile Erosion Calculation Record

Info: Profile: **Construction Phase**
Project Location : Truckee Bypass - Nevada county
Rainfall Intensity: 40"- 44 "
Soil: Sandy Clay loam

File: profiles\Truckee-Bypass\Truckee Bypass - Const(Hyd Mulch w/ Sed Control)

Inputs:
Location: DIST-03\Nevada County\CA_Nevada_R40-44
Soil: sandy clay loam (l-m OM,s-m perm)
Horiz. overland flow path length: 50.0 ft
Avg. slope steepness: 50 %

Management	*Vegetation*	*Yield units*	*Yield (# of units)*
Highly disturbed\Strips/Barrier Management\Fiber Roll (SC-5)	Permanent cover not harvested\Fiber Roll-Coir/Coconut(SC-5)	pounds	50
Highly disturbed\Strips/Barrier Management\Silt fence(SC-1)	Permanent cover not harvested\silt fence	pounds	50

Contouring: a up-and-down slope
Strips/barriers: (none)
Diversion/terrace, sediment basin: (none)
Subsurface drainage: (none)
Adjust res. burial level: Normal res. burial

Outputs:
Soil loss erod. portion: 7.5 t/ac/yr
Detachment on slope: 7.3 t/ac/yr
Soil loss for cons. plan: 5.4 t/ac/yr
Sediment delivery: 1.1 t/ac/yr
Crit. slope length:
Surf. cover after planting: 0 %

RUSLE2 Profile Erosion Calculation Record

Date	*Operation*	*Vegetation*	*Surf. res. cov. after op, %*
4/15/0	Highly disturbed land\blade cut material		0
5/1/0	Highly disturbed land\add mulch		77
1/1/1	Begin growth	Permanent cover not harvested\Fiber Roll-Coir/Coconut(SC-5)	0
4/15/0	Highly disturbed land\blade cut material		0
5/1/0	Highly disturbed land\add mulch		77
1/1/1	Begin growth	Permanent cover not harvested\Fiber Roll-Coir/Coconut(SC-5)	0
4/15/0	Highly disturbed land\blade cut material		0
5/1/0	Highly disturbed land\add mulch		77
5/2/0	basic/general\begin growth	Permanent cover not harvested\silt fence	0

Section E-5 Post-Construction

The steps for the post-construction phase runs are as follows:

Step 1: Setup the post-construction Caltrans RUSLE2 analysis for program input variables that do not change with management practices: climate (Step 1.1), soil (Step 1.2), and topography (Step 1.3).

Step 2: Caltrans RUSLE2 Run 1 with minimal management practices. Compare resulting erosion rate to MAER from the pre-construction phase (Section E-3). IF result is still greater than the MAER, move to Step 3. IF result is less than the MAER, post-construction runs are complete.

Step 3: Caltrans RUSLE2 Run 2 with revised management practices. Compare resulting erosion rate to MAER from the pre-construction phase (Section E-3). IF result is still greater than the MAER, repeat this step until the result is less than the MAER.

Step 4: When the user is complete with the post-construction Caltrans RUSLE2 analysis (Step 3), print the output results and begin the EC Report (Section E-6).

STEP 1.1 – CHOOSE LOCATION TO SET CLIMATE

Rainfall Erosivity, R: The rainfall intensity and erosivity factor for the post-construction phase is the same as used in the pre-construction and construction phases model runs, as shown in Figure E-22.

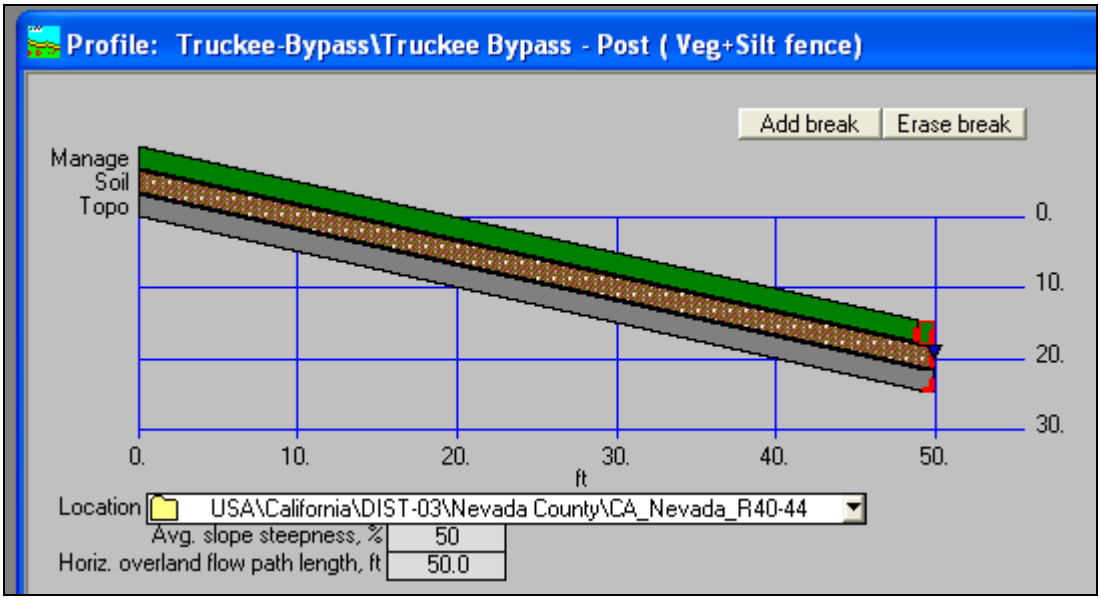


Figure E-22: Truckee Bypass - Post-Construction Rainfall and Erosivity

STEP 1.2 – CHOOSE SOIL TYPE

Soil Erodibility, K: For this project site, the soil texture was "Sandy Clay Loam," as shown in Figure E-23. The Caltrans RUSLE2 program then calculates soil erodibility.

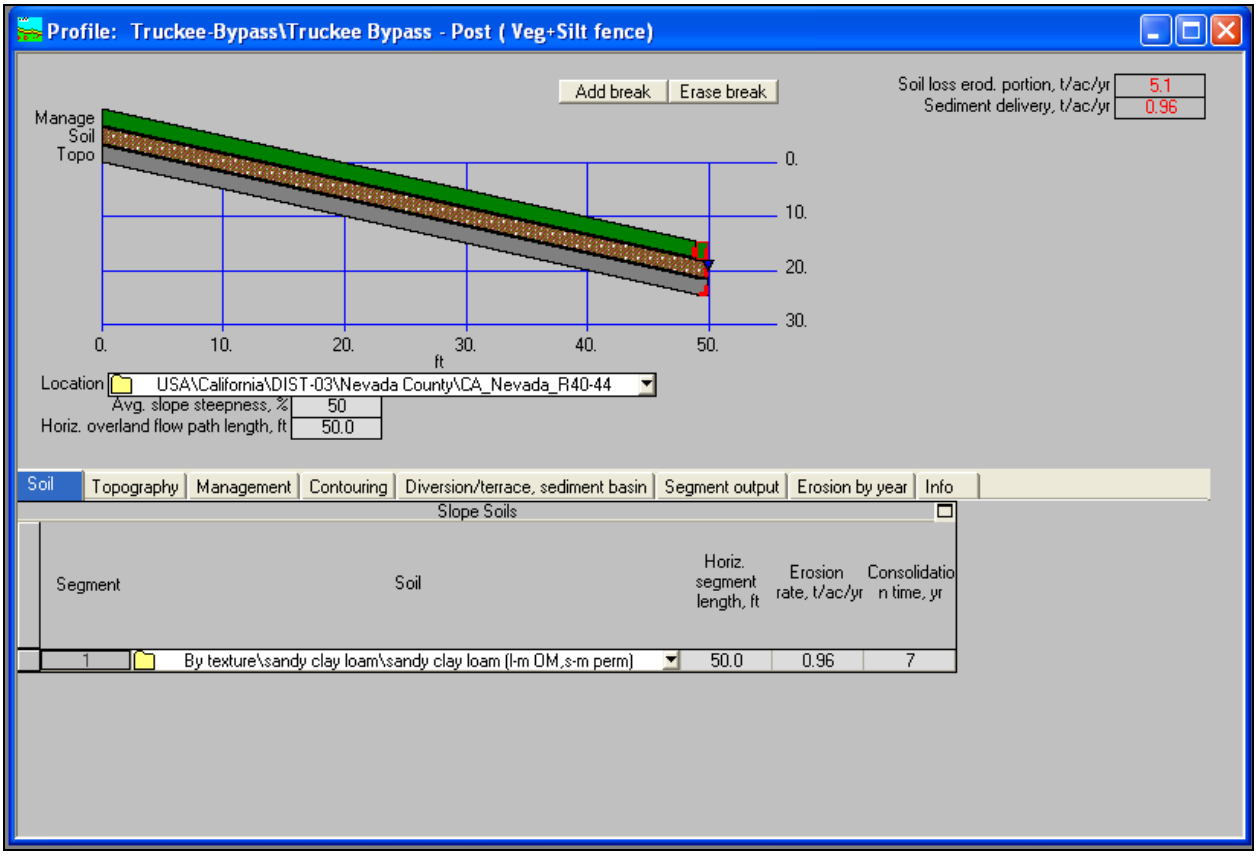


Figure E-23: Truckee Bypass - Post-Construction Soil Texture

STEP 1.3 – SET SLOPE TOPOGRAPHY

Slope Length and Steepness, LS: The path length for the project was 50 feet and steepness was 50 percent. The profile of the overland flow path is shown in Figure E-24.

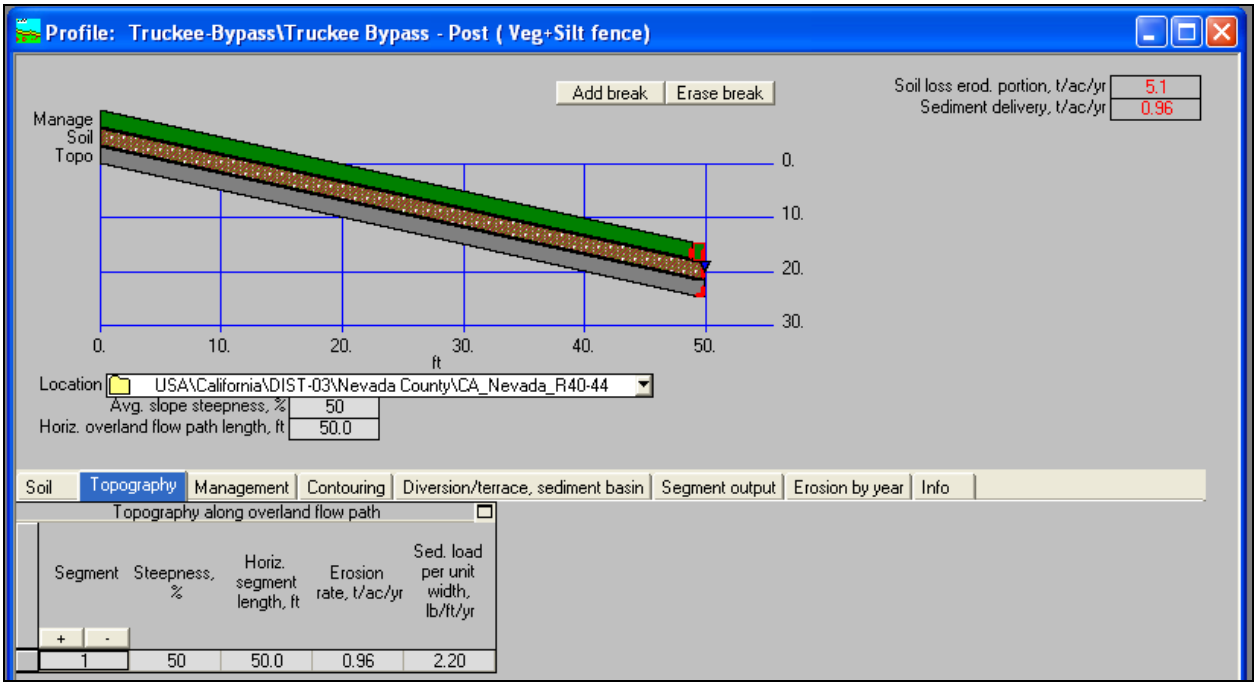


Figure E-24: Truckee Bypass - Post-Construction Topography

STEP 2 – CALTRANS RUSLE2 RUN 1 (MINIMAL MANAGEMENT PRACTICES)

The first post-construction Caltrans RUSLE2 analysis (Run 1) should be run with minimal management practices to evaluate the proposed permanent BMP effectiveness. Minimal management practices are assumed to include vegetation cover on the surface and fiber roll at the toe of the slope.

The Caltrans RUSLE2 results are for site conditions15 years after completion of the project as shown in Figure E-25. Note, the post-construction period should be validated based on the vegetation yield (crop yield) results found at the project site.

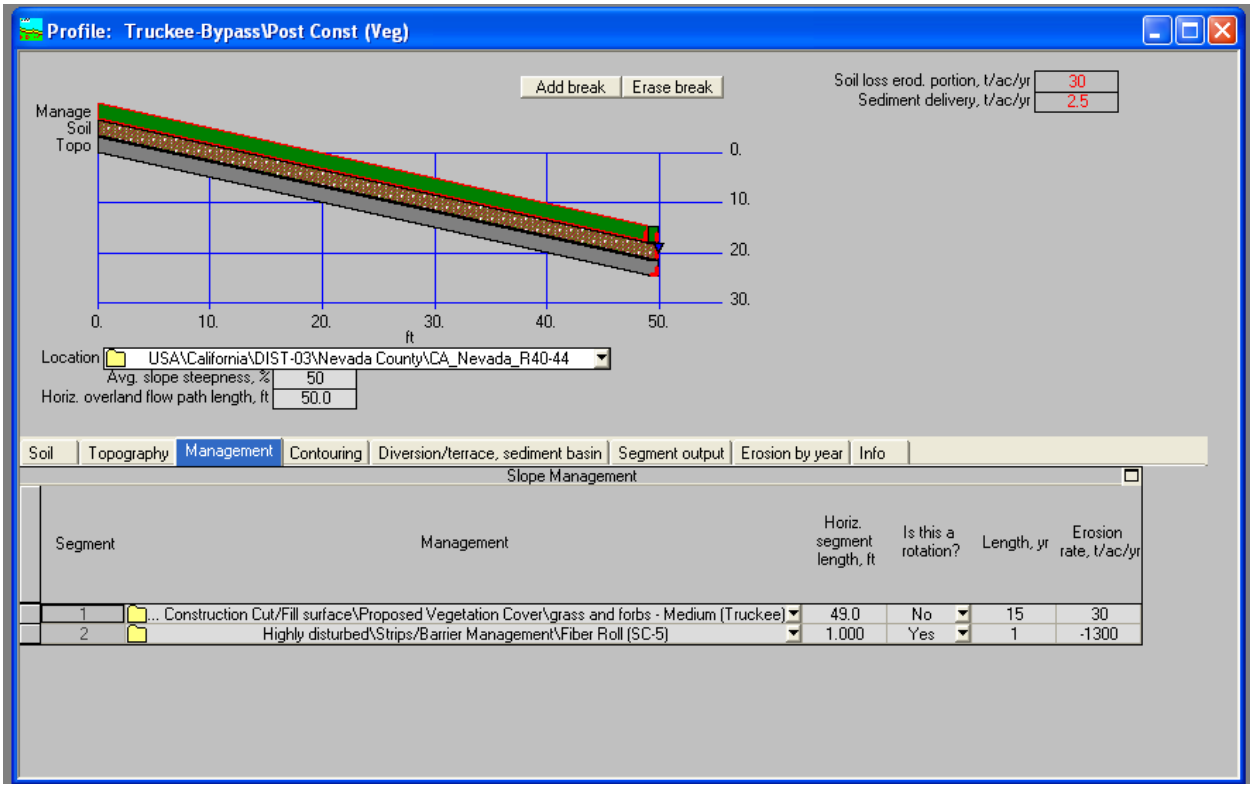


Figure E-25: Truckee Bypass - Post-Construction Management

The Truckee Bypass post-construction Caltrans RUSLE2 analysis for Run 1 was based on two segments.

Segment 1 – Grasses and Forbs - Medium. The first segment was defined by the cover condition of "Grasses and Forbs" with "Medium" density. This management practice is found under the management tab for Segment 1 at: "Highly Disturbed / Post Construction / Cut/Fill surface / Proposed Vegetation Cover / Grasses and Forbs-Medium". The management practice also has operation values and corresponding vegetation options that are identified by clicking on the yellow folder. The yield can be altered based on local conditions by inputting values into the "Yield" (# Harv Units) cell under the management tab. These local conditions should be verified with project site conditions. The cover selection is shown in Figure E-26.

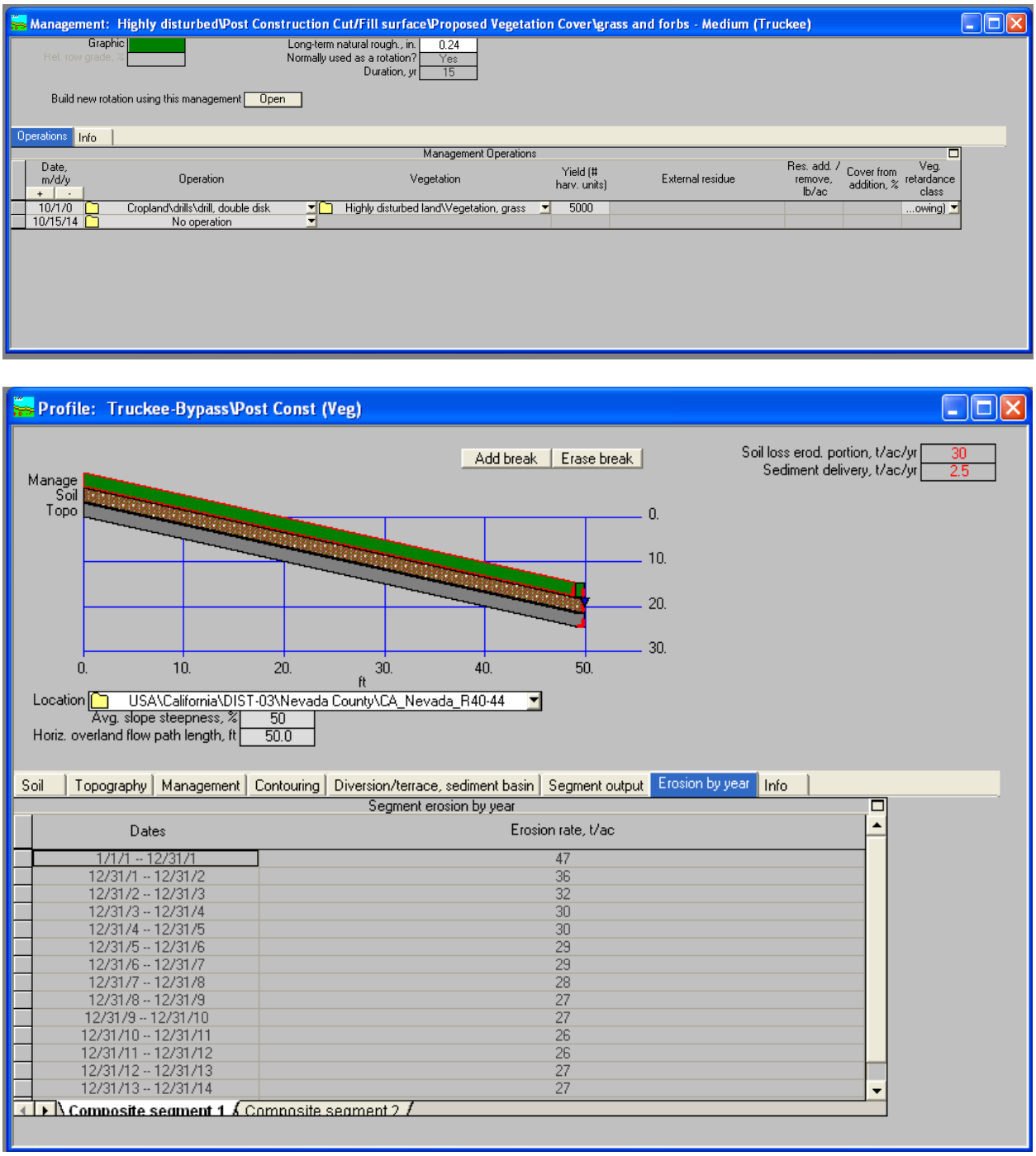


Figure E-26: Truckee Bypass - Post-Construction with Vegetation Cover & Erosion by Year

Segment 2 – Strips/Barriers. The management practice, fiber roll, was then selected (located under the management tab of Segment 2, as: "Highly Disturbed / Strip/Barrier Management"). Fiber roll was selected over silt fencing to trap the sediment at the toe because of its

comparative biodegradability when compared to silt fencing. The results of adding the fiber roll used to trap the sediment at toe is shown in Figure E-27.

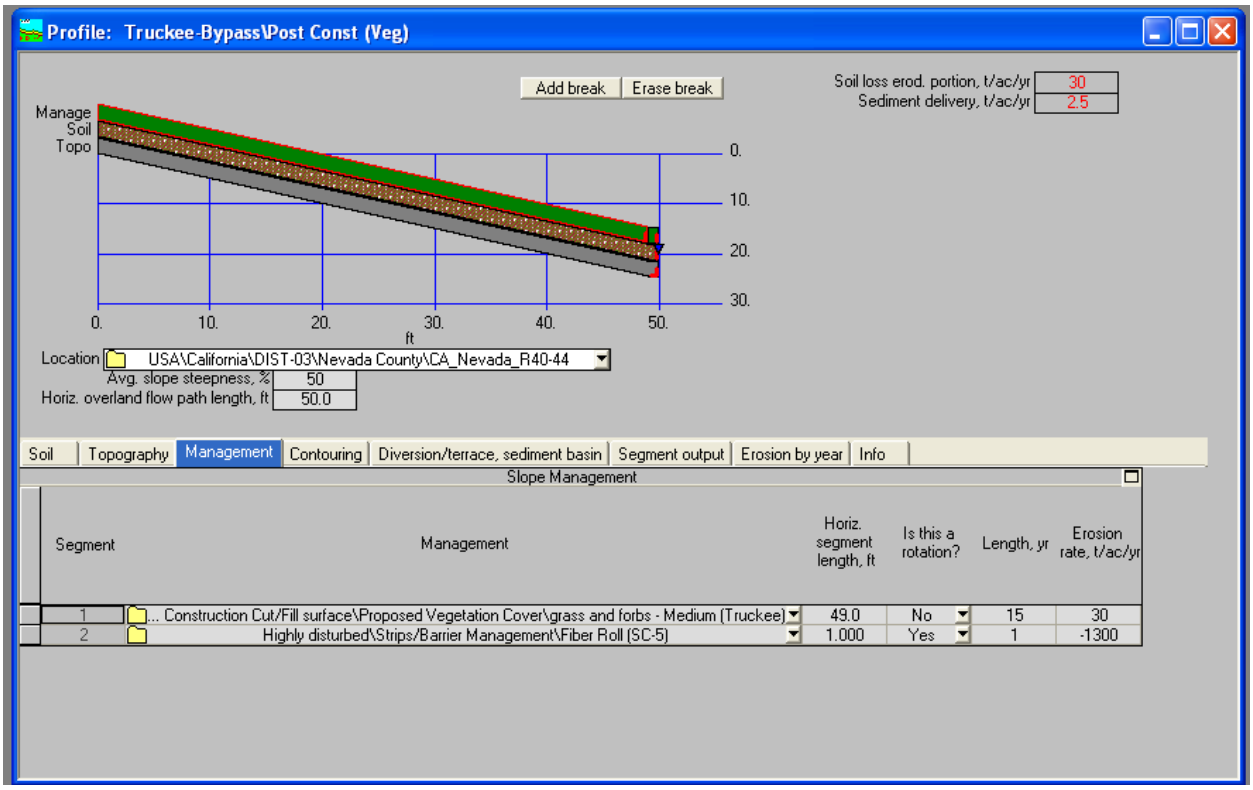


Figure E-27: Truckee Bypass - Post-Construction with Fiber Roll

Post-construction Run 1 Results (Soil Loss Erod. Portion):

The predicted erosion rate for this project site with minimal management measures was estimated to be 30 t/ac/yr (Figure E-27). This does not meet the MAER goal of 5.5 t/ac/yr. Thus the user should move on to Step 3.

STEP 3 – CALTRANS RUSLE2 RUN 2 (REVISED MANAGEMENT PRACTICES)

In this scenario, the post-construction Caltrans RUSLE2 analysis needed to be run again with revised management practices to reduce erosion to meet the MAER performance goal. In this Run 2 analysis, erosion was further controlled by defining intermediate segments on the slope with the addition of straw blankets to the vegetation and fiber rolls on the slope, in addition to replacing the fiber roll at the toe of the slope with silt fencing. The vegetation and blanket combination is located under: “Highly Disturbed /Post Construction Cut/Fill surface/ Proposed Vegetation cover/ Grasses/Forbs, shrubs, and trees – Medium w/ Straw Blanket.” The vegetation and straw blanket management practice was selected for Segments 1, 3 and 5, fiber rolls were selected for Segments 2 and 4, and silt fence was selected for Segment 6 to slow runoff and induce sediment deposition. This analysis is shown in Figure E-28.

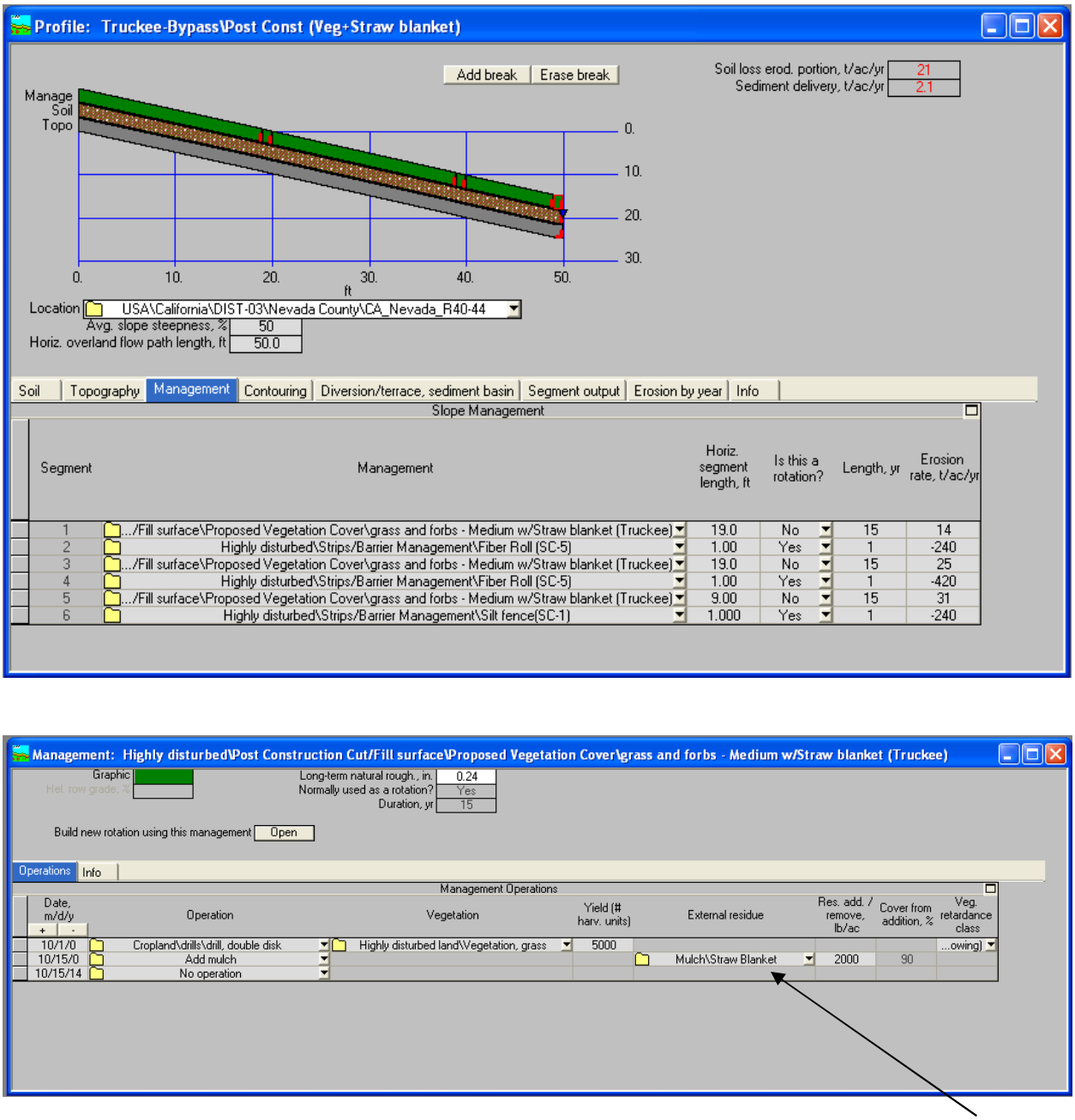


Figure E-28: Truckee Bypass - Post-Construction Run 1 Results (Vegetation + Straw Blanket)

Post-construction Run 2 Results (Soil Loss Erod. Portion):

Run 2 resulted in an estimated erosion rate of 21 t/ac/yr and sediment delivery of 2.1 t/ac/yr. Therefore, the post-construction BMP design for Run 2 does not meet the established pre-construction MAER of 5.5 t/ac/yr, and the post-construction Caltrans RUSLE2 analysis requires further analysis with revised management practices to reduce erosion to meet the MAER performance goal.

The post-construction analysis was rerun under Step 3 (Run 3). In Run 3, erosion was evaluated by applying a synthetic fiber (non-biodegradable) blanket and implementing sediment control at two locations.

During Run 3, Grasses and forbs of medium density with a synthetic fiber blanket was selected from the "Highly disturbed/Post Construction Cut/Fill surface/ Proposed Vegetation Cover" management folder for application on Segments 1 and 3, fiber rolls were added at Segment 2, and silt fence was added at Segment 4 to slow runoff and induce sediment deposition. These management practices are shown in Figure E-29.

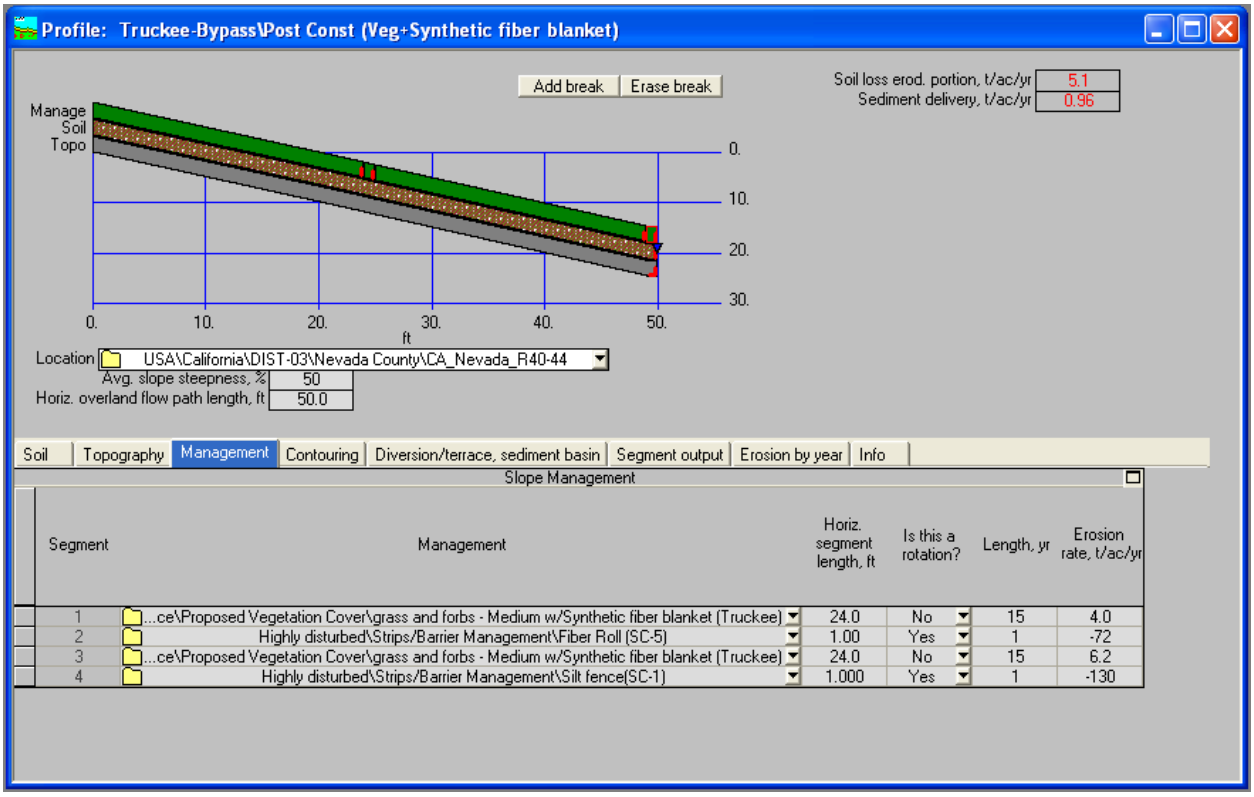


Figure E-29: Truckee Bypass - Post-Construction Run 2 Results (Vegetation + Straw Blanket)

Post-construction Run 3 Results (Soil Loss Erod. Portion):

The resulting erosion rate for Run 3 was 5.1 t/ac/yr and sediment delivery was 0.96 t/ac/yr. Therefore, the post-construction BMP design for Run 3 meets the established pre-construction MAER of 5.5 t/ac/yr.

STEP 4 - RESULTS

The post-construction Caltrans RUSLE2 analysis was run three times to evaluate BMP performance for erosion and sediment control. Run 3 with revised BMPs resulted in a predicted post-construction erosion rate of 5.1 t/ac/yr and sediment delivery of 0.96 t/ac/yr, as is shown in Figure E-30. Therefore, the post-construction BMP design meets the goal of not increasing the sediment above the established pre-construction MAER of 5.5 t/ac/yr.

OUTPUT FILES

An example output file is shown below.

RUSLE2 Profile Erosion Calculation Record

Info: Profile: **Post Construction Phase**
Project Location : Truckee Bypass - Nevada county
Rainfall Intensity: 40"- 44 "
Soil: Sandy Clay loam

File: profiles\Truckee-Bypass\Truckee Bypass - Post (w/ sed control)

Inputs:
Location: DIST-03\Nevada County\CA_Nevada_R40-44
Soil: sandy clay loam (l-m OM,s-m perm)
Horiz. overland flow path length: 50.0 ft
Avg. slope steepness: 50 %

Management	*Vegetation*	*Yield units*	*Yield (# of units)*
Highly disturbed\Post Construction Cut/Fill surface\Proposed Vegetation Cover\grass and forbs - Medium	Highly disturbed land\Vegetation, grass	lbs	5000
Highly disturbed\Strips/Barrier Management\Fiber Roll (SC-5)	Permanent cover not harvested\Fiber Roll-Coir/Coconut(SC-5)	pounds	50

Contouring: a up-and-down slope
Strips/barriers: (none)
Diversion/terrace, sediment basin: (none)
Subsurface drainage: (none)
Adjust res. burial level: Normal res. burial

Outputs:
Soil loss erod. portion: 5.1 t/ac/yr
Detachment on slope: 5.1 t/ac/yr
Soil loss for cons. plan: 5.0 t/ac/yr
Sediment delivery: 0.96 t/ac/yr
Crit. slope length:
Surf. cover after planting: 0 %

RUSLE2 Profile Erosion Calculation Record

Date	*Operation*	*Vegetation*	*Surf. res. cov. after op, %*
10/1/0	Cropland\drills\drill, double disk	Highly disturbed land\Vegetation, grass	0
10/15/0	Highly disturbed land\add mulch		90
10/15/14	No operation		41
1/1/15	Begin growth	Permanent cover not harvested\Fiber Roll-Coir/Coconut(SC-5)	0

Section E-6 Erosion Control Report Template

Following the completion of the data collection, Site Summary Form, and Caltrans RUSLE2 analyses, the user should complete the EPP by preparing an EC Report that documents the inputs and outputs and conclusions. The EC Report documents the entire procedure and provides a summary for the project that can be used to justify the decision process for implementation of selected erosion and sediment control management practices (BMPs) at the project site. The sample EC Report for the Truckee Bypass project is provided below.

EROSION CONTROL REPORT

For Truckee Bypass Project, Nev 80, 89, 267

Prepared by:

District Revegetation and Erosion Control Unit
Robert Schott, CPESC

Table of Contents

Attachments

1.0 Introduction

1.1 PURPOSE

The purpose of this report is to document soil surface and vegetative conditions, provide analysis of anticipated site conditions as they pertain to predicted surface erosion and sediment delivery, and recommend best management practices (BMPs) for soil stabilization and sediment control. The recommendations presented herein are based on reviews of published data, site reconnaissance, soil sampling, laboratory testing, and use of the Revised Universal Soil Loss Equation, Version 2 (RUSLE2) modified for Caltrans (Caltrans RUSLE2).

1.2 SCOPE

This report will provide analysis for pre-construction, construction, and post-construction phases of the project. Analysis of conditions at the project site prior to the beginning of construction activities is necessary to establish success criteria and set revegetation goals for the post-construction phase. A major element of the pre-construction phase is determining the existing rate of erosion for assessment of the post-construction condition. Establishing a maximum allowable rate of erosion (MAER) and selecting soil stabilization and sediment control BMPs is vital to limiting erosion and sediment delivery during the construction phase. Success during the post-construction phase will be measured by comparing the rate of erosion for the established revegetation and erosion control measures against the rate of erosion for the pre-construction phase.

1.3 DESCRIPTION

The project is located in Nevada County in Truckee on Route 89 from Alder Drive/Prosser Dam Road to Nevada/Placer County Line on Route 267 and on Route 80 from Trout Creek under-crossing to Fibreboard under-crossing. The project will create four-lane highway to bypass the town on Truckee by adding a new connection to Route 89, an interchange with Route 80, and a connection to Route 267. A new bridge and overhead will be constructed to span the Truckee River and cross the Union Pacific Railroad tracks. The bypass alignment will create several excavation and embankment slopes.

2.0 Pre-Construction Phase

The pre-construction phase is the period prior to any significant ground disturbing activity at the project site.

2.1 PERFORMANCE GOALS

The determination of the existing conditions and rate of surface and rill erosion for the slopes at the project site is useful in determining performance goals and success criteria for the completed project slopes referred to here as the post-construction phase. The pre-construction erosion rate shall set the MAER which is considered the post-construction performance goal for erosion for the completed project slopes where vegetation has become established and the soil surface is considered stabilized. If the post-construction erosion rate is equal to or less than the MAER, then the performance goal is achieved.

Information used to predict the pre-construction erosion rate is described below.

2.2 REFERENCE SITE

Since this report is being developed prior to project construction, specifically grading to create any excavation (cut) or embankment (fill) slopes, a reference site was selected to represent the project slopes. A reference site representative of the project's topography, climate, slope, soils, and vegetation was performed in a similar manner to the analysis for the proposed project slopes.

The reference site is a vegetated cut slope along an access road servicing a borrow pit. The access road is located on United States Forest Service (USFS) land within a quarter mile of the project site. This proximity assures similarity to the project site as to soils, climate, and vegetation. Field observation confirmed additional characteristics. In addition, soil sampling was conducted on the site. Sampling consisted of scraping the duff aside and digging two collection holes approximately 30 feet apart to a depth of 12-inches. Enough material was collected to fill a 1.5-gallon container.

The various characteristics of the reference site are summarized in Tables 2-1 and 2-2 below. Figure 1 includes a photo of the reference site.

TABLE 2-1 REFERENCE SITE

Variable	Comment	Data Source
Slope Steepness	**1V: 2H to 1V: 1.5H**	Field Observation
Slope Length	**25 –50 feet**	Field Observation
Slope Aspect	**South facing**	Field Observation
Vegetative Cover	Portion of soil surface covered by woody (shrubs) and herbaceous plant material ≤ 3 feet high. **35% - 40%**	Field Observation
Canopy Cover	Portion of soil surface covered by trees and woody plant material > 3 feet high. **10% - 15%**	Field Observation
Rock Cover	Portion of soil surface covered by rock fragments sufficiently large not to be moved by runoff. Rock diameter must be ≥ 10 mm (≥ 3/8") to qualify as cover. **15% - 20%**	Field Observation
Duff	Provide description of the covering organic material: Approximately 85% of the slope was covered with pinecones, pine needles, leaves and twigs. Duff layer was approximately 2-inches in depth increasing to 4-inches under the trees.	Field Observation
Structure class	Soil structure should be consistent with texture and categorized as one of the following: **Fine granular (1-2 mm)**	Field Observation
Hydrologic Soil Group (undrained)	Index for potential of undrained soil profile to produce runoff under unit plot conditions. **B (moderate – low runoff potential)**	Laboratory Test / Field Observation
Soil Texture Breakdown	Based on mass (weight), proportion of the total for the clay, silt, and sand: **30 % Clay** < 0.002 mm **6 % Silt** 0.002 mm ≥ to < 0.05 mm **64 % Sand** 0.05 mm ≥ to < 2.0 mm	Laboratory Test Sieve Analysis and Hydrometer (test 203)
Soil Texture Classification	USDA soil texture classification based on proportion of sand, silt, and clay. **Sandy clay loam**	Laboratory Test
Inherent Organic Matter content	Based on mass (weight), proportion of the total sand, silt, clay and organic matter. **1 % Organic matter**	Assumed by presence of duff and topsoil
Permeability class	The permeability class reflects the runoff potential of the soil profile. Possible selections: **Slow** 0.06 to < 0.2 in/hr	PPDG Table B-3

TABLE 2-2 REFERENCE SITE VEGETATION

Plant Group	Botanical Name	Common Name
Trees	Pinus contorta 'Murrayanna'	Lodgepole Pine
	Pinus Jeffreyi	Jeffrey Pine
	Salix scouleriana	Scouler's Willow
Shrubs	Purshia tridentata	Bitterbrush
	Rosa woodsii	Interior Wildrose
	Chysothamnus nauseosus	Rabbit Brush
	Artemesia tridentata	Basin Sagebrush
Grasses	Elymus elymoides	California Squirreltail
	Elymus glaucus	Blue Wildrye
	Deschampsia caespitosa	Tufted Hairgrass
	Bromus carinatus	California Brome

Figure 1 Reference Site Vegetation

2.3 DETERMINATION OF PRE-CONSTRUCTION MAXIMUM ALLOWABLE EROSION RATE

The pre-construction erosion rate was estimated using Caltrans RUSLE2. Climate data was entered for the project site in addition to soils, vegetation and topographic data for the reference site.

The site is located in an area with a rainfall intensity range of 40 to 44 inches. The reference site soil texture is "Sandy Clay Loam" with 30% clay, 6% silt, and 64% sand. A slope length of 50 feet with a slope steepness of 50% [1(vertical): 2(horizontal)] was used. The rock cover is 20%, canopy cover is 40%, and approximately 80% of site covered with leaves and twigs. The resulting average annual erosion rate is 5.6 tons per acre per year (t/ac/yr). This becomes the established MAER for the post-construction condition.

3.0 Construction Phase

The construction phase is the period when construction activities occur, including major site preparation, grading, excavation, structures and roadway construction, drainage facilities, and other construction activities that disturb soil.

3.1 MAER

The determination of a MAER is a necessary step in the process of selecting and evaluating the various soil stabilization and sediment control BMPs under consideration for temporary slope stabilization. Using Caltrans RUSLE2, the effectiveness of the different BMPs can be compared. The optimal combinations of BMPs are those limiting the erosion rate to equal to or less than the established construction phase MAER.

The project site was evaluated with the construction slope conditions and bare cut, smooth surface with no management practices to determine the MAER value. The MAER value was calculated as 20 percent of the resulting erosion rate (66 t/ac/yr) and established as 13.2 t/ac/yr.

3.2 SLOPE STABILIZATION PROCESS

The project slopes will be constructed with BMPs that provide effective erosion control and sediment control as determined in the Caltrans RUSLE2 analysis (Run 3). BMPs will be installed in the following sequence:

1) Grade to construct excavation (cut) slopes.
2) Install erosion control product of Hydraulic Mulch (SS-3).
3) Install sediment control "Fiber rolls" placed at 20' on center with the first fiber roll placed 10' above the Toe and install "Silt fence" at Toe.

Figure 2 Projects most severe slope. Photo taken after construction before installation of container plants

3.3 SLOPE EVALUATION

The embankment slopes located at the interchange where route 80 crosses the realigned route 267 are the most severe on the project. These south facing slopes vary in steepness from 1:2 (vertical [V]:horizontal [H]) to 1:1.5(V:H) with a length of 25 to 50 feet. The combination of erosion control and sediment control BMPs in this location are assumed to be sufficient for the less severe slopes located throughout the project; therefore, these slopes were used for evaluation of BMP performance for the project.

Soils data from the reference site and climate data from the project site were used for a slope length of 50 feet and a slope steepness of 1:2 (V:H) (50% slope). Final selected BMPs included hydraulic mulch/bonded fiber matrix (BFM) with sediment control BMPs include Fiber rolls and Silt fence.

An estimate of the annual rate of erosion for this construction slope was performed using the Caltrans RUSLE2 erosion prediction tool. The resulting erosion rate is 7.5 t/ac/yr. Since this erosion rate for the construction analysis is less than the MAER, the performance goal is satisfied and the BMP selection is considered adequate.

4.0 Post-Construction Phase

The post-construction phase is the period after construction work has been completed and the permanent erosion control and revegetation, such as seeding and planting, have established and matured. This period will usually be 15 years after construction, although shorter periods may be achievable under optimum conditions and longer periods may be acceptable under extreme conditions.

Proposed vegetation is expected to become structurally similar to the surrounding native vegetation in 15 years. The revegetation is anticipated to progress as outlined in Table 4-1.

TABLE 4-1 VEGETATION ESTABLISHMENT

Type of Vegetation	Revegetation Progress (% Cover)					
	Yr 1	Yr 2	Yr 3	Yr 5	Yr 10	Yr 15
Native Shrubs and Trees	2	20	40	60	75	85
Native Perennial Grasses	25	20	15	10	7	5
Native Annual Grasses	20	20	15	5	5	2
Alien Annual Grasses and Forbs	25	20	15	12	5	3
Plant Litter (Duff/Chipped Material)	3	5	5	5	5	5
Erosion Control BMPs (Pine Needle Mulch /Bare Ground/Rock)	25	15	10	8	3	0
Total (%)	100	100	100	100	100	100

4.1 MAER

The project site MAER performance goal for the post-construction phase is the established pre-construction MAER of 5.5 t/ac/yr.

4.2 SLOPE EVALUATION

The slope evaluated for the construction phase was also evaluated for the post-construction phase. An estimate of the annual rate of erosion for this slope was performed using the Caltrans RUSLE2 erosion prediction tool at different time intervals adjusting for increased vegetation cover. Soils data from the reference site and climate data from the project site were used for a slope length of 50 feet and a slope steepness of 1:2 (V:H) (50% slope).

Erosion control and sediment control BMPs include the temporary BMPs installed during the construction phase and permanent BMPs installed prior to the post-construction phase. Permanent erosion control BMPs consist of additional hydroseeding (SS-4) with Synthetic fiber (SS-7). Container grown trees and shrubs will also be planted on the slope. A temporary irrigation system will be used for 5 years to assist plant establishment (Figure 3).

Figure 3 Temporary irrigation system to augment vegetation establishment

Since the erosion rate for the post-construction slopes decreases over time as the planting becomes established, the selected permanent soil stabilization and sediment control BMPs are considered adequate.

An estimate of the annual rate of erosion for this post-construction slope was performed using the Caltrans RUSLE2 erosion prediction tool. The soil loss was estimated to be 5.1 t/ac/yr, which is less than the established MAER of 5.5 t/ac/yr.

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET No	TOTAL SHEETS
03	Nev	80,89,267	Var	1	

STATE OF CALIFORNIA

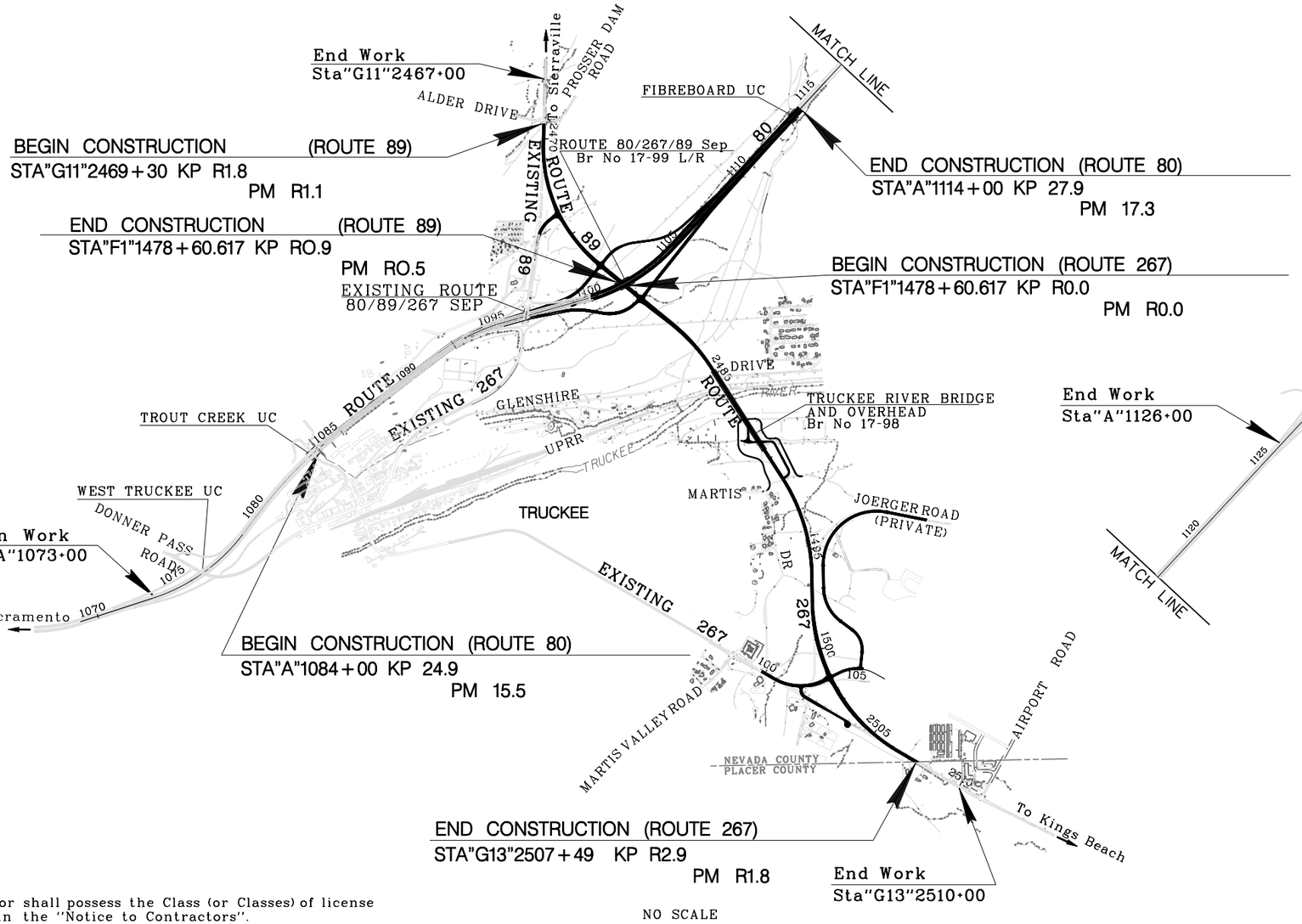
DEPARTMENT OF TRANSPORTATION

PROJECT PLANS FOR CONSTRUCTION ON

STATE HIGHWAY

IN NEVADA COUNTY IN TRUCKEE
ON ROUTE 89 FROM ALDER DRIVE/PROSSER DAM ROAD
TO NEVADA/PLACER COUNTY LINE ON ROUTE 267
AND ON ROUTE 80 FROM TROUT CREEK UNDERCROSSING
TO FIBREBOARD UNDERCROSSING

To be supplemented by Standard Plans dated July, 1997



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Caltrans Metric

The Contractor shall possess the Class (or Classes) of license as specified in the "Notice to Contractors".

NO SCALE

Mitch Andrus
Project Engineer Date 10-15-98
Registered Civil Engineer

REGISTERED PROFESSIONAL ENGINEER
MITCH ANDRUS
No. C 48753
Exp. 09/30/00
CIVIL
STATE OF CALIFORNIA

Plans Approval Date

PROJECT ENGINEER	DATE	PROJECT MANAGER	DATE
M. ANDRUS		H. SYKES	

DATE PLOTTED =) $DATE
PLOT TIME =) $TIME
LAST REVISION 06-31-98

Contract No. 03-291004

FORM DC-OE-93-PF (REV. 3/88)

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DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET No	TOTAL SHEETS
03	Nev	80,89,267	Var		

Mitch Andrus 10-15-98
REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER
MITCH ANDRUS
No. C48753
Exp. 9-30-00
CIVIL
STATE OF CALIFORNIA

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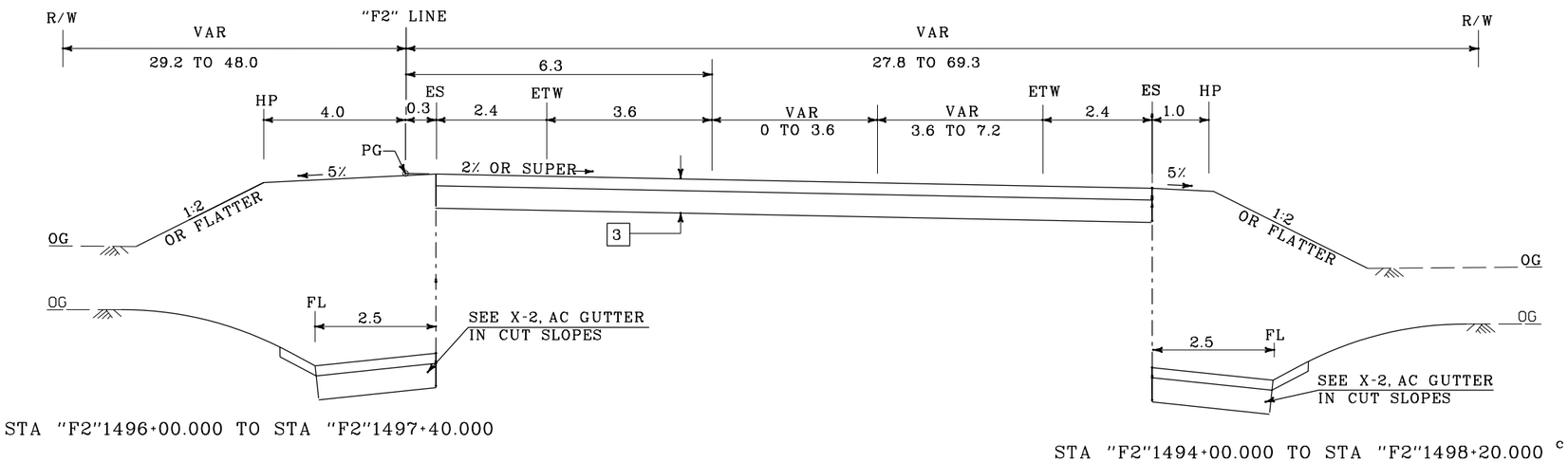
Caltrans Metric

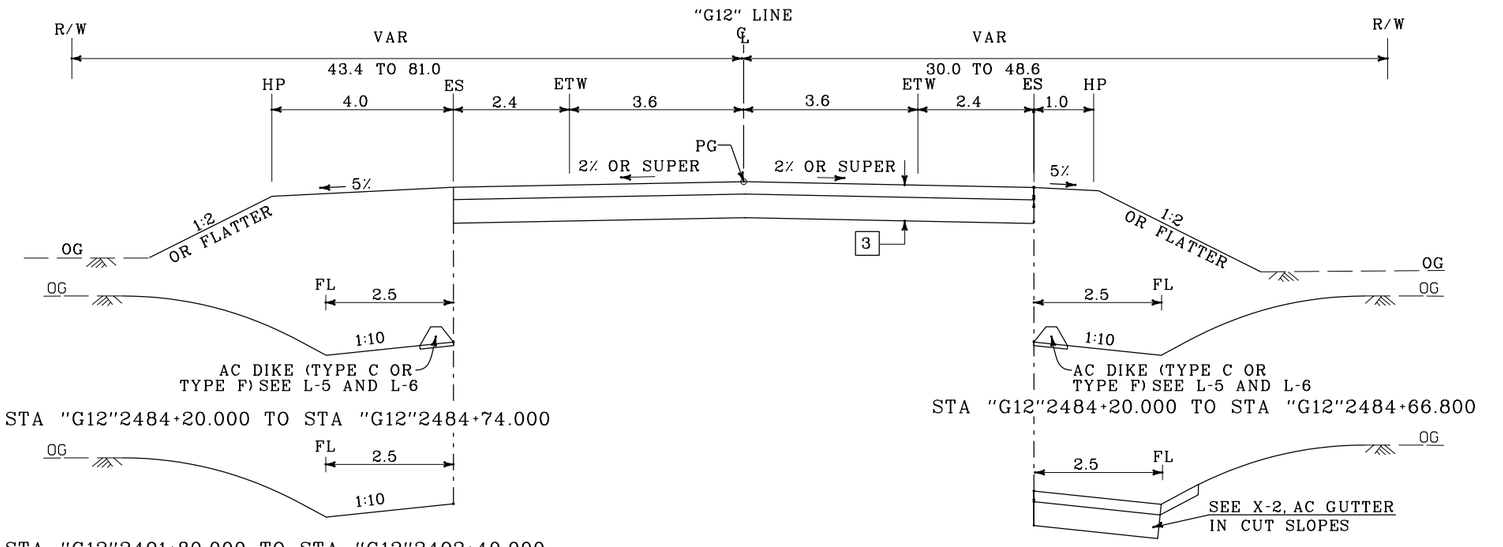


STA "F2"1496+00.000 TO STA "F2"1497+40.000

STA "F2"1494+00.000 TO STA "F2"1498+20.000 c

"F2" LINE (ROUTE 267)

STA "F2"1494+00.000 TO STA "F2"1502+25.347



STA "G12"2484+20.000 TO STA "G12"2484+74.000

STA "G12"2491+80.000 TO STA "G12"2492+40.000

STA "G12"2484+20.000 TO STA "G12"2484+66.800

STA "G12"2490+58.300 TO STA "G12"2492+75.000 c
STA "G12"2493+60.000 TO STA "G12"2493+98.070 c

"G12" LINE (ROUTE 267)

STA "G12"2484+20.000 TO STA "G12"2484+81.000
STA "G12"2489+52.000 TO STA "G12"2493+98.070

ADDITIONAL NOTES:

a. SEE DRAINAGE AND LAYOUT SHEETS FOR SEDIMENTATION BASIN LOCATIONS AND AC GUTTER OFFSETS AND ELEVATIONS.

b. SEE STRUCTURES PLANS FOR STA"G12"2484+81 TO STA"G12"2489+52.

c. SEE G-4, G-5, G-6 AND C-13 FOR SOUND BERM CONTOUR GRADING AND DETAIL.

NOTES:

1. DIMENSIONS OF THE STRUCTURAL SECTIONS ARE SUBJECT TO TOLERANCES SPECIFIED IN THE STANDARD SPECIFICATIONS.
2. SUPERELEVATION AS SHOWN OR AS DIRECTED BY THE ENGINEER.
3. TYPICAL SECTIONS NOT SHOWN FOR TRANSITION AREAS.
4. SEE LAYOUT PLANS FOR AC DIKE, AC GUTTER AND MBGR LOCATIONS.
5. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN.

TYPICAL CROSS SECTIONS

NOT TO SCALE

X-6

DATE REVISED BY | DATE REVISED
CALCULATED/DESIGNED BY | CHECKED BY
PROJECT ENGINEER: MITCH ANDRUS
STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans
DIVISION OF DESIGN

DATE PLOTTED =) $DATE
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NOTES:

1. FOR COMPLETE R/W AND ACCURATE ACCESS DATA, SEE R/W RECORD MAPS AT DISTRICT OFFICE.
2. UNLESS DENOTED OTHERWISE, ALL DIMENSIONS FOR MEASUREMENT OF LENGTH SHOWN ON THIS PLAN ARE IN METERS.
3. COORDINATE VALUES SHOWN ARE CCS27 ZONE 2. MULTIPLY BY 1.00036 TO OBTAIN GROUND DISTANCES.
4. SEE UTILITY PLANS FOR ACCURATE UTILITY INFORMATION.
5. SEE DRAINAGE PLANS FOR ACCURATE DRAINAGE INFORMATION.

CURVE DATA				
No.	R	Δ	T	L
(1)	35.000	64° 30'33"	22.087	39.406
(2)	100.000	14° 35'10"	12.798	25.457
(3)	100.000	11° 12'46"	9.816	19.570
(4)	50.000	60° 30'46"	29.167	52.807
(5)	60.000	74° 00'29"	45.220	77.501
(6)	30.000	89° 05'31"	29.528	46.648
(7)	30.000	90° 54'29"	30.479	47.599
(8)	50.000	32° 09'39"	14.413	28.066
(9)	25.000	60° 15'18"	14.508	26.291
(10)	20.000	66° 52'43"	13.207	23.345

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET No	TOTAL SHEETS
03	Nev	80,89,267	Var		

Mitch Andrus 10-15-98
REGISTERED CIVIL ENGINEER

REGISTERED PROFESSIONAL ENGINEER — MITCH ANDRUS No. C48753 Exp. 9-30-00 CIVIL — STATE OF CALIFORNIA

PLANS APPROVAL DATE

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Caltrans Metric

"SD" 17+10.745 EC
TCE
"SD" 16+87.400 BC
28.221
N86° 58'20"E
"SD" LINE
179.216
S 26° 08'57"E
"SD" 15+70.523 EC
"SD" 15+82.821 BC
12.298
S00° 36'43"E
"SD" 16+59.179 EC
"SD" 16+10.887 EC
"SD" 16+32.888 BC
22.001
S32° 46'22"E
"T"11+96.623 BC
CL FENCE(TYPE CL-1.8)
SEE G-3 FOR CONTOUR GRADING
"SD"15+22.924 BC
56.021
N 88° 28'49"E
LT "G12"+27.96
46.91 LT
"G12"+00.67
"T" LINE
136.715
N 27° 58'04"W
SB-10
(SEE D-7 AND G-3)
"SD"14+69.125 POT=
"G12" 2487+68.360 POT
"G12"2489+03.242 POT=
"T"12+84.526 POT
"T"12+36.029 EC
APPROACH SLAB
(SEE BRIDGE PLANS)
SEE G-3 FOR CONTOUR GRADING
+52 BEGIN STRUCTURAL SECTION
+55.50 BEGIN MBGR (WOOD POST) BEGIN AC DIKE (TYPE F)
133.35 MBGR (WOOD POST)
+40.00 END AC DIKE (TYPE F)
TRUCKEE RIVER BRIDGE AND OVERHEAD BR NO 17-98
SEE G-3 FOR CONTOUR GRADING
"SD"14+66.903 EC
"G12" LINE
ROUTE 267
S 32° 46'20"E
659.890
2490
2488
"S"11+00.000 PI
N 00°36'42"W
"S" LINE
100.000
"G12"2489+49.000 END BRIDGE
+72.39 BEGIN MBGR (WOOD POST) BEGIN AC DIKE (TYPE F)
+29 END AC DIKE(TYPE F) BEGIN AC DIKE MBGR (WOOD POST) (TYPE C)
+40 END
68.58 MBGR (WOOD POST)
+25 BEGIN AC GUTTER (CASE 1) (SEE D-7)
+58.30 END AC DIKE (TYPE C)
7.02 RT
"G12"+70.60
24.91 RT
"G12"+67.05
SB-9
(SEE D-7 AND G-3)
SB-11
(SEE D-7 AND G-3)
9.2 LT
"T"+06.33
CL FENCE(TYPE CL-1.8)
SEE C-12 FOR T-S INTERSECTION
RT "G12"+71.64
"SD" 11+06.320 BC
"T"13+54.677 EC
"T"13+29.220 BC
"SD"12+01.818 EC
"SD"14+20.255 BC
"T"13+82.815 PI
"T"13+38.922 POC=
"S"10+00.000 PI
46.403
N 74° 37'11"W
"SD"11+49.011 BC
23.121
N14° 06'25"W
"SD"11+25.890 EC
94.533
N 00° 36'42"W
S 28.138
N 77° 53'29"W
TCE
"SD"12+48.221 BC
2.4 RT
"SD"+26.07
"SD"13+25.722 EC
SECTION LINE SEC 13 SEC 14
SEC 11 SEC 14
SECTION LINE
TRUCKEE
T17N R16E,MDM
SEC. 11,12,13 & 14
MATCH LINE SHEET L-6
MATCH LINE SHEET L-8

LAYOUT
SCALE 1:500

L-7

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION	DESIGN	PROJECT ENGINEER	MITCH ANDRUS	CALCULATED/ DESIGNED BY		DATE	REVISED BY
				CHECKED BY		DATE REVISED	

DATE PLOTTED =) $DATE
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NOTES:

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3. COORDINATE VALUES SHOWN ARE CCS27 ZONE 2. MULTIPLY BY 1.00036 TO OBTAIN GROUND DISTANCES.
4. SEE UTILITY PLANS FOR ACCURATE UTILITY INFORMATION.
5. SEE DRAINAGE PLANS FOR ACCURATE DRAINAGE INFORMATION.

Caltrans Metric

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET No	TOTAL SHEETS
03	Nev	80,89,267	Var		

Mitch Andrus 10-15-98
REGISTERED CIVIL ENGINEER

REGISTERED PROFESSIONAL ENGINEER — MITCH ANDRUS — No. C48753 — Exp. 9-30-00 — CIVIL — STATE OF CALIFORNIA

PLANS APPROVAL DATE

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TRUCKEE
T17N R16E,MDM
SEC 13

"SD" 19+31.336 PI
"SD" 19+28.932 EC
END STRUCTURAL SECTION
CONFORM TO EXISTING

179.216
S 26° 08'57"E
"SD" 18+89.961 BC
TCE
"SD" LINE
UTILITY EASEMENT
CL FENCE(TYPE CL-1.8)
SEE G-4 FOR CONTOUR GRADING
"T"10+59.908 EC
"T" LINE 136.715
N 27° 58'04"W
SEE G-4 FOR CONTOUR GRADING
"T"10+22.737 BC
+15 4.6 DOUBLE PIPE GATE(SEE C-15)
+00 END MBGR (WOOD POST)
129.54 MBGR (WOOD POST)
659.890
S 32° 46'20"E
"G12"2491+17.730 BC
SEE C-10 GI2-T INTERSECTION
ROUTE 267
"G12" LINE
2492
2491
2493
AC GUTTER (CASE 1)
+75 END AC GUTTER (CASE 1)
"G12"2491+20.000 POC*
"T"10+00.000 PI
SOUND BERM (SEE C-13 AND G-4)
SB-12 (SEE D-8 AND G-4)
+30 BEGIN AC GUTTER (CASE 1)
+60
DRAINAGE EASEMENT
R/W
CF
FC
RT +15.00
1.2 CL GATE
(TYPE CL 1.8)
CL FENCE(TYPE CL-1.8)
BACKFLOW PREVENTER ASSEMBLY
(SEE STD PLN H-7 AND C-17)
WATER METER
(BY OTHERS)
"SD" 10+60.187 EC
"SD" LINE
38.843
N25° 19'12"W
"SD" 10+33.750 POC
BEGIN STRUCTURAL SECTION
"SD" 10+22.391 BC
DECK
ASPH
MATCH LINE
SHEET L-7
SHEET L-9

CURVE DATA				
No.	R	Δ	T	L
①	914.501	17° 33'51"	141.278	280.340
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③	30.000	72° 11'08"	21.870	37.796
④	30.000	74° 25'46"	22.783	38.971

LAYOUT
SCALE 1:500

L–8

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION	DESIGN
PROJECT ENGINEER	MITCH ANDRUS
CALCULATED/DESIGNED BY	
CHECKED BY	
DATE REVISED	
REVISED BY	
DATE PLOTTED =) $DATE	
PLOT TIME =) $TIME	
LAST REVISION	08-03-98

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NOTES:

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2. UNLESS DENOTED OTHERWISE, ALL DIMENSIONS FOR MEASUREMENT SHOWN ON THIS PLAN ARE IN METERS.
3. CONTOUR INTERVAL-0.5 m.

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET No	TOTAL SHEETS
03	Nev	80,89,267	Var		

Mitch Andrus 10-19-98
REGISTERED CIVIL ENGINEER

REGISTERED PROFESSIONAL ENGINEER — MITCH ANDRUS — No. C48753 — Exp. 9-30-00 — CIVIL — STATE OF CALIFORNIA

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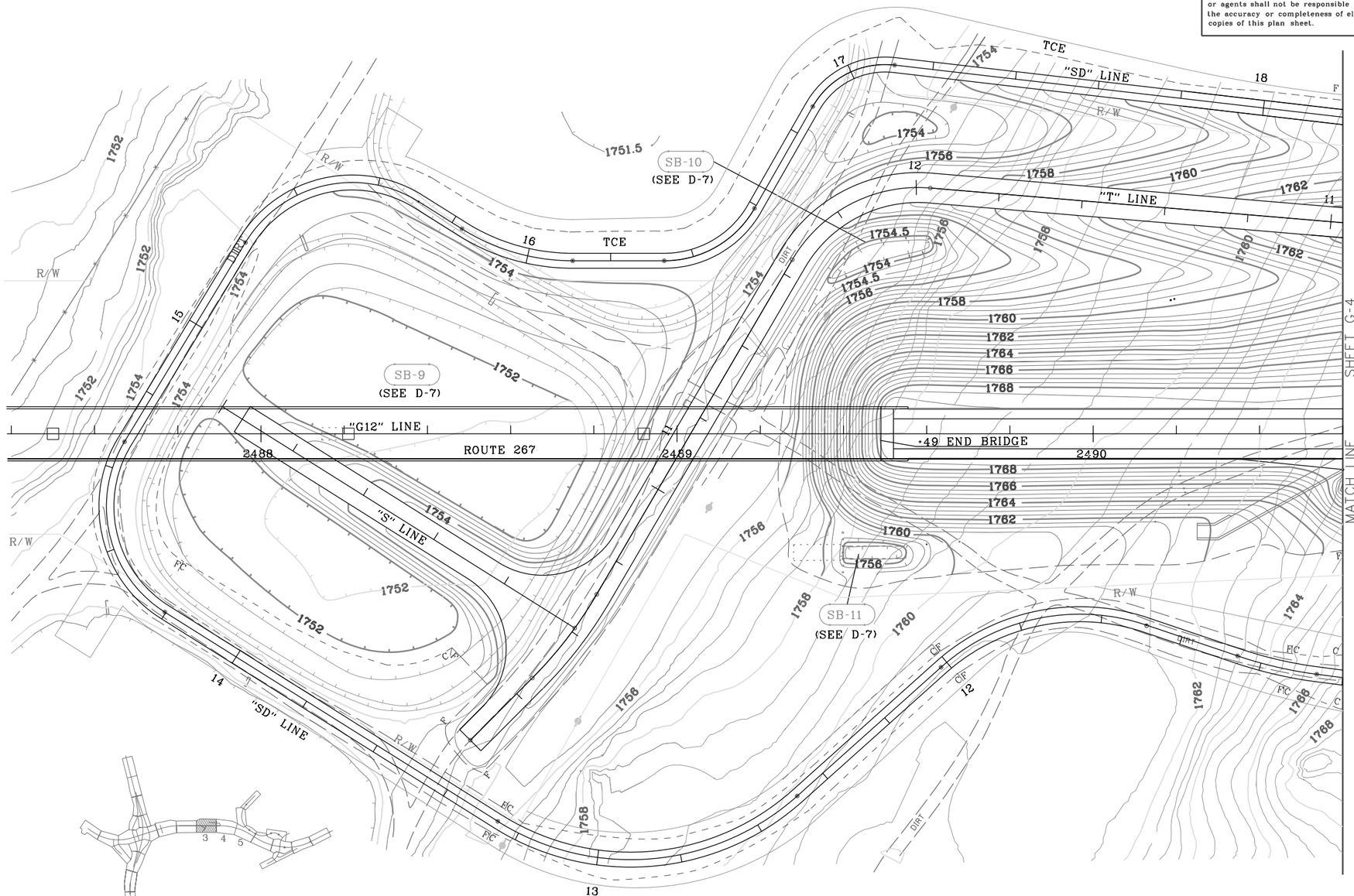

CONTOUR GRADING
SCALE 1:500

G-3

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION	DIVISION OF DESIGN	PROJECT ENGINEER	MITCH ANDRUS	CALCULATED/ DESIGNED BY	CHECKED BY	DATE	REVISED BY	DATE REVISED

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PLOT TIME =) $TIME

LAST REVISION 09-15-98

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NOTES:

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3. CONTOUR INTERVAL-0.5 m.

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET No	TOTAL SHEETS
03	Nev	80,89,267	Var		

Mitch Andrus 10-19-98
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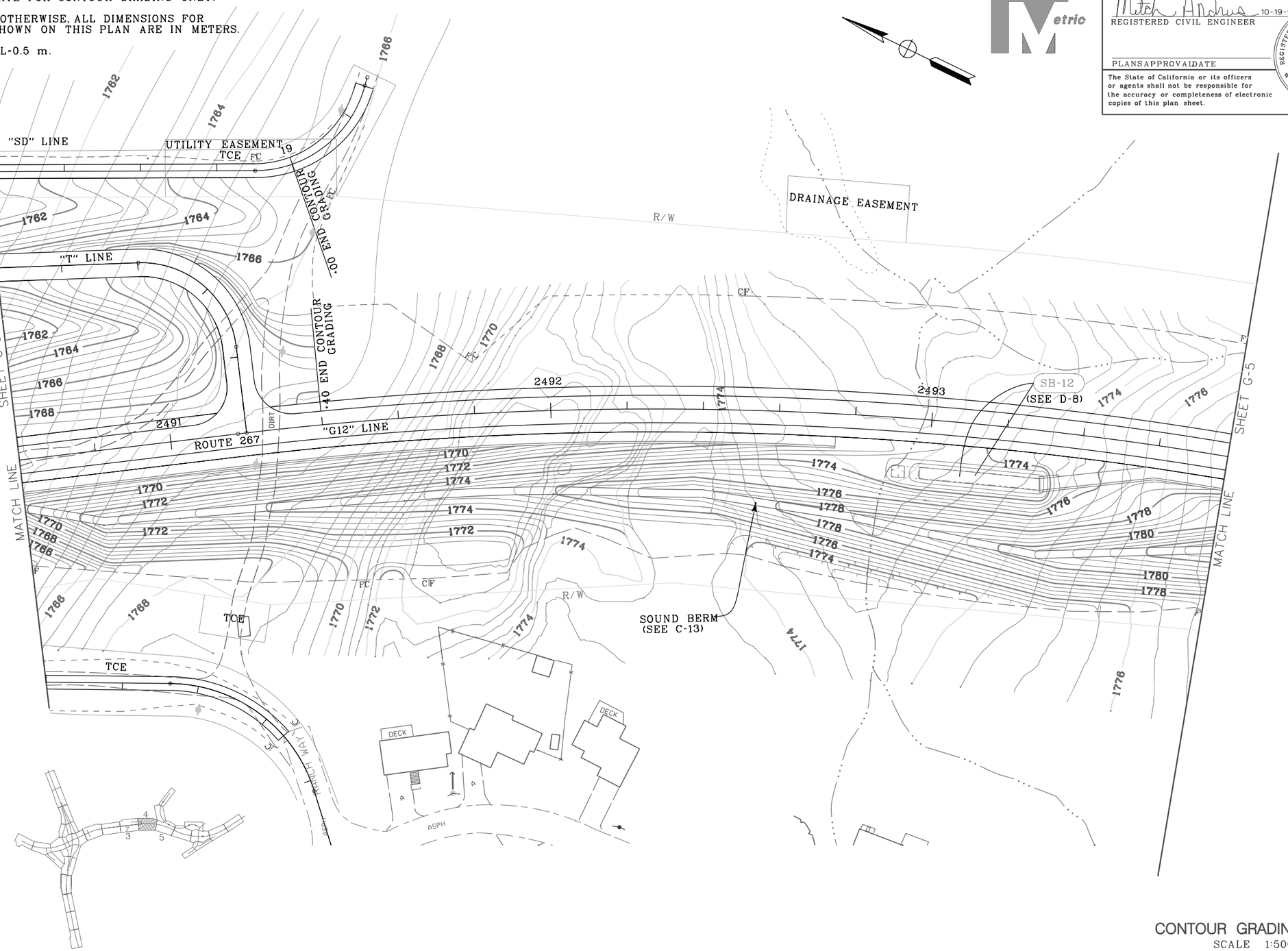
REGISTERED PROFESSIONAL ENGINEER
MITCH ANDRUS
No. C48753
Exp. 9-30-00
CIVIL
STATE OF CALIFORNIA



CONTOUR GRADING
SCALE 1:500

G-4

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
DESIGN
Caltrans

PROJECT ENGINEER
MITCH ANDRUS

CALCULATED/ DESIGNED BY
CHECKED BY

DATE REVISED BY
DATE REVISED

LAST REVISION 08-03-98
DATE PLOTTED =) $DATE
PLOT TIME =) $TIME

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DGN FILE =) $REQUEST

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EA 291001

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NOTES:

1. THIS PLAN ACCURATE FOR DRAINAGE ONLY.
2. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN.
3. SEE SHEET D-36 FOR DRAINAGE PROFILE 14.
4. SEE SHEET D-37 FOR DRAINAGE PROFILES 15 AND 16.
5. SEE SHEET D-43 FOR DRAINAGE PROFILE 26.

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET No	TOTAL SHEETS
03	Nev	80,89,267	Var		

Martin B. Earles 10-20-98
REGISTERED CIVIL ENGINEER

REGISTERED PROFESSIONAL ENGINEER
MARTIN B EARLES
No. C46589
Exp. 6-30-99
CIVIL
STATE OF CALIFORNIA

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Caltrans Metric

SHEET D-6

MATCH LINE

SHEET D-8

MATCH LINE

SEE SHEET G-3 FOR SEDIMENT BASIN CONFIGURATION

SEE SHEET G-3 FOR FLOWLINE

SEE BRIDGE PLANS

SEE SHEET G-3 FOR SEDIMENT BASIN CONFIGURATION

SEE SHEET G-3 FOR FLOWLINE

"G12" 2489+49.000
END BRIDGE

"G12" LINE
ROUTE 267

"S" LINE

"SD" LINE

"T" LINE
N 27°58'04"W
158.795

"G12"2489+03.242 POT=
"T"12+84.526 POT

"T"13+38.922 POC=
"S"10+00.000 PI

RSP (BACKING NO. 1) METHOD B
SEE DETAIL THIS SHEET

450 mm APC

200 mm APC

600 mm APC

SB-9
SB-10
SB-11

TCE

DIRT

FC

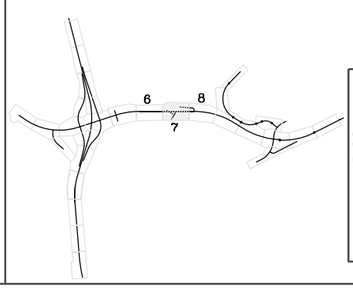
CIP

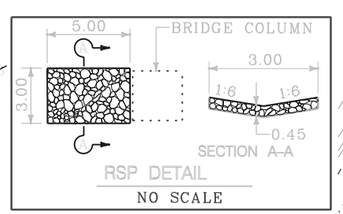
R/W

1749.56
1752.60
1753.50
1754.50
1755.65
1756.75
1758.70
1761.75
1761.81
1764.80
1767.84

25.50 RT @25
FL ELEV 1761.747

25.50 RT @30
FL ELEV 1761.865





RSP DETAIL
NO SCALE

DRAINAGE PLAN
SCALE 1:500

D-7

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION	PROJECT ENGINEER	CALCULATED/ DESIGNED BY	DATE	REVISED BY	DATE REVISED
Caltrans DIVISION OF DESIGN	MITCH ANDRUS	CHECKED BY			

LAST REVISION	DATE PLOTTED =) $DATE PLOT TIME =) $TIME
10-14-98	

FOR REDUCED PLANS ORIGINAL SCALE IS IN MILLIMETERS 0 20 40 60 80

USERNAME =) $USER
DGN FILE =) $REQUEST

CU 03226

EA 291001

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NOTES:

1. THIS PLAN ACCURATE FOR DRAINAGE ONLY.
2. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN.
3. SEE SHEET D-38 FOR DRAINAGE PROFILE 17.
4. SEE SHEET D-39 FOR DRAINAGE PROFILE 18.

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET No	TOTAL SHEETS
03	Nev	80,89,267	Var		

Caltrans Metric

Martin B. Earles 10-20-98
REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — MARTIN B EARLES — No. C46589 — Exp. 6-30-99 — CIVIL — STATE OF CALIFORNIA

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200 mm ALTERNATIVE CONDUIT (SEE "IRRIGATION CROSSOVER" DETAIL ON SHEET C-13)

"T" LINE

"G12"2491+20.000 POC
"T"10+00.000 PI

"G12" LINE
ROUTE 267

200 mm ALTERNATIVE CONDUIT (SEE "IRRIGATION CROSSOVER" DETAIL ON SHEET C-13)

"G12"2491+17.730 BC

SOUND BERM

SEE SHEET G-4 FOR SEDIMENT BASIN CONFIGURATION

SHEET D-7 MATCH LINE

SHEET D-9 MATCH LINE

15.60 RT +97.820
FL ELEV 1772.500

15.60 RT +30
FL ELEV 1772.500

MARTIS DRIVE

DECK

ASPH

DRAINAGE PLAN
SCALE 1:500

D-8

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION	PROJECT ENGINEER	CALCULATED/ DESIGNED BY	CHECKED BY	DATE	REVISED BY	DATE REVISED
Caltrans DIVISION OF DESIGN	MITCH ANDRUS					

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DGN FILE =) $REQUEST

CU 03226

EA 291001

LAST REVISION 09-21-98

DATE PLOTTED =) $DATE
PLOT TIME =) $TIME

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FINAL

RUSLE2 Computation Error and Post-construction Vegetation Selection Summary Memorandum

September 29, 2008

CTSW-TM-07-172.50.1

California Department of Transportation
Division of Environmental Analysis
Stormwater Program
1120 N Street
Sacramento, CA 95814
http://www.dot.ca.gov/hq/env/stormwater/index.htm

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RUSLE2 COMPUTATION ERROR AND POST-CONSTRUCTION VEGETATION SELECTION SUMMARY MEMORANDUM

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The California Department of Transportation (Caltrans) initiated modifications to the Agricultural Research Service (ARS) Revised Universal Soil Loss Equation Version 2 (RUSLE2) model to facilitate use of the program in highway construction projects in California. The modified program is referred to as the Caltrans RUSLE2.

The Caltrans RUSLE2 program incorporated modifications that improve its applicability to California ecosystems and construction activities. Changes included improvements and simplifications to the program interface and to the underlying database, including climate information and management practices.

During development and revision of the Caltrans RUSLE2 program, it became evident that a number of computation errors existed in the ARS RUSLE2 program regarding vegetation and residue. Specifically, long-term erosion rates did not appear to match field observation data, particularly for time frames exceeding 3 years. In addition, assumptions for post-construction vegetation options in Caltrans RUSLE2 and the associated ARS RUSLE2 crop vegetation and yield needed to be reviewed, summarized, and refined.

The purpose of this Summary Memorandum is to address RUSLE2 computation errors, present recommendations on how to resolve these errors, and summarize the assumptions that were used to characterize the post-construction vegetation options available in Caltrans RUSLE2, as well as the assumptions that were revised to better match field observations and empirical evidence.

2.1 RUSLE2 Computation Errors

In response to the variation in Caltrans RUSLE2 output and long-term erosion prediction rates (i.e., not matching field observation data for time frames exceeding 3 years), data results were reviewed for various vegetation scenarios and time frames. After reviewing the results and determining that previous modifications to the Caltrans RUSLE2 program were not the source of the errant results, ARS RUSLE2 programmers were contacted to determine the source and possible resolutions to the long term prediction errors.

The following information is based on verbal and e-mail communications (October 2007 through May 2008) with a core member of the ARS RUSLE2 development team, Seth Dabney.

- Software researchers and programmers have been working on a revision of RUSLE2 for improved functionality and better representation of perennial vegetation. It is critical that RUSLE2 vegetation and management options reflect realistic amounts of residue and dead roots over time for perennial systems, particularly those involving mixed species such as grasses, shrubs, and trees. The residue may be produced more or less continuously (i.e., one declining while another is growing), and not just when the aboveground canopy declines.

- The next anticipated revision of the ARS RUSLE2 will calculate residue and dead roots differently and, as such, will be more accurate.

- This next revision of RUSLE2 will create more appropriate vegetation options/characterizations based on inputs such as life span of vegetation, monthly yield, and root biomass.

- This next version of the ARS RUSLE2 is anticipated to be released in the final quarter of 2008.

A summary of specific discussion points follows:

- "Volunteer vegetation" from the Natural Resources Conservation Service (NRCS) database can be used to represent vegetation for Caltrans projects as long as it represents the location and matches the corresponding "growth chart."
- The time period of the growth chart in the NRCS database is 10 years. The growth chart represents the gradual increase of root mass, canopy, and fall height. It represents live cover increases up to 3 years and live cover decreases to "0."
- The current ARS RUSLE2 program often computes different soil loss for the same scenarios/runs. The programmers are aware of this issue and are developing the next release of RUSLE2 with improved functionality that should solve this problem, as well as related issues.
- Using ARS RUSLE2 volunteer vegetation to represent the Caltrans grass/forbs option may not be accurate as volunteer vegetation acts as an umbrella with a

canopy of 95 percent from 105 days of growth throughout its 10 year growth period; however, this depends on whether grass/forbs is a perennial or annual option.

- It was suggested that Caltrans RUSLE2 vegetation options be modified to better fit long-term vegetation growth patterns. However, even if vegetation options are modified into long-term vegetation in RUSLE2, continuous growth and root biomass will still not be modeled effectively. Vegetation in the current version of ARS RUSLE2 grows as a crop and thus cannot calculate root biomass and residue effectively. The ARS RUSLE2 version that is presently being developed (for fall 2008) will calculate variability in the growth chart more effectively than the current version.
- The next version of ARS RUSLE2 will have improved functionality in calculating perennial vegetation effects. It will calculate residue and dead roots based on inputs such as life span of vegetation, monthly yield, and root biomass with more accuracy than the current ARS RUSLE2.
- A vegetation record can be developed; however, in order to do so, the exact life span of vegetation, monthly yield, and root biomass needs to be recorded. The next version of ARS RUSLE2 will allow for the creation of new vegetation types more effectively if these data (life span, yield, root biomass) are available.
- The ARS RUSLE2 programmers are actively developing the new version of RUSLE2 and are not available to help validate the Caltrans RUSLE2 vegetation types and associated assumptions.
- In developing new vegetation types for Caltrans RUSLE2, several vegetation options need to be considered to represent different regions of California. A general vegetation type cannot be applied to the entire state; root biomass and yield change soil loss substantially. The next version of ARS RUSLE2 will create more appropriate vegetation types easily, assuming they are based on accurate data.

The following general observations and conclusions were made based on discussions with ARS and further review of Caltrans RUSLE2 output:

- Grasses and forbs and their corresponding ARS vegetation type give reasonable results in the Caltrans RUSLE2 model runs in general (with erosion rates decreasing over time).
- Shrubby vegetation does not generally give realistic or reasonable results (erosion rates were increasing over time), particularly over long time periods. ARS confirmed this issue, stating that there is a canopy problem with shrubs and trees, especially noticeable beyond the 3-year level.
- California vegetation behaves as expected, whereas nonnative vegetation does not produce as accurate or realistic of results in Caltrans RUSLE2 runs.

- The Caltrans RUSLE2 user must be aware that much of RUSLE2 calculations are based on extrapolations vs. actual data, especially for long-term calculations. Results should be compared with expected values and empirical evidence whenever possible.

2.2 Permanent Vegetation

In order to respond further to the variation in Caltrans RUSLE2 long-term erosion prediction rates, post-construction vegetation assumptions (basis of vegetation type as well as crop yield) were reviewed for consistency with field observations and empirical evidence. Several additional ARS vegetation types and crop yields were considered a basis for each of the Caltrans RUSLE2 post-construction vegetation types to better characterize the recommended Caltrans post-construction vegetation options. A summary of results is presented in Table 2-1.

It should also be noted that post-construction erosion rates are expected to decrease after project completion and subsequently level out. As the permanent vegetation establishes several years (particularly 3 years and beyond) after construction, the erosion rate is expected to remain constant and stable. This level rate indicates equilibrium and sustainability.

Table 2-1 OPTIONS IN ARS/NRCS DATABASE FOR CALTRANS RUSLE-2 POST CONSTRUCTION VEGETATION

			Default Erosion rate (t/ac)							Proposed Erosion rate (t/ac)					
Default Vegetation	**RUSLE2 BMP Vegatation Name**	**Default Yield (lb)**	**1 Yr**	**3 Yr**	**5 Yr**	**10 Yr**	**15 Yr**	**Model Results Based on:**	**Proposed Yield (lb)**	**1 Yr**	**3 Yr**	**5 Yr**	**10 Yr**	**15 Yr**	**Database Info**
Volunteer Vegetation, Grass	Grasses and Forbs - medium	5000	47	39	35	32	30	Grass Cool season, fall seeded	1400	31	14	10	7.2	6.1	Permanent cool season grass cover, fall seeded. Includes senescence, overwintering and yr2 regrowth. Base location Columbia, MO 01-03-02 DTL
								Brome california, established cover, CA	3000	5.7	3	2.1	1.4	1.1	dormancy through day 200 and fall regrowth in mid October. Annual root sloughing accounted for in May. Use Begin growth each year to call in this file. Base location Napa Valley California. 020705 DTL
								Fescue, Red, established, CA	2000	5.3	3.2	2.3	1.5	1.3	Red Fescue perennial cover, established years. This file represents years 2 and later and includes summer dormancy through day 165 and fall regrowth in mid October. Annual root sloughing accounted for in dormant period. Use "Begin growth" to repeat this record each year in mid April .Base location Napa Valley California. 020705 DTL
								Pine bluegrass, established perennial cover, CA	2000	4	4.2	3.7	3.2	3.0	Pine bluegrass perennial cover, established years. This file is 2nd and later year and begins in mid April and includes summer dormancy through day 120 and fall regrowth in mid August. Annual root sloughing accounted for in regrowth in May. Use "Begin growth" to restart this record each year in mid April. Base location Napa Valley California. 020705 DTL
Volunteer Vegetation, Grass	Grasses and Forbs - dense	7500	36	28	26	23	22	Weeping Lovegrass, not harvested	6000	1	2.3	2.3	2.3	2.2	Weeping Lovegrass permanent cover on critical areas, filter trips, buffer strips, construction sites, CRP, etc. File begins with spring green up. 06-24-03 DTL
								Grass,Warm season, Permanent, not harvested, 3 yr establishment, spring seeded	6000	8.1	3	2.2	1.3	1.0	includes establishment, fall senescence, overwintering, and yr2 and yr3 growth and senescence and yr4 greenup. This file should be followed by Grass, warm season permanent, not harvested called in with a begin growth operation in late spring of year 4. Base location Columbia, MO Seeded in late April. 165 days to frost & senescence The yield represents the amount of forage available at the next
								Switch grass, biomass prod, Year 2 over winter and yr 3	10000	1	1.9	2.6	3.1	3.3	Switchgrass for biomass production, overwinter and third and later season growths. Use for year 3 and beyond. File ends and harvest Nov 1st of yr3 and later years. Base location Columbia, MO 05-02-02 DTL
								Volunteer Vegetation, grass	20000	7.9	5.6	4.9	4.3	4.0	Volunteer vegetation (swidden), primarily grasses. Growth begins after harvest of cultivated crops and cultivated cropping has ceased for multiple years. Primarily grass vegetation that becomes more coarse and woody over the years of growth.This record represents 10 years of growth but may be used for shorter periods by specifying beginning and ending dates in management record. Type location: tropical-subtropical locations in Pacific Basin.Yield - 20,000 lb (Consider 100% yield in NRCS/ARS database)
Volunteer Vegetation, mixed shrub	Grasses/Forbs and Shrubs - medium	7500	26	28	30	33	34	Blueberry, Low bush, cover crop	4000	19	15	20	22	23.0	Blueberries. Low growing variety. 9 ft. spacing. 1200 plants/ac. Established with grass cover crop between bushes**.** Cover mowed during growing season, accounting for fluctuations in canopy. Type location: western Oregon. 7/30/98 gaw & tmg, Rev 3/7/02 gaw.
Volunteer Vegetation, mixed shrub	Grasses/Forbs and Shrubs - Dense	10500	21	23	25	28	29	Volunteer Vegetation, mixed shrub	30000	10	9	9.5	11	12.0	Volunteer vegetation (swidden), primarily shrubs. Growth begins after harvest of cultivated crops and cultivated cropping has ceased for multiple years. Primarily woody shrubs, scrub trees and vines, with some grass. This record represents 10 years of growth but may be used for shorter or longer periods by specifying beginning and ending dates in management record. Type location: tropical-subtropical locations in Pacific Basin. Yield - 30,000 lb (Consider 100% yield in NRCS/ARS database)
Volunteer Vegetation, woody	Grasses/Forbs, Shrubs and Trees - medium	10000	27	29	35	42	45	Citrus, full cover	20000	7	7.5	7.6	7.6	7.7	Citrus orchard; ie. orange, grapefruit, lemon, lime.Trees cover 75-85% of area. Full grass cover below & between trees. Residue at harvest is leaf drop. Use operations that effect external residue cover to simulate mowing or other management of cover under trees. 1/29/99 gaw, Rev 4/1/04 gaw.
Volunteer Vegetation, woody	Grasses/Forbs, Shrubs and Trees - dense	15000	21	23	29	38	41	Volunteer Vegetation, woody	40000	5.5	7	14	23	26.0	Volunteer vegetation (swidden), primarily trees. Growth begins after harvest of cultivated crops and cultivated cropping has ceased for multiple years. Primarily tall regrowth jungle trees, with smaller woody understory and a few shrubs and vines. Includes a few forbs and grasses in early years. This record represents 10 years of growth but may be used for shorter or longer periods by specifying beginning and ending dates in management record. Type location: tropical-subtropical locations in Pacific Basin- yield 40,000 lb (Consider 100% yield in NRCS/ARS database)
Volunteer Vegetation, mixed shrub	Shrubs - medium	9000	23	25	27	30	31	Blueberry, Low bush	4000	31	53	56	55	54.0	Blueberries. Low-growing variety. 9 ft. spacing. 1200 plants/acre. File begins Jan. 1. Weeds in interrow killed either mechanically or chemically on day 105 (Mar 15), day 165 (May 15) and day 225 (July 15), which accounts for variation in root mass and canopy cover on those days. Residue at harvest is fall leaf drop.
								Blueberry, Tall bush	4000	34	56	58	56	55.0	Blueberries. Tall, older (13 yr), mature variety. 10 ft. spacing. 870 plants/acre. File begins Jan 1. Weeds in interrow killed either mechanically or chemically on day 180 (Jun. 1) and day 255 (Aug. 15), which accounts for variation in root mass and canopy cover on those days. Residue at harvest is fall leaf drop. Base location is Harrisburg, PA. jbc, rev. gaw 12/15/00
Volunteer Vegetation, mixed shrub	Shrubs - Dense	13000	17	19	21	24	26	Volunteer Vegetation, shrub	35000	7	6	7	9	10.0	Volunteer vegetation (swidden), primarily shrubs. Growth begins after harvest of cultivated crops and cultivated cropping has ceased for multiple years. Primarily woody shrubs, scrub trees and vines, with some grass. This record represents 10 years of growth but may be used for shorter or longer periods by specifying beginning and ending dates in management record. Type location: tropical-subtropical locations in Pacific Basin. Consider Yield - 35,000 lb

3.1 RUSLE2 Computation Errors Recommendations

In order to address Caltrans RUSLE2 program errors and inaccuracies, the following modifications are recommended:

- Limit Caltrans RUSLE2 calculations out to 3 years, as erosion rates appear to lose accuracy beyond that point. As discussed in Section 2.2, this should reflect the stable conditions at most Caltrans sites and it can be assumed that erosion and sediment control beyond that time period would be similar or less than the 3-year levels due to the balance of vegetation growth and litter.
- Revise the RUSLE2 Erosion Prediction Procedure (EPP) to include a section on the post-construction (beyond 3 years) program limitations of RUSLE2 discussed in this Summary Memorandum. The limitations discussion will include a table that will help the user characterize vegetation types.
- Revise the EPP to include a discussion on long-term erosion patterns, particularly that, in general, erosion rates will decrease over time to be at or below 3-year levels.
- The future revision to ARS RUSLE2 should allow the user to model post-construction vegetation beyond the 3-year time frame. When complete, this should address the program limitation in the Caltrans RUSLE2 version.
- Modify Caltrans RUSLE2 program post-construction vegetation options in the database and corresponding sections of the EPP as discussed in Section 3.2 below.

3.2 Permanent Vegetation Modifications

Based on review of post-construction vegetation options and their corresponding assumptions, the following Caltrans RUSLE2 database modifications are recommended:

- Grasses and Forbs, medium density should be based on ARS vegetation California Brome and a yield of 3000 lb/acre.
- Grasses and Forbs, dense should be based on ARS vegetation California Brome and a yield of 4500 lb/acre.
- If Grasses/Forbs and Shrubs consists of greater than or equal to 60 percent grasses/forbs, user should select grasses and forbs, medium density.
- Grasses/Forbs and Shrubs (less than 60 percent grasses/forbs), medium density should be based on ARS vegetation “Blueberry, Low bush, Cover crop” and a yield of 4,000 lb/acre.

- Grasses/Forbs and Shrubs (less than 60 percent grasses/forbs), dense should be based on ARS vegetation "Blueberry, Low bush, Cover crop" and a yield of 6,000 lb/acre.

- If Grasses/Forbs, Shrubs, and Trees consists of greater than or equal to 60 percent grasses/forbs, user should select grasses and forbs, medium density.

- Grasses/Forbs, Shrubs, and Trees (less than 60 percent grasses/forbs), medium density should be based on ARS vegetation "Citrus, Cover in alley" and a yield of 20,000 lb/acre.

- Grasses/Forbs, Shrubs, and Trees (less than 60 percent grasses/forbs), dense should be based on ARS vegetation "Citrus, Cover in alley" and a yield of 30,000 lb/acre.

- There are only two options available for shrub vegetation in the current version of ARS RUSLE2; Blueberry, Low or High Bush and Volunteer Vegetation, mixed shrub. Volunteer Vegetation, mixed shrub only represents up to 10 years of vegetative growth and is valid for tropical to subtropical locations as it is based on vegetation in the Pacific Basin. The Blueberry option more closely resembles vegetation native to California. Therefore, it is recommended that the Shrubs, medium density option in Caltrans RUSLE2 be based on ARS vegetation "Blueberry, Low bush" and a yield of 4,000 lb/acre.

- Shrubs, dense should be based on ARS vegetation "Blueberry, Low bush" and a yield of 6,000 lb/acre.

Vegetation assumptions will be changed within the Caltrans RUSLE2 database, and BMP data sheets (Appendix D) in the RUSLE2 EPP will be updated accordingly.

Communication with Seth Dabney October 2007 – May 2008. (sdabney@msa-oxford.ars.usda.gov), USDA-ARS National Sedimentation Laboratory, Oxford, Mississippi.

FINAL

Construction General Permit-Erosion Prediction Procedure/RUSLE2 Relationship
Technical Memorandum

September 27, 2008

CTSW-TM-07-172.50.2

California Department of Transportation
Division of Environmental Analysis
Stormwater Program
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CGP-EPP/RUSLE2 RELATIONSHIP TECHNICAL MEMORANDUM

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The California Department of Transportation (Caltrans) initiated modifications to the Agricultural Research Service (ARS) Revised Universal Soil Loss Equation Version 2 (RUSLE2) model to facilitate use of the program in highway construction projects in California (Caltrans RUSLE2).

The Caltrans RUSLE2 program incorporated modifications that improved its applicability to California ecosystems and construction activities. Changes included improvements and simplifications to the program interface and to the underlying database, including climate information and management practices.

One of the Caltrans goals is to be able to use the Caltrans RUSLE2 program to meet the requirements of the State Water Resources Control Board's (SWRCB) revised Draft Construction General Permit (CGP) (SWRCB 2008) in relation to erosion and water quality.

The purpose of this Technical Memorandum (TM) is to provide a review of the Draft CGP as it relates to the Caltrans Erosion Prediction Procedure (EPP) and Caltrans RUSLE2. This TM provides a summary and analysis of Caltrans EPP (Caltrans 2008) and RUSLE2 applicability to the Draft CGP and recommendations on how the EPP and Caltrans RUSLE2 can be used to achieve permit goals as well as suggestions on how to revise the CGP to benefit from efforts to date and effective methods for implementation and enforcement of compliance requirements.

The Clean Water Act (CWA) provides that the discharge of pollutants to waters of the United States from any point source is unlawful unless in compliance with a National Pollutant Discharge Elimination System (NPDES) permit. United States (U.S.) Environmental Protection Agency (USEPA) regulations require that discharges of storm water to waters of the U.S. from construction projects that encompass one or more acres of soil disturbance be in compliance with an NPDES permit.

In California, the USEPA has delegated administration of the NPDES program to the SWRCB and the Regional Water Quality Control Boards (RWQCBs). The SWRCB CGP (Water Quality Order 99-08-DWQ) applies to most storm water discharges associated with construction activity in California.

On March 18, 2008, the SWRCB released a draft amendment to Order 99-08-DWQ to provide further revisions and direction including numeric action levels (NALs) and numeric effluent limits (NELs) for pH and turbidity, risk level classification, more best management practices (BMPs) and related requirements, required monitoring and reporting of soil characteristics at the project location, and required effluent monitoring and reporting for pH and turbidity in storm water discharges. In addition to CGP requirements, storm water discharges must also be in compliance with applicable local, state, and federal water quality standards or objectives (e.g., Statewide Water Quality Control Plan, the California Toxics Rule, the National Toxics Rule, or the applicable RWQCB's Water Quality Control Plan).

To facilitate compliance with NPDES regulations and specifically erosion and sediment control objectives to protect water quality, Caltrans has developed the EPP and Caltrans RUSLE2 program. The Caltrans EPP and RUSLE2 approach provides a consistent and routine methodology for assessing and documenting site conditions before, during, and after construction of a project to evaluate and manage erosion. The process is expected to provide an effective method for achieving the goals and objectives of the revised CGP.

The Draft CGP requires dischargers to assess the overall risk of a project to sediment discharge issues, and to place the project into one of three risk categories – low, medium, or high risk based on the project's sediment and receiving water risks computed from a worksheet attachment to the CGP. Variables on the worksheet used to calculate risk include discharge to 303(d)-listed receiving waters, distance to sensitive receiving waters, channel stability, the rainfall factor, the soil erodibility factor, the hillslope length and gradient factors, and the resulting watershed erosion estimate. The Draft CGP also establishes turbidity NALs based on a project's site-specific characteristics such as rainfall amount and intensity, runoff peak flow and volume, soil erodibility, slope length and steepness, and erosion and sediment control measures.

The Caltrans EPP and RUSLE2 program may be applied more broadly to construction projects to help facilitate compliance with Draft CGP requirements. Draft CGP requirements that have applicability to the Caltrans EPP and RUSLE2 are summarized in Table 3-1 below.

Table 3-1. Draft CGP (SWRCB 2008) Requirements Applicable to Caltrans RUSLE2

Numeric Reference	Context	Location in Draft CGP
Turbidity NALs	Turbidity NALs are based on the project's site-specific characteristics.	Page 3 of 27, Item No. 14
1,000 NTU NAL for turbidity = 1,000 NTU NEL for turbidity.	As the NEL for turbidity is 1,000 NTUs, then the NAL for turbidity is also 1,000 NTUs .	Page 3 of 27, Item No. 14
NAL	NAL exceedances trigger the discharger to immediately implement additional BMPs and revise the SWPPP.	Page 4 of 27, Item No. 15
Turbidity NEL of 1,000 NTU	Exceedances are a violation and must be electronically reported to SWRCB.	Page 4 of 27, Item No. 16
NEL	Dischargers must comply with applicable water quality standards (including those that are more restrictive than NELs).	Page 5 of 27, Item No. 26
TMDL	RWQCB may impose additional requirements in drainage areas having TMDLs.	Page 5 of 27, Item No. 27
Discharge prohibitions	Dischargers shall not	Page 9 of 27, Item III.1

found in Basin Plans	violate any discharge prohibitions contained in Basin Plans or statewide water quality control plans.	
NELs and NALs	Table 1 provides NALs and NELs for pH and turbidity, as well as required analytical methodology.	Page 10 of 27, Table B
RUSLE C Factor	An Erosion Control requirement that specifies that, for Risk Level 3, the discharger shall provide cover for all disturbed, inactive areas equivalent to RUSLE C Factor of 0.003.	Page 16 of 27, Item VIII.B.3
70% Vegetative Cover	In order to file a Notice of Termination, the discharger must provide information proving that final stabilization has been achieved. 70 percent vegetative cover is one of the approved methods of stabilization.	Page 25 of 27, Item XI.3.a
RUSLE	In order to file a NOT, soil loss as predicted by RUSLE must be at or below pre-project levels.	Page 26 of 27, Item XI.3.a
RUSLE C Factor	In order to file a NOT, stabilization must be implemented that provides a RUSLE C Factor of 0.003 or less on each individual parcel.	Page 26 of 27, Item XI.3.b

Notes:
BMP Best Management Practice
NAL Numeric Action Level
NEL Numeric Effluent Limit
NOT Notice of Termination
TMDL Total Maximum Daily Load
NTU Nephelometric Turbidity Unit
RUSLE Revised Universal Soil Loss Equation
RWQCB Regional Water Quality Control Board
SWPPP Storm Water Pollution Prevention Plan

4.1 Applicability of EPP and Caltrans RUSLE2 to Draft CGP

The Caltrans EPP and RUSLE2 program can be used for future highway construction projects to characterize project sites in terms of the site's vegetation types, vegetative cover, topography, soil classification, and erodibility potential and help assess which BMPs would provide the most effective erosion prevention and minimization at the site. More specifically and in relation to Table 3-1, the EPP can be used to determine pre-construction site conditions, as required by the Draft CGP. The EPP and Caltrans RUSLE2 can subsequently be used to calculate construction and post-construction soil loss and select the most appropriate BMPs for the project site, as required by the Draft CGP, to either the Maximum Extent Practicable (MEP) or those which are the Best Available Technology economically achievable/Best Conventional Pollutant Control Technology (BAT/BCT). The resulting construction and post-construction erosion rates from Caltrans RUSLE2 can be used to assess risk levels outlined in the Draft CGP and determine whether erosion rates are at or below pre-construction conditions.

4.2 Recommended Revisions to Draft CGP

Based on professional experience and lessons from the Caltrans EPP development effort, a number of revisions are recommend in the Final CGP to facilitate effective methods to assess projects on erosion control. The EPP and Caltrans RUSLE2 development process has resulted in a process that can provide tools to achieve CGP requirements. Suggested modifications are as follows:

- Currently the CGP relates sediment loss directly to turbidity (i.e., at a 1:1 ratio). This is not a justified relationship or representative of actual field conditions, nor is it applicable to RUSLE2. Other factors, including biological and chemical properties may also affect turbidity in water and are not indicative of sediment issues. RUSLE2 calculates soil loss in tons per acre per year (t/acre/yr). It is suggested that the CGP be revised to use a maximum soil loss (or range of losses) in t/acre/yr, similar to the maximum allowable erosion rates (MAERs) listed in the Caltrans EPP, as a limit for construction projects. However, when receiving waters are 303(d)-impaired and have additional water quality objectives (WQOs) or total maximum daily loads (TMDLs), the more restrictive water quality-related requirements must be met.

- Post-construction numeric limits are difficult to set that are applicable to all site conditions and situations. It is suggested that post-construction soil loss should be limited to equal to or less than pre-construction soil loss, as outlined in the Caltrans EPP. Again, when receiving waters are 303(d)-impaired and have additional WQOs or TMDLs, the more restrictive water quality-related requirements must be met.

- The CGP requires the use of both C and P factors when calculating soil loss. The RUSLE2 program combines the two factors in management practices; therefore,

use of C or P factors as decision-making criteria would not be feasible with use of the RUSLE2 program.

- The C factor currently required in order to file a Notice of Termination (NOT) is 0.003. This number seems to be considerably lower than actual achievable C factors. Considering a C factor alone for termination of a permit fails to consider the combined effect of management efforts (combined C and P factors) to achieve erosion control goals. In addition, a numeric C value goal does not allow for variability of site-specific conditions, natural erosion rates, or achievable final conditions. It is recommended that conditions of permit termination focus on soil loss (t/ac/yr) and, when applicable, other numeric WQOs or TMDLs.

California Department of Transportation (Caltrans). 2008. *Erosion Prediction Procedure and Caltrans RUSLE2 Refinement Work Plan*. March.

State Water Resources Control Board (SWRCB). 2008. National Pollutant Discharge Elimination System (NPDES) Draft General Permit for Storm Water Discharges Associated With Construction and Land Disturbance Activities. March 18.