Section A
MASS WASTING

INTRODUCTION

This module summarizes the methods and results of a mass wasting assessment conducted on the Mendocino Redwood Company, LLC (MRC) ownership in the Greenwood Creek watershed, the Greenwood Creek Watershed Analysis Unit (Greenwood Creek WAU). California Planning Watersheds included in the Greenwood Creek WAU include portions of the Lower Greenwood Creek (CG) and Upper Greenwood Creek (CU). This assessment is part of a watershed analysis initiated by MRC and utilizes modified methodology adapted from procedures outlined in the Standard Methodology for Conducting Watershed Analysis (Version 4.0, Washington Forest Practices Board).

The principle objectives of this assessment are to:
1) Identify the types of mass wasting processes active in the basin.
2) Identify the link between mass wasting and forest management related activities.
3) Identify where the mass wasting processes are concentrated.
4) Partition the ownership into zones of relative mass wasting potential based on the likelihood of future mass wasting and sediment delivery to stream channels.

Additionally, the role of mass wasting sediment input to watercourses is examined. This information combined with the results of the Surface and Fluvial Erosion module is used to construct a sediment input summary for the Greenwood Creek WAU, contained in the Sediment Input Summary section of this watershed analysis.

The products of this report are: a landslide inventory map (Map A-1), a Terrain Stability Unit (TSU) map (Map A-2), and a mass wasting inventory database (Appendix A). The assembled information will enable forestland managers to make better forest management decisions to reduce management-induced risk of mass wasting. The mass wasting inventory will provide the information necessary to understand the spatial distribution, causal mechanisms, relative size, and timing of mass wasting processes active in the basin with reasonable confidence.

The Role of Mass Wasting in Watershed Dynamics

Mass wasting is a naturally occurring process, but can be accelerated by anthropogenic disturbances. Forest management practices can alter the natural frequency and magnitude of mass wasting events by changing the relative resisting and driving forces acting on a hillslope, altering soil and bedrock pore water pressures, and/or altering the effective cohesion of soil and bedrock. Increases in sediment yield due to mass wasting can disrupt the dynamic equilibrium of stream channels, resulting in a decline in the quality and quantity of amphibian and anadromous fish habitat, water quality, or stream ecology.

Mass wasting events are able to alter stream environments by increasing bed and suspended sediment loads, modifying the grain-size distribution of channel sediment, introducing woody debris, altering channel morphology by aggradation, damming and obstructing the channel, and in extreme cases scouring the channel to bedrock. Stream systems ultimately adjust to major alterations downstream, as well as upstream of individual mass wasting events. However, the consequences may last for a long while.

In the Pacific Northwest where anadromous fish are present, mass wasting can have both beneficial and adverse effects on salmonid habitat. Beneficial effects include formation of new spawning, rearing, and over-wintering habitat due to addition of coarse gravels to the channel. The introduction of woody debris and boulders from landslides can increase cover and improve pool:riffle ratios. Adverse effects include filling of pools and scouring of riffles, blockage of fish access, disturbing side-channel rearing areas, and siltation of spawning gravels. The magnitude of these effects are dependent on the frequency, location, and intensity of mass wasting events, as well as the sediment transporting capabilities of a particular stream. Beneficial and adverse effects typically occur simultaneously, and the relative relationship between the two will vary, even for individual events. Because of their greater stream powers, larger streams and rivers adjust to mass wasting perturbations faster than smaller streams.

LANDSLIDE TYPES AND PROCESSES IN THE GREENWOOD CREEK WAU

The terminology used to describe landslides in this report closely follows the definitions of Cruden and Varnes (1996). This terminology is based on two nouns, the first describing the material that the landslide is composed of and the second describing the type of movement. Landslides identified in the Greenwood Creek WAU were described using the following names: debris slides, debris torrents, debris flows, and rockslides. These names are described in Cruden and Varnes (1996) with the exception of our use of debris torrent.

Shallow-Seated Landslides

Debris slides, debris flows, and debris torrents are terms used throughout Mendocino Redwood Company's ownership to identify shallow-seated landslide processes. The material composition of debris slides, flows, or torrents is considered to be soil with a significant proportion of coarse material; 20 to 80 percent of the particles are larger than 2 mm (Cruden and Varnes, 1996). Shallow-seated slides generally move quickly downslope and commonly break apart during failure. Shallow-seated slides commonly occur in converging topography where colluvial materials accumulate and subsurface drainage concentrates. Susceptibility of a slope to fail by shallow-seated landslides is affected by slope steepness, saturation of soil, soil strength (friction angle and cohesion), and root strength. Due to the shallow depth and fact that debris slides, flows, or torrents involve the soil mantle, these are landslide types that can be significantly influenced by forest practices.

Debris slides are the most common landslide type observed in the WAU. The landslide mass typically fails along a surface of rupture or along relatively thin zones of intense shear strain located near the base of the soil profile. The landslide deposit commonly slides a distance beyond the toe of the surface of rupture and onto the ground surface below the failure; it generally does not slide more than the distance equal to the length of the failure scar. Landslides with deposits that traveled a longer distance below the failure scar would likely be defined as a debris flow or debris torrent. Debris slides commonly occur on steep planar slopes, convergent slopes, along forest roads and on steep slopes adjacent to watercourses. They usually fail by translational movement along an undulating or planar surface of failure. By definition debris slides do not continue downstream upon reaching a watercourse.

A debris flow is similar to a debris slide with the exception that the landslide mass continues to "flow" down the slope below the failure a considerable distance on top of the ground surface. A debris flow is characterized as a mobile, potentially rapid, slurry of soil, rock, vegetation, and water. High water content is needed for this process to occur. Debris flows generally occur on both steep, planar hillslopes and confined, convergent hillslopes. Often a failure will initiate as a debris slide, but will change as its moves downslope to a debris flow.

Debris torrents have the greatest potential to destroy stream habitat and deliver large amounts of sediment. The main characteristic distinguishing a debris torrent is that the mass of failed soil and debris "torrents" downstream in a confined channel and erodes the channel. As the debris torrent moves downslope and scours the channel, the liquefied landslide material increases in mass. Highly saturated soil or run-off in a channel is required for this process to occur. Debris torrents move rapidly and can potentially run down a channel for great distances. They typically initiate in headwall swales and torrent down intermittent watercourses. Often a failure will initiate as a debris slide, but will develop into a debris torrent upon reaching a channel. While actually a combination of two processes, these features were considered debris torrents.

Deep-Seated Landslides

Rockslides and earthflows are terms used throughout Mendocino Redwood Company's ownership to identify deep-seated landslide processes. The failure dates of the deep-seated landslides could not be estimated with any confidence, they are likely to be of varying age with some potentially being over 10,000 years old. Many of the deep-seated landslides are considered "dormant", but the importance of identifying them lies in the fact that if reactivated, they have the potential to deliver large amounts of sediment and impair stream habitat. Accelerated or episodic movement is likely to have occurred over time in response to seismic shaking or high rainfall events.

Rockslides are deep-seated landslides with movement involving a relatively intact mass of rock and overlying earth materials. The failure plane is below the colluvial layer and involves the underlying bedrock. Mode of rock sliding generally is not strictly rotational or translational, but involves some component of each. Rotational slides typically fail along a concave surface, while translational slides typically fail on a planar or undulating surface of rupture. Rockslides commonly create a flat, or back-tilted, bench below the crown of the scarp. A prominent bench is usually preserved over time and can be indicative of a rockslide. Rockslides fail in response to triggering mechanisms such as seismic shaking, adverse local structural geology, high rainfall, offloading or loading material on the slide, or channel incision (Wieczorek, 1996). The stream itself can be the cause of chronic movement, if it periodically undercuts the toe of a rockslide.

Earth flows are deep-seated landslides composed of fine-grained materials and soils derived from clay-bearing rocks. Earth flow materials typically consist of 80% or more of particles smaller than 2mm (Cruden and Varnes, 1996). Materials in an earth flow also commonly contain boulders, some very large, which move down slope in the clay matrix. Failure in earth flows is characterized by spatially differential rates of movement on discontinuous failure surfaces that are not preserved. The "flow" type of movement creates a landslide that can be very irregularly shaped. Some earth flow surfaces are dominantly grassland, while some are partially or completely forested. The areas of grassy vegetation are likely due to the inability of the unstable, clay-rich soils to support forest vegetation. The surface of an earth flow is characteristically hummocky with locally variable slope forms and relatively abundant gullies. The inherently weak materials within earth flows are not able to support steep slopes, therefore slope gradients are low to moderate. The rates of movement vary over time and can be accelerated by persistent high groundwater conditions. Timber harvesting can have the effect of increasing the amount of subsurface water, which can accelerate movement in an earth flow (Swanston et al, 1988).

Use of SHALSTAB by Mendocino Redwood Company for the Greenwood Creek WAU

SHALSTAB, a coupled steady state runoff and infinite-slope stability model, is used by MRC as one tool to demonstrate the relative potential for shallow-landslide hazard across the MRC ownership (Dietrich and Montgomery, 1998). A validation study of the SHALSTAB model is presented by Dietrich and others (1998). In the watershed analysis, mass wasting hazard is expanded beyond SHALSTAB. Areas of mass wasting and sediment delivery hazards are mapped using field and aerial photograph interpretation techniques. However, SHALSTAB output was used to assist in this interpretation of the landscape and Terrain Stability Units.

METHODS

Landslide Inventory

The mass wasting assessment relies on an inventory of mass wasting features collected through the use of aerial photographs and field observations. MRC owned photographs from 2000 (color, 1:12,000), 1990 (color, 1:12,000), 1978 (color, 1:15,840), and 1969 (black and white, 1:15,840) were used to interpret landslides. Approximately 160 acres of Lower Greenwood Creek was not covered by the 1969 photo set. In order to get complete coverage, two frames from the 1964 photo set (black and white, 1:15,840) were utilized.

MRC collected data regarding characteristics and measurements of the identified landslides. We acknowledge that some landslides may have been missed, particularly small ones that may be obscured by vegetation. A brief description of select parameters inventoried for each landslide observed in the field and during aerial photograph interpretation is presented in Figure A-1. A detailed discussion of these parameters follows.

Figure A-1. Description of Select Parameters used to Describe Mass Wasting in the Mass Wasting Inventory.

- Slide Identification: Each landslide is assigned a unique identification number, a two letter code (see below) that denotes which planning watershed (PWS) the slide is located, and a number which indicates the USGS designated map section number the slide is mapped in.
  - Planning Watershed Codes:
  - CG – Lower Greenwood Creek
  - CU – Upper Greenwood Creek
- TSU # – Terrain Stability Unit in which landslide is located.
- Landslide Type:
  - DS – debris slide
  - DF – debris flow
  - DT – debris torrent
  - RS – rockslide
  - EF – earthflow
- Certainty: The certainty of identification is recorded.
  - D – Definite
  - P – Probable
  - Q – Questionable
- Physical Characteristics: Includes average length, width, depth, and volume of individual slides. Length of torrent, if present, is recorded as a comment.
- Sediment Routing: Denotes the type of stream the sediment was routed into.
  - P – Perennial
  - I – Intermittent or Ephemeral
  - N – no sediment delivered
- Sediment Delivery: Quantification of the relative percentage of the landslide volume and mass delivered to the stream.
- Slope: Percent slope angle is recorded for all shallow-seated landslides observed in the field.

- Age: Relative age of the observed slide is estimated.
  - N – new (<5 years old)
  - R – recent (5-10 years old)
  - O – old (>10 years old)
- Slope Form: Denotes morphology of the slope where the landslide originated
  - C – concave
  - D – divergent
  - P – planar
- Slide Location: Interpretation of the location where the landslide originated
  - H – Headwall Swale
  - S – Steep Streamside Slopes
  - I – Inner Gorge
  - N – Neither
- Road Association: Denotes the association of the landslide to land-use practices.
  - R – Road
  - S – Skid Trail
  - L – Landing
  - N – Neither
  - I – Indeterminate
- Deep-seated landslides morphologic descriptions: toe, body, lateral scarps, and main scarp (see section below on Systematic Description of Deep-seated Landslide Features).

Landslides identified in the field and from aerial photograph observations are plotted on a landslide inventory map (Map A-1). All shallow-seated landslides are identified as a point plotted on the map at the interpreted head scarp of the failure. Deep-seated landslides are represented as a polygon representing the interpreted perimeter of the landslide body. Physical and geomorphic characteristics of all inventoried landslides are categorized in a database in Appendix A. Landslide dimensions and depths can be quite variable, therefore length, width, and depth values that are recorded are considered to be the average dimension of that feature. When converting landslide volumes to mass (tons), we assume a soil bulk density of 1.35 grams/cubic centimeter.

The certainty of landslide identification is assessed for each landslide. Three designations are used: definite, probable, and questionable. Definite means the landslide definitely exists. Probable means the landslide probably is there, but there is some doubt in the analyst's interpretation. Questionable means that the interpretation of the landslide identification may be inaccurate; the analyst has the least amount of confidence in the interpretation. Accuracy in identifying landslides on aerial photographs is dependent on the size of the slide, scale of the photographs, thickness of canopy, and logging history. Landslides mapped in areas recently logged or through a thin canopy are identified with the highest level of confidence. Characteristics of the particular aerial photographs used affects confidence in identifying landslides. For example, sun angle creates shadows which may obscure landslides, the print quality of some photo sets varies, and photographs taken at small scale makes identifying small landslides difficult. The landslide inventory results are considered a minimum estimate of sediment production. This is because landslides that were too small to identify on aerial photographs may have been missed, landslide surfaces could have reactivated in subsequent years and not been quantified, and secondary erosion by rills and gullies on slide surfaces is difficult to assess.

Two techniques were employed in order to extrapolate a sediment volume delivery percentage to landslides not visited in the field. Landslides that were determined to be directly adjacent to a watercourse from topographic maps and aerial photograph interpretation were assigned 100% delivery. Landslides that were determined to deliver, but were not directly adjacent to a watercourse, were assigned the mean delivery percentage from landslides observed in the field.

Landslides were classified based on the likelihood that a road associated land use practice was associated with the landslide. In this analysis, the effects of silvicultural techniques were not observed. The Greenwood Creek WAU has been managed, recently and historically, for timber production. Therefore, it was determined that the effect of silvicultural practices was too difficult to confidently assign to landslides. There have been too many different silvicultural activities over time for reasonable confidence in a landslide evaluation based on silviculture. The land use practices that were assigned to landslides were associations with roads, skid trails, or landings. It was assumed that a landslide adjacent to a road, skid trail, or landing was triggered either directly or indirectly by that land use practice. If a landslide appeared to be influenced by more than one land use practice, the more causative one was noted. If a cutslope failure did not cross the road prism, it was assumed that the failure would remain perched on the road, landing, or skid trail and would not deliver to a watercourse. Some surface erosion could result from a cutslope failure and is assumed to be addressed in the road surface erosion estimates (Surface and Fluvial Erosion Module).

Sediment Input from Shallow-Seated Landslides

The overall time period used for mass wasting interpretation and sediment budget analysis is twenty-three years. Sediment input to stream channels by mass wasting is quantified for four time periods (1960-1969, 1970-1978, 1979-1990, 1991-2000). The evaluation assumes that approximately the last 10 years of mass wasting can be observed in the aerial photograph. This is due to landslide surfaces revegetating quickly, making mass wasting features older than about 10 years difficult to see. We acknowledge that we have likely missed an unknown quantity of small mass wasting events during the aerial photograph interpretation. However, we assume we have captured the majority of the larger mass wasting events in this analysis.

Sediment delivery estimates from mapped shallow-seated landslides were used to produce the total mass wasting sediment input. In order to extrapolate depth to the shallow-seated landslides not visited in the field, an average was taken from the measured depths of landslides visited in the field. Field measurements revealed a bimodal distribution of depths for management associated (which includes roads, skid trails, and landings), and non-management associated shallow-seated landslides. Therefore, the shallow-seated landslides were categorically defined as management associated, or non-management associated, and assigned the appropriate average depth. Overall, the average depths of the management associated shallow-seated landslides measured in the field were greater than the non-management associated shallow-seated landslides. In order to extrapolate sediment delivery percentage to landslides not verified in the field, an average was taken from the estimated delivery percentage of field verified landslides.

Delivery statistics were not calculated for deep-seated landslides, however, some of the sediment delivery from shallow-seated landslides is the result of conditions created by deep-seated landslides. For example, a deep-seated failure could result in a debris slide or torrent, which could deliver sediment. Furthermore, over-steepened scarps or toes of deep-seated landslides may have shallow failures associated with them. These types of sediment delivery from shallow-seated landslides associated with deep-seated landslides are accounted for in the delivery estimates.

Sediment Input from Deep-Seated Landslides

Large, active, deep-seated landslides can potentially deliver large volumes of sediment. Delivery generally occurs over long time periods compared to shallow-seated landslides, with movement delivering earth materials into the channel, resulting in an increased sediment load downstream of the failure. Actual delivery can occur by over-steepening of the toe of the slide and subsequent failure into the creek, or by the slide pushing out into the creek. It is very important not to confuse normal stream bank erosion at the toe of a slide as an indicator of movement of that slide. Before making such a connection, the slide surface should be carefully explored for evidence of significant movement, such as wide ground cracks. Sediment delivery could also occur in a catastrophic manner. In such a situation, large portions of the landslide essentially fail and move into the watercourse "instantaneously". These types of deep-seated failures are relatively rare on MRC property and usually occur in response to unusual storm events or seismic ground shaking.

Movement of deep-seated landslides has definitely resulted in some sediment delivery in the Greenwood Creek WAU. Quantification of the sediment delivery from deep-seated landslides was not determined in this watershed analysis. Factors such as rate of movement, or depth to the slide plane, are difficult to determine without subsurface geotechnical investigations that were not conducted in this analysis. Sediment delivery to watercourses from deep-seated landslides (landslides typically ≥10 feet thick) can occur by several processes. Such processes can include surface erosion and shallow-or deep-seated movement of a portion or all of the deep-seated landslide deposit.

The ground surface of a deep-seated landslide, like any other hillside surface, is subject to surface erosion processes such as rain drop impact, sheet wash (overland flow), and gully/rill erosion. Under these conditions the sediment delivery from surficial processes is assumed the same as adjacent hillside slopes not underlain by landslide deposits. The materials within the landslide are disturbed and can be arguably somewhat weaker. However, once a soil has developed, the fact that the slope is underlain by a deep-seated landslide should make little difference regarding sediment delivery generated by erosional processes that act at the ground surface. Although fresh, unprotected surfaces that develop in response to recent or active movement could become a source of sediment until the bare surface becomes covered with leaf litter, re-vegetated, or soils developed.

Clearly, movement of a portion or all of a deep-seated landslide can result in delivery of sediment to a watercourse. This determination is made by exploring for any evidence of movement. However, movement would need to be on slopes immediately adjacent to or in close proximity to a watercourse and of sufficient magnitude to push the toe of the slide into the watercourse. A deep-seated slide that toes out on a slope far from a creek or moves only a short distance downslope will generally deliver little to a watercourse. It is also important to realize that often only a portion of a deep-seated slide may become active, though the portion could be quite variable in size. Ground cracking at the head of a large, deep-seated landslide does not necessarily equate to immediate sediment delivery at the toe of the landslide. Movement of large deep-seated landslides can create void spaces within the slide mass. Though movement can be clearly indicated by the ground cracks, many times the toe may not respond or show indications of movement until some of the void space is "closed up". This would be particularly true in the case of very large deep-seated landslides that exhibit ground cracks that are only a few inches to a couple of feet wide. Compared to the entire length of the slide, the amount of movement implied by the ground crack could be very small. This combined with the closing up or "bulking up" of the slide, would not generate much movement, if any, at the toe of the slide. Significant movement, represented by large wide ground cracks, would need to occur to result in significant movement and sediment delivery at the toe of the slide.

Systematic Description of Deep-seated Landslide Features

The characteristics of deep-seated landslides received less attention in the landslide inventory than shallow-seated landslides mainly due to the fact that subsurface analyses would have to be conducted to estimate attributes such as depth, volume, failure date, current activity, and sediment delivery. Subsurface investigation was beyond the scope of this report. Few of the mapped deep-seated landslides were observed to have recent movement associated with them, mainly due to oversteepening of the slope at the toe or scarp. Further assessment of deep-seated landslides will occur on a site-by-site basis in the Greenwood Creek WAU, likely during timber harvest plan preparation and review.

Deep-seated landslides were only interpreted by reconnaissance techniques (aerial photograph interpretation rather than field observations). Reconnaissance mapping criteria consist of observations of four morphologic features of deep seated landslides – toe, internal morphology, lateral flanks, main scarp, and vegetation (after McCalpin 1984 as presented by Keaton and DeGraff, 1996, p. 186, Table 9-1). The mapping and classification criteria for each feature are presented in detail below.

Aerial photo interpretation of deep seated landslide features in the Greenwood Creek WAU suggests that the first three morphologic features above are the most useful for inferring the presence of deep-seated landslides. The presence of tension cracks and/or sharply defined and topographically offset scarps are probably a more accurate indicator of recent or active landslide movement. These features, however, are rarely visible on aerial photos.

Sets of five descriptions have been developed to classify each deep-seated landslide morphologic feature or vegetation influence. The five descriptions are ranked in descending order from characteristics more typical of active landslides to dormant to relict landslides. One description should characterize the feature most accurately. Nevertheless, some overlap between classifications is neither unusual nor unexpected. We recognize that some deep-seated landslides may lack evidence with respect to one or more of the observable features, but show strong evidence of another feature. If there is no expression of a particular geomorphic feature (e.g. lateral flanks), the classification of that feature is considered "undetermined". If a deep-seated landslide is associated with other deep-seated landslides, it may also be classified as a landslide complex.

In addition to the classification criteria specific to the deep-seated landslide features, more general classification of the strength of the interpretation of the deep-seated landslide is conducted. Some landslides are obscured by vegetation to varying degrees, with areas that are clearly visible and areas that are poorly visible. In addition, weathering and erosion processes may also obscure geomorphic features over time. The quality of different aerial photograph sets varies and can sometimes make interpretations difficult. Owing to these circumstances, each inferred deep-seated landslide feature is classified according to the strength of the evidence as definite, probable or questionable as defined with respect to interpretation of shallow landslides.

At the project scale (THP development and planning), field observations of deep-seated landslide morphology and other indicators by qualified professionals are expected to be used to reduce uncertainty of interpretation inherent in reconnaissance mapping. Field criteria for mapping deep-seated landslides and assessment of activity are presented elsewhere.

Deep Seated Landslide Morphologic Classification Criteria:

I. Toe Activity

1. Steep streamside slopes with extensive unvegetated to sparsely vegetated debris slide scars. Debris slides occur on both sides of stream channel, but more prominently on side containing the deep-seated landslide. Stream channel in toe region may contain coarser sediment than adjacent channel. Stream channel may be pushed out by toe. Toe may be eroding, sharp topography/geomorphology.
2. Steep streamside slopes with few unvegetated to sparsely vegetated debris slide scars. Debris slides generally are distinguishable only on streamside slope containing the deep-

seated landslide. Stream channel may be pushed out by toe. Sharp edges becoming subdued.

3. Steep streamside slopes that are predominantly vegetated with little to no debris slide activity. Topography/geomorphology subdued.
4. Gently sloping stream banks that are vegetated and lack debris slide activity. Topography/geomorphology very subdued.
5. Undetermined

II. Internal Morphology

1. Multiple, well defined scarps and associated angular benches. Some benches may be rotated against scarps so that their surfaces slope back into the hill causing ponded water, which can be identified by different vegetation than adjacent areas. Hummocky topography with ground cracks. Jack-strawed trees may be present. No drainage to chaotic drainage/disrupted drainage.
2. Hummocky topography with identifiable scarps and benches, but those features have been smoothed. Undrained to drained but somewhat subdued depressions may exist. Poorly established drainage.
3. Slight benches can be identified, but are subtle and not prominent. Undrained depressions have since been drained. Moderately developed drainage to established drainage but not strongly incised. Subdued depressions but are being filled.
4. Smooth topography. Body of slide typically appears to have failed as one large coherent mass, rather than broken and fragmented. Developed drainage well established, incised. Essentially only large undrained depressions preserved and would be very subdued. Could have standing water. May appear as amphitheater slope where slide deposit is mostly or all removed.
5. Undetermined

III. Lateral Flanks

1. Sharp, well defined. Debris slides on lateral scarps fail onto body of slide. Gullies/drainage may begin to form at boundary between lateral scarps and sides of slide deposit. Bare spots are common or partially unvegetated.
2. Sharp to somewhat subdued, rounded, essentially continuous, might have small breaks; gullies/drainage may be developing down lateral edges of slide body. May have debris slide activity, but less prominent. Few bare spots.
3. Smooth, subdued, but can be discontinuous and vegetated. Drainage may begin to develop along boundary between lateral scarp and slide body. Tributaries to drainage extend onto body of slide.
4. Subtle, well subdued to indistinguishable, discontinuous. Vegetation is identical to adjacent areas. Watercourses could be well incised, may have developed along boundary between lateral scarp and slide body. Tributaries to drainage developed on slide body.
5. Undetermined

IV. Main Scarp

1. Sharp, continuous geomorphic expression, usually arcuate break in slope with bare spots to unvegetated; often has debris slide activity.
2. Distinct, essentially continuous break in slope that may be smooth to slightly subdued in parts and sharp in others, apparent lack of debris slide activity. Bare spots may exist, but are few.

3. Smooth, subdued, less distinct break in slope with generally similar vegetation relative to adjacent areas. Bare spots are essentially non-existent.
4. Very subtle to subdued, well vegetated, can be discontinuous and deeply incised, dissected; feature may be indistinct.
5. Undetermined

V. Vegetation

1. Less dense vegetation than adjacent areas. Recent slide scarps and deposits leave many bare areas. Bare areas also due to lack of vegetative ability to root in unstable soils. Open canopy, may have jack-strawed trees; can have large openings.
2. Bare areas exist with some regrowth. Regrowth or successional patterns related to scarps and deposits. May have some openings in canopy or young broad-leaf vegetation with similar age.
3. Subtle differences from surrounding areas. Slightly less dense and different type vegetation. Essentially closed canopy; may have moderately aged to old trees.
4. Same size, type, and density as surrounding areas.
5. Undetermined

Terrain Stability Units

Terrain Stability Units (TSUs) are delineated by partitioning the landscape into zones characterized by similar geomorphic attributes, shallow-seated landslide potential, and sediment delivery to stream channels. A combination of aerial photograph interpretation, field investigation, and SHALSTAB output were utilized to delineate TSUs. The TSU designations for the Greenwood Creek WAU are only meant to be general characterizations of similar geomorphic and terrain characteristics related to shallow seated landslides. Deep-seated landslides are also shown on the TSU map (Map A-2). The deep-seated landslides have been included to provide land managers with supplemental information to guide evaluation of harvest planning and subsequent needs for geologic review. The landscape and geomorphic setting in the Greenwood Creek WAU is certainly more complex than generalized TSUs delineated for this evaluation. The TSUs are only meant to be a starting point for gauging the need for site-specific field assessments.

The delineation of each TSU described is based on landforms present, the mass wasting processes, sensitivity to forest practices, mass wasting hazard, delivery potential, and forest management related trigger mechanisms for shallow seated landslides. The landform section of the TSU description defines the terrain found within the TSU. The mass wasting process section is a summary of landslide types found in the TSU. Sensitivity to forest practice and mass wasting hazard is, in part, a subjective call by the analyst based on the relative landslide hazard and influence of forest practices. Delivery potential is based on proximity of TSU to watercourses and the likelihood of mass wasting in the unit to reach a watercourse. The hazard potential is based on a combination of the mass wasting hazard and delivery potential (Table A-1). The trigger mechanisms are a list of forest management practices that may have the potential to create mass wasting in the TSU.

Table A-1. Ratings for Potential Hazard of Delivery of Debris and Sediment to Streams by Mass Wasting (L= low hazard, M= moderate hazard, H = high hazard)(from Version 4.0, Washington Forest Practices Board, 1995).

		Mass Wasting Potential		
		Low	Moderate	High
Delivery Potential	Low	**L**	**L**	**M**
	Moderate	**L**	**M**	**H**
	High	**L**	**M**	**H**

RESULTS

Mass Wasting Inventory

A Landslide Inventory Data Sheet (Appendix A) was used to record attributes associated with each landslide. The spatial distribution and location of landslides is shown on Map A-1.

A total of 276 shallow-seated landslides (debris slides, torrents, or flows) were identified and characterized in the Greenwood Creek WAU. A total of 69 deep-seated landslides (rockslides and earthflows) were mapped in the Greenwood Creek WAU. A considerable effort was made to field verify as many landslides as possible to insure greater confidence in the results. Approximately 37% of the identified shallow-seated landslides were field verified. From this level of field observations, extrapolation of landslide depth and sediment delivery is assumed to be performed with a reasonable level of confidence.

The temporal distribution of the 276 shallow-seated landslides observed in the Greenwood Creek WAU is listed in Table A-2. The distribution by landslide type is shown in Table A-3.

Table A-2. Shallow-Seated Landslide Summary for Greenwood Creek WAU by Time Periods.

Planning Watershed	1960 - 1969 Landslides	1970 - 1978 Landslides	1979 - 1990 Landslides	1991 – 2000 Landslides
Lower Greenwood Creek	76	28	30	43
Upper Greenwood Creek	44	28	9	18

Table A-3. Landslide Summary by Type and Planning Watershed for Greenwood Creek WAU.

Planning Watershed	Debris Slides	Debris Flows	Debris Torrents	Rock-slides	Earth-flows	Total	Road[a] Assoc.
Lower Greenwood Creek	162	15	0	52	1	230	101
Upper Greenwood Creek	83	15	1	16	0	115	64

a – Includes roads, skid trails, and landings

The majority of the landslides observed in the Greenwood Creek WAU are debris slides and rockslides. Of the 276 shallow-seated landslides in the Greenwood Creek WAU, 165 are determined to be road associated (includes roads, skid trails, or landings). This is approximately 60% of the total number of shallow-seated landslides. There were 31 debris torrents and flows observed in the Greenwood Creek WAU. This is approximately 11 percent of the total shallow-seated landslides observed in the Greenwood Creek WAU.

Of the 103 field observed shallow-seated landslides, 99% were initiated on slopes of 65% gradient or higher. Only one shallow-seated landslide occurred on slopes with gradients less than

65%; a road fill failure on 45% slopes. The majority of inventoried landslides originated in convergent topography where subsurface water tends to concentrate, or on steep, planar topography, where sub-surface water can be concentrated at the base of slopes, in localized topographic depressions, or by local geologic structure. Few landslides originated in divergent topography, where subsurface water is routed to the sides of ridges. Such observations were, in part, the basis for the delineation of the WAU into Terrain Stability Units.

Terrain Stability Units

The landscape was partitioned into six Terrain Stability Units representing general areas of similar geomorphology, landslide processes, and sediment delivery potential for shallow-seated landslides (Map A-2). The units are to be used by forest managers to assist in making decisions that will minimize future mass wasting sediment input to watercourses. The delineation for the TSUs was based on qualitative observations and interpretations from aerial photographs, field evaluation, and SHALSTAB output. Deep-seated landslides are also shown on the TSU map (Map A-2). The deep-seated landslides have been included to provide land managers with supplemental information to guide evaluation of harvest planning and subsequent needs for geologic review.

Shallow-seated landslide characteristics considered in determination of map units are size, frequency, delivery to watercourses, and spatial distribution. Hillslope characteristics considered are slope form (convergence, divergence, planar), slope gradient, magnitude of stream incision, and overall geomorphology. The range of slope gradients was determined from USGS 1:24,000 topographic maps and field observations. Hillslope and landslide morphology vary within each individual TSU and the boundaries are not exact. This evaluation is not intended to be a substitute for site-specific field assessments. Site-specific field assessments will still be required in TSUs and at deep-seated landslides or specific areas of some TSUs to assess the risk and likelihood of mass wasting impacts from a proposed management action. The TSUs are compiled on the entitled Terrain Stability Unit Map (Map A-2).

TSU Number: 1

Description: Inner Gorge or Steep Streamside Slopes adjacent to Low Gradient Watercourses

Materials: Shallow soils formed on weathered marine sedimentary rocks. Maybe composed of toe sediment of deep-seated landslide deposit.

Landform: Characterized by steep streamside slopes or inner gorge topography along low gradient watercourses (typically less than 6-7%). An inner gorge is a geomorphic feature created from down cutting of the stream, generally in response to tectonic uplift. Inner gorge slopes extend from either one or both sides of the stream channel to the first break in slope. Inner gorge slope gradients typically exceed 70%, although slopes with lower inclination are locally present. Inner gorge slopes commonly contain areas of multiple, coalescing shallow seated landslide scars of varying age. Steep streamside slopes are characterized by their lack of a prominent break in slope. Slopes are generally planar in form with slope gradients typically exceeding 70%. The upper extent of TSU 1 is variable. Where there is not a break in slope, the unit may extend 300 feet upslope (based on the range of lengths of landslides observed, 20-300 feet). Landslides in this unit generally deposit sediment directly into Class I and II streams. Small areas of incised terraces may be locally present.

Slope: Typically >65 %, (mean slope of observed mass wasting events is 87%, range is 65%-110%)

Total Area: 605 acres; 6% of the total WAU area.

MW Processes: 34 *road-associated landslides*

- 34 Debris slides
- 0 Debris flow
- 0 Debris torrent

33 non-road associated landslides

- 33 Debris slides
- 0 Debris torrent
- 0 Debris flows

Non Road-related Landslide Density: 0.05 landslides per acre for the past 41 years.

Forest Practices Sensitivity: High sensitivity to road construction due to proximity to watercourses, high sensitivity to harvesting and forest management practices due to steep slopes with localized colluvial or alluvial soil deposits adjacent to watercourses.

Mass Wasting Potential: High localized potential for landslides in both unmanaged and managed conditions.

Delivery Potential: High

Delivery Criteria Used: Steep slopes adjacent to stream channels, a majority of the observed landslides delivered sediment into streams.

Hazard-Potential Rating: **High**

Forest Management Related Trigger Mechanisms:

- Sidecast fill material placed on steep slopes can initiate debris slides or flows in this unit.
- Concentrated drainage from roads onto unstable areas can initiate debris slides or flows in this unit.
- Poorly sized culvert or excessive debris at watercourse crossings can initiate failure of the fill material creating debris slides, torrents or flows in this unit.
- Cut-slope of roads can expose potential failure planes creating debris slides, torrents or flows in this unit.
- Cut-slope of roads can remove support of the toe or expose potential failure planes of rockslides or earth flows.
- Sidecast fill material created from skid trail construction placed on steep slopes can initiate debris slides or flows in this unit.
- Concentrated drainage from skid trails onto unstable areas can initiate debris slides or flows in this unit.
- Cut-slope of skid trails can remove support of slope creating debris slides, torrents or flows in this unit.
- Cut-slope of skid trails can remove support of the toe or expose potential failure planes of rockslides or earth flows.
- Concentrated drainage from roads can increase groundwater, accelerating movement of rockslides or earth flows and over-steepening TSU 1 slopes.
- Removal of vegetation from these slopes can result in loss of evapotranspiration and thus increase pore water pressures that could initiate slope failure in this unit.
- Post timber harvest root decay of hardwood or non-redwood conifer species can be a contributing factor in the initiation of debris slides, torrents or flows in this unit.

Confidence: High confidence for susceptibility of landslides and sediment delivery in this unit. Moderate confidence in placement of the unit boundary. This unit is locally variable and exact boundaries are best determined during field observations. Within this unit there are likely areas of low gradient slopes that are less susceptible to mass wasting.

TSU Number:	2
Description:	Inner gorge or Steep Streamside Slopes adjacent to high gradient intermittent or ephemeral watercourses.
Materials:	Shallow soils formed from weathered marine sedimentary rocks with localized areas of thin to thick colluvial deposits.
Landforms:	Characterized by steep streamside slopes or inner gorge topography along low gradient watercourses (typically greater than 6-7%). An inner gorge is a geomorphic feature created from down cutting of the stream, generally in response to tectonic uplift. Inner gorge slopes extend from either one or both sides of the stream channel to the first break in slope. Inner gorge slope gradients typically exceed 70%, although slopes with lower inclination are locally present. Inner gorge slopes commonly contain areas of multiple, coalescing shallow seated landslide scars of varying age. Steep streamside slopes are characterized by their lack of a prominent break in slope. Slopes are generally planar in form with slope gradients typically exceeding 70%. The upper extent of TSU 2 is variable. Where there is not a break in slope, the unit may extend 132 feet upslope (based on the range of lengths of landslides observed, 16-132 feet). Landslides in this unit generally deposit sediment directly into Class II and III streams.
Slope:	Typically >65% (mean slope of observed mass wasting events is 82%, range is 65%-105%).
Total Area:	904 acres; 9% of total WAU area
MW Processes:	43 *road-associated landslides* • 41 Debris slides • 2 Debris flow • 0 Debris torrent *28 non-road associated landslides* • 26 Debris slides • 2 Debris flow • 0 Debris torrent
Non Road-related Landslide Density:	0.08 landslides per acre for the past 41 years.
Forest Practices Sensitivity:	High sensitivity to roads due to steep slopes adjacent to watercourses, high to moderate sensitivity to harvesting and forest management due to steep slopes next to watercourses. Localized areas of steeper and/or convergent slopes may have an even higher sensitivity to forest practices.

Mass Wasting Potential: High in both unmanaged and managed conditions due to the steep morphology of the slope.

Delivery Potential: High

Delivery Criteria Used: Steep slopes adjacent to stream channels, a majority of the observed landslides delivered sediment into streams.

Hazard-Potential Rating: **High**

Forest Management Related Trigger Mechanisms:

- Sidecast fill material placed on steep slopes can initiate debris slides, torrents or flows in this unit.
- Concentrated drainage from roads onto unstable areas can initiate debris slides, torrents or flows in this unit.
- Poorly sized culvert or excessive debris at watercourse crossings can initiate failure of the fill material creating debris slides, torrents or flows in this unit.
- Cut-slope of roads can expose potential failure planes creating debris slides, torrents or flows in this unit.
- Cut-slope of roads can remove support of the toe or expose potential failure planes of rockslides or earth flows.
- Sidecast fill material created from skid trail construction placed on steep slopes can initiate debris slides, torrents or flows.
- Concentrated drainage from skid trails onto unstable areas can initiate debris slides, torrents or flows.
- Cut-slope of skid trails can expose potential failure planes creating debris slides, torrents or flows in this unit.
- Cut-slope of skid trails can remove support of the toe or expose potential failure planes of rockslides or earth flows.
- Removal of vegetation from these slopes can result in loss of evapotranspiration and thus increase pore water pressures that could initiate slope failure in this unit.
- Post timber harvest root decay of hardwood or non-redwood conifer species can be a contributing factor in the initiation of debris slides, torrents or flows in this unit.

Confidence: High confidence for susceptibility of unit to landslides and sediment delivery. Moderate confidence in the placement of this unit. This unit is highly localized and exact boundaries are better determined from field observations. Within this unit there are likely areas of low gradient slopes that are less susceptible to mass wasting.

TSU Number: 3

Description: Dissected and convergent topography

Materials: Shallow soils formed from weathered marine sedimentary rocks with localized thin to thick colluvial deposits.

Landforms: These areas have steep slopes (typically greater than 65%) that have been sculpted over geologic time by repeated debris slide events. The area is characterized primarily by 1) steep convergent and dissected topography located within steep gradient collivial hollows or headwall swales and small high gradient watercourses, and 2) locally steep planar slopes where there is strong evidence of past landsliding. MRC intends this unit to represent areas with a high hazard potential for shallow landsliding, while not constituting a continuous streamside unit (otherwise it would classify as TSU 1 or 2). The mapped unit may represent isolated individual “high hazard” areas or areas where there is a concentration of “high hazard” areas. Boundaries between higher hazard areas and other more stable areas (i.e. divergent and lower gradient slopes) within the unit should be keyed out as necessary based on field observation of landslide features.

Slope: Typically >65%, (mean slope of observed mass wasting events is 77%, range is 70%-95%)

Total Area: 325 ac., 3% of the total WAU

MW Processes: 8 *road associated landslides*

- 7 Debris slides
- 1 Debris flow
- 0 Debris Torrent

7 non-road associated landslides

- 5 Debris slides
- 2 Debris flow
- 0 debris torrent

Non Road-related Landslide Density: 0.05 landslides per acre for the past 41 years.

Forest Practices Sensitivity: Moderate to high sensitivity to road building, moderate to high sensitivity to harvesting and forest management practices due to moderate to steep slopes within this unit. Localized areas of steeper and/or convergent slopes have even higher sensitivity to forest practices.

Mass Wasting Potential: High

Delivery Potential: Moderate

Delivery Criteria Used: The converging topography directs mass wasting down slopes toward watercourses. Delivery potential may be high based on relatively high number of debris slides. Landslides in headwater swales often torrent or flow down watercourses. Approximately 80% of landslides in this unit delivered sediment.

Hazard-Potential Rating: **High**

Forest Management Related Trigger Mechanisms:

- Sidecast fill material placed on steep slopes can initiate debris slides, torrents or flows in this unit.
- Concentrated drainage from roads onto unstable areas can initiate debris slides, torrents or flows in this unit.
- Concentrated drainage from roads can increase groundwater, accelerating movement of rockslides or earth flows in this unit.
- Poorly sized culvert or excessive debris at watercourse crossings can initiate failure of the fill material creating debris slides, torrents or flows in this unit.
- Cut-slope of roads can expose potential failure planes creating debris slides, torrents or flows in this unit.
- Cut-slope of roads can remove support of the toe or expose potential failure planes of rockslides or earth flows.
- Concentrated drainage from skid trails onto unstable areas can initiate debris slides, torrents or flows.
- Cut-slope of skid trails can expose potential failure planes creating debris slides, torrents or flows in this unit.
- Cut-slope of skid trails can remove support of the toe or expose potential failure planes of rockslides or earth flows.
- Sidecast fill material created from skid trail construction placed on steep slopes can initiate debris slides, torrents or flows.
- Removal of vegetation from these slopes can result in loss of evapotranspiration and thus increase pore water pressures that could initiate slope failure in this unit.
- Post timber harvest root decay of hardwood or non-redwood conifer species can be a contributing factor in the initiation of debris slides, torrents or flows in this unit.

Confidence: Moderate confidence in placement of unit. This unit is locally variable and exact boundaries are best determined from field observations. Some areas within this unit could have higher susceptibility to landslides and higher delivery rates due to localized areas of steep slopes with weak earth materials, and unusually adverse ground water conditions.

TSU Number: 4

Description: Non-dissected topography

Materials: Shallow to moderately deep soils formed from weathered marine sedimentary rocks.

Landforms: Moderate to moderately steep hillslopes with planar, divergent, or broadly convergent slope forms with isolated areas of steep topography or strongly convergent slope forms. Unit 4 is generally a midslope region of lesser slope gradient and more variable slope form than unit 3.

Slope: Typically 40% - 65%, (mean slope of observed mass wasting events is 77%, range is 45% - 120%)

Total Area: 7508 acres, 78% of the total WAU

MW Processes: 80 *road-associated landslides*

- 69 Debris slides
- 1 Debris flow
- 10 Debris torrent

43 non-road associated landslides

- 30 Debris slides
- 13 Debris flow
- 0 Debris Torrents

Non Road-related Landslide Density: 0.006 landslides per acre for the past 41 years.

Forest Practices Sensitivity: Moderate sensitivity to road building, moderate to low sensitivity to harvesting and forest management practices due to moderate slope gradients and non-converging topography within this unit. Localized areas of steeper slopes have higher sensitivity to forest practices.

Mass Wasting Potential: Moderate

Delivery Potential: High

Delivery Criteria Used: This unit constitutes a majority of the WAU, which accounts for it having the highest number of landslides. This unit has a low non-road related landslide density, and therefore has a moderate mass wasting hazard. Although landslides in this unit are localized, when landslides occur, the landslide has a high potential to deliver. Approximately 90% of the landslides in this unit delivered sediment. This unit has a moderate sensitivity to road building due to low road landslide density.

Hazard-Potential Rating: **Moderate**

Forest Management Related Trigger Mechanisms:

- Sidecast fill material placed on steep slopes can initiate debris slides, torrents or flows in this unit.
- Concentrated drainage from roads onto unstable areas can initiate debris slides, torrents or flows in this unit.
- Concentrated drainage from roads can increase groundwater, accelerating movement of rockslides or earth flows in this unit.
- Poorly sized culvert or excessive debris at watercourse crossings can initiate failure of the fill material creating debris slides, torrents or flows in this unit.
- Cut-slope of roads can expose potential failure planes creating debris slides, torrents or flows in this unit.
- Cut-slope of roads can remove support of the toe or expose potential failure planes of rockslides or earth flows.
- Concentrated drainage from skid trails onto unstable areas can initiate debris slides, torrents or flows.
- Cut-slope of skid trails can expose potential failure planes creating debris slides, torrents or flows in this unit.
- Cut-slope of skid trails can remove support of the toe or expose potential failure planes of rockslides or earth flows.
- Sidecast fill material created from skid trail construction placed on steep slopes can initiate debris slides, torrents or flows.
- Removal of vegetation from these slopes can result in loss of evapotranspiration and thus increase pore water pressures that could initiate slope failure in this unit.
- Post timber harvest root decay of hardwood or non-redwood conifer species can be a contributing factor in the initiation of debris slides, torrents or flows in this unit.

Confidence: High confidence in placement of unit, however, this unit is locally variable and exact boundaries are best determined from field observations. Some areas within this unit could have higher susceptibility to landslides and higher delivery rates due to localized areas of steep slopes with weak soils, and adverse groundwater conditions.

TSU Number:	5
Description:	Low relief topography
Material:	Moderately deep to deep soils, derived from weathered marine sedimentary rocks.
Landforms:	Characterized by low gradient slopes generally less than 40%, although in some places slopes may be steeper. This unit occurs on ridge crests, low gradient side slopes, and well-developed terraces. Shallow-seated landslides seldom occur and usually do not deliver sediment to stream channels.
Slope:	Typically <40% (based on field observations)
Total Area:	283 acres, 3% of WAU area
MW Processes:	0 *landslides*
Non Road-related Landslide Density:	0 landslides per acre for past 41 years.
Forest Practices Sensitivity:	Low sensitivity to road building and forest management practices due to low gradient slopes
Mass Wasting Potential:	Low
Delivery Potential:	Low
Delivery Criteria Used:	Sediment delivery in this unit is low.
Hazard-Potential Rating:	**Low**
Forest Management Related Trigger Mechanisms:	•Poorly sized culvert or excessive debris at watercourse crossings can initiate failure of the fill material creating debris slides, torrents or flows in this unit. •Concentrated drainage from roads and skid trails can initiate or accelerate gully erosion, which can increase the potential for mass wasting processes.
Confidence:	High confidence in placement of unit in areas of obviously stable topography. High confidence in mass wasting potential and sediment delivery potential ratings.

TSU Number:	6
Description:	Earth Flow Topography
Materials:	Fine-grained soils and clays of highly weathered and sheared marine sedimentary rocks. Soils contain >80% particles less than 2mm in size with boulders, some very large, within the soil matrix.
Landforms:	Boundaries of this unit correspond to the mapped, deep-seated earth flows from mass wasting inventory, regardless of state of activity. Characterized by hummocky slopes with localized areas of steep, and areas of flat topography. Slopes commonly contain areas of backtilted topography, creating ponded water. Ground surfaces in this unit commonly contain areas of grassy vegetation, which may be attributed to the inability of the clay-rich soil to support dense forests. Gullies are common in this unit. Rate of movement within earth flows typically is variable and likely fluctuates seasonally according to groundwater conditions. Most of unit 6 is earth flow complexes with many scarps and benches that create a step-like profile.
Slope:	Typically <50%
Total Area:	7 acres; <0.01% of the total WAU.
MW Processes:	0 *landslides*
Non Road-related Landslide Density:	0 landslides per acre for past 41 years.
Forest Practices Sensitivity:	High sensitivity to roads, harvesting, and forest management practices on active earth flow surfaces. Potential forest practices in this unit should be assessed on at a site specific basis due to variable topography and differing rates of movement within an earth flow.
Mass Wasting Potential:	High
Delivery Potential:	High
Delivery Criteria Used:	Many of the earth flows in the Navarro WAU have the toe or lateral edges along watercourses. If earth flow movement occurs the landslides will deliver sediment.
Hazard Potential Rating:	**High**

Forest Management Related Trigger Mechanisms:

- Sidecast fill material placed on locally steep slopes can initiate debris slides, torrents or flows in this unit.
- Concentrated drainage from roads onto unstable areas can initiate debris slides, torrents or flows in this unit.
- Concentrated drainage from roads can increase groundwater, accelerating movement of earth flows of this unit.
- Poorly sized culvert or excessive debris at watercourse crossings can initiate failure of the fill material creating debris slides, torrents or flows in this unit.
- Cut-slope of roads can over-steepen the slope creating debris slides in this unit.
- Concentrated drainage from skid trails onto unstable areas can initiate debris slides, torrents or flows in this unit.
- Loss of evapo-transpiration from forest harvest can increase groundwater levels initiating or accelerating movement of earth flows of this unit or aid in initiation of debris slides, torrents or flows.
- Concentrated drainage from roads and skid trails can initiate or accelerate gully erosion, which can increase the potential for mass wasting processes.
- Cut-slope of skid trails can remove support of the toe or expose potential failure planes of earth flows.
- Sidecast fill material created from skid trail construction placed on locally steep slopes can initiate debris slides, torrents or flows.
- Root decay of hardwood or non-redwood conifer species can be a contributing factor in the initiation of debris slides, torrents or flows in this unit.

Confidence: Confidence in delineation of unit is consistent with confidence level in mass wasting inventory mapping of deep-seated earth flows. High confidence in hazard potential rating due to relatively low hazard for shallow-seated landslides

Sediment Input from Mass Wasting

Sediment delivery was estimated for shallow-seated landslides in the Greenwood Creek WAU. Depth values were estimated to facilitate approximation of mass for the landslides not observed in the field. In order to extrapolate depth to the shallow-seated landslides not visited in the field, an average was taken from the measured depths of landslides visited in the field. The mean depth of all shallow-seated landslides interpreted as being unrelated to road systems was 4.7 feet. The mean depth of all shallow seated landslides interpreted as being associated with road systems was 5.5 feet. Due to the relative lack of debris flows and torrents, no effort was made to differentiate landslide depths among different shallow landslide types. The mean depths of 4.7 feet for non road related landslides, and 5.5 feet for road related landslides, were assigned to all landslides not verified in the field.

Landslides that were determined to be immediately adjacent to a watercourse, from topographic maps and aerial photograph interpretation, were assigned 100% sediment delivery. The mean sediment delivery percentage assigned to shallow landslides determined to deliver sediment, but not field verified, is 60%. Of the 276 shallow-seated landslides mapped by MRC in this watershed analysis, 255 of the landslides delivered some amount of sediment (Table A-4).

Table A-4. Total Shallow-Seated Landslides Mapped for each PWS in Greenwood Creek WAU.

Planning Watershed	Total Landslides	Landslides with Sediment Delivery	Landslides with No Sediment Delivery
Lower Greenwood	177	162	15
Upper Greenwood	99	93	6
sum	***276***	***255***	***21***
Percentage	***100%***	***92%***	***8%***

Mass wasting was separated into four time periods for analysis: 1960-1969, 1970-1978, 1979-1990, and 1991-2000. The dates for each of the time periods are based on the date of aerial photographs used to interpret landslides (1969, 1978, 1990, and 2000) and field observations (2003). The available aerial photography did not correspond exactly to ten year time periods for mass wasting assessment, however the time periods and the aerial photographs analyzed approximate decadal intervals. These time periods allow for a general evaluation of the relative magnitude of sediment delivery rate estimates across the Greenwood Creek WAU.

A total of approximately 223,000 tons of mass wasting sediment delivery was estimated for the time period 1960-2000 in the Greenwood Creek WAU. This equates to approximately 359 tons/sq. mi./yr. Of the total estimated amount, 58% delivered from 1960-1969, 21% from 1970-1978, 7% from 1979-1990, and 14% delivered in the 1991-2000 time period (Table A-5).

Table A-5. Sediment Delivery (in tons) by Time Period for Greenwood Creek WAU[a].

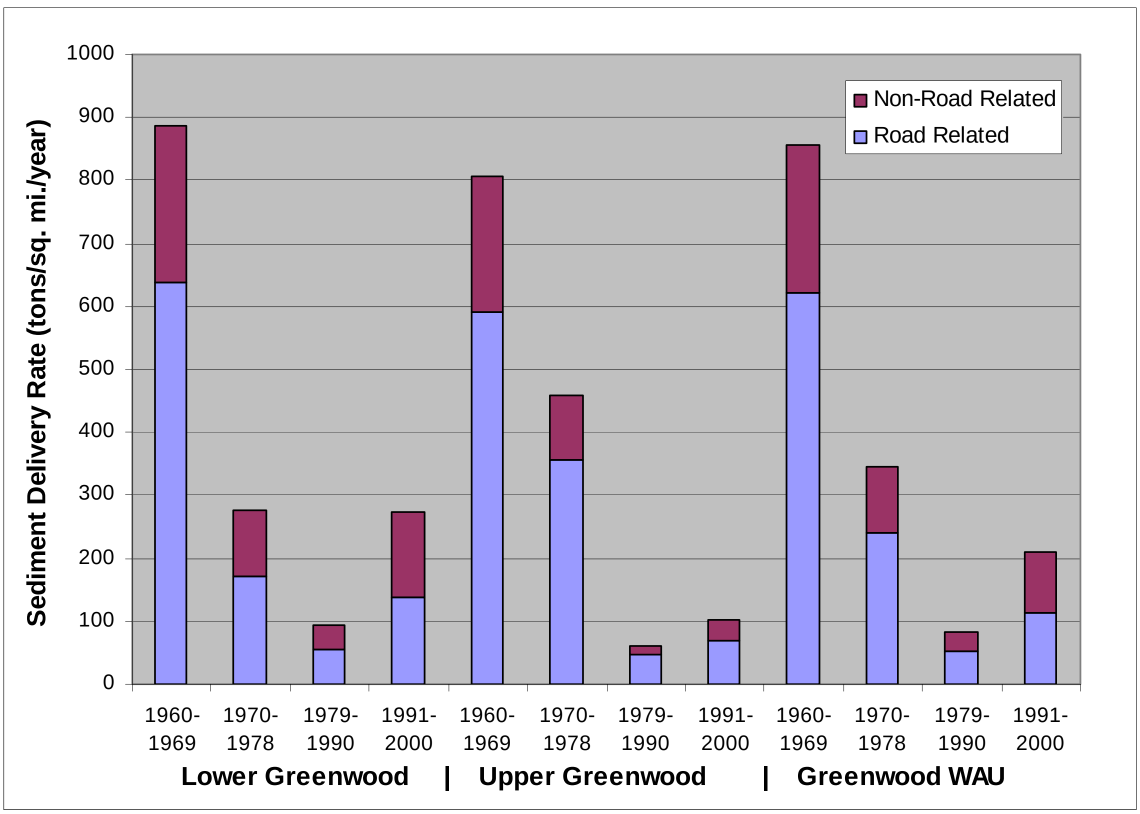
Planning Watershed	1960 – 1969		1970 - 1978		1979 – 1990		1991 - 2000	
	RR[b]	NRR[c]	RR	NRR	RR	NRR	RR	NRR
Lower Greenwood	60,000	23,400	14,500	8,700	6,100	4,600	13,000	12,700
Upper Greenwood	34,000	12,300	18,300	5,400	3,300	800	3,900	1,900
Sub-Total	***94,000***	***35,700***	***32,800***	***14,100***	***9,400***	***5,400***	***16,900***	***14,600***
Total	***129,700***		***46,900***		***14,800***		***31,500***	

a – Sediment delivery rounded to the nearest 100 tons
b – Road related (including roads, skid trails, and landings)
c – Non-road related

Relatively large amounts of sediment delivered from 1960-1969 is likely the result of poor road building techniques. Poor road building techniques employed during this era of forest management included the practice of sidecasting excavated fill material on steep slopes adjacent to watercourses. Additionally, according to local rainfall data, the December 1964 storm event produced the wettest days on record at 80 precipitation stations on the northwest coast (Goodridge, 1997). Although the 1964 storm was most intensely focused in Humboldt County, a large portion of Mendocino County was subjected to a 100 year recurrence interval precipitation event. Numerous studies reveal there is a pronounced effect of pore water pressure changes on factor of safety for shallow-seated landslides (Sidle et al., 1985).

The sediment delivery estimates were normalized by time (years) and area (square miles) for the purposes of relative comparison between time intervals and planning watershed. The resulting sediment delivery rates in the Greenwood Creek WAU change dramatically over the time period investigated (Chart A-1).

Chart A-1. Mass Wasting Sediment Delivery Rate (tons/sq.mi./year) from Landslides for MRC Ownership in Greenwood Creek Shown by Watershed and Time Period.



Lower Greenwood has a slightly higher sediment delivery rate from mass wasting than Upper Greenwood over the entire 41 year period (371 tons/sq.mi./yr versus 340 tons/sq.mi./yr). The larger sediment delivery rate may be due to generally steeper terrain, and a large amount of land area underlain by deep-seated landslide deposits. The area of mapped deep-seated landslide deposits in Lower Greenwood (1754 acres, or 29% of the MRC acreage in Lower Greenwood) was found to be greater than Upper Greenwood (344 acres, or 9% of the acreage of Upper Greenwood). Although many of the large deep-seated landslides mapped in Lower Greenwood are likely dormant, several shallow-seated failures which delivered considerable quantities of sediment to a watercourse originated on slopes underlain by deep-seated landslide deposits.

Road associated mass wasting (including roads, skid trails, and landings) was found to have contributed 153,200 tons (247 tons/sq. mi./yr) of sediment over the 41 years analyzed in the Greenwood Creek WAU (Table A-6). This represents approximately 69% of the total mass wasting inputs for the Greenwood Creek WAU for 1960-2000. The road related sediment delivery rates for both Lower and Upper Greenwood Creek planning watersheds were nearly identical.

Table A-6. Road Associated Sediment Delivery (in tons) for Shallow-Seated Landslides for Greenwood Creek WAU by Planning Watershed.

Planning Watershed	Road Associated Mass Wasting Sediment Delivery (tons)	Percent of Total Sediment Delivery From Planning Watershed
Lower Greenwood Creek	93,600	65%
Upper Greenwood Creek	59,600	74%
Total	***153,200***	***69%***

Sediment Input by Terrain Stability Unit

Total mass wasting sediment delivery for the Greenwood Creek WAU was separated into respective Terrain Stability Units. Sediment delivery statistics for each TSU are summarized in Table A-7. It should be noted that not all planning watersheds contain all six TSUs.

Table A-7. Total Sediment Delivery (in tons) by TSU in the Greenwood Creek WAU (tons)

TSU	1	2	3	4	5	6
Road Related Sediment Delivered (tons)	25,700	36,600	10,900	80,000	0	0
Non-Road Related Sediment Delivered (tons)	29,700	12,900	8,200	19,100	0	0
Total Sediment Delivered (tons)	55,400	49,500	19,100	99,100	0	0
% road related delivery	17%	24%	7%	52%	0%	0%
% non-road related delivery	42%	18%	12%	27%	0%	0%
% of total delivered	25%	22%	9%	44%	0%	0%
% of WAU area	6%	9%	3%	78%	3%	<1%
% ratio: delivery %/area %	4.2	2.4	2.6	0.6	0.0	0.0

The TSU with the largest estimated sediment delivery is TSU 4, which is estimated to deliver 44% of the total sediment input for the Greenwood Creek WAU. This is partly due to the high road density within this unit which makes the actual hazard of the unit appear artificially high; 80% of the total delivered sediment in TSU 4 came from road related features. Combining all high hazard units (TSU 1, 2, and 3) would yield 72% of the estimated non-road related sediment input off approximately 18% of the MRC owned acreage. Combining the moderate and low hazard units (TSU 4 and 5) would yield 28% of the estimated non-road related sediment input off the remaining 82% of the property. One measure of the intensity of mass wasting processes in a given TSU is the amount of sediment produced divided by the area in the TSU. The last row in Table A-7 expresses landslide intensity as the ratio of the percentage of total sediment delivered by the percentage of watershed area in the TSU. A ratio of 1.0 would indicate that the map unit is producing a proportion of the sediment delivery equal to the proportion of the map unit area within the WAU. Values of this ratio greater than 1.0 indicate high landslide rates in a relatively concentrated area. The TSUs with the largest ratios were units 1, 2, and 3, with ratios of 4.2, 2.4, and 2.6, respectively. The smallest ratios are found in units 4, 5, and 6; 0.6, 0.0, and 0.0, respectively. Although unit 6 is a high hazard area, the small area mapped (7 acres) coupled with no observed sediment delivery results in a ratio of 0.0. The ratios suggest that the delineation of the high hazard Terrain Stability Units has captured the majority of the estimated sediment delivery from mass wasting over the past 41 years in the Greenwood Creek WAU.

CONCLUSIONS

In forest environments of the California Coast Range, mass wasting is a common, natural occurrence. In the Greenwood Creek WAU this is due to steep slopes, the condition of weathered and intensely sheared and fractured marine sedimentary rocks, seismic activity, locally thick colluvial soils, a history of timber harvest practices, and the occurrence of high intensity rainfall events. Mass wasting events are episodic and many landslides may happen in a short time frame. Mass wasting features of variable age and stability are observed throughout the Greenwood Creek WAU. All but one of the landslides visited in the field during this assessment occurred on slopes greater than 65%. Seeps and springs were evident in the evacuated cavity at many sites. Particular caution should be exercised when conducting any type of forest management activity in areas with convergent or locally steep topography.

Mass wasting sediment input is estimated to be at least 359 tons/sq.mi./yr. over the 1960-2000 time period for the entire Greenwood Creek WAU. However, approximately 31% of the shallow-seated landslides inventoried in the Greenwood Creek WAU are road associated (includes roads, skid trails, and landings). Road associated mass wasting represented 69% of the estimated sediment delivery, or at least 247 tons/sq. mi./yr of sediment over the 41 years analyzed. Road construction is thus a significant factor in the cause of shallow-seated mass wasting events. Improved road construction practices combined with design upgrades of old roads can reduce anthropogenic sediment input rates and mass wasting hazards

The steep streamside areas of TSU 1, 2, and 3 contribute the highest amount of the sediment per unit area in the watershed. In the moderate and low hazard units of TSU 4 and 5, a large amount of road associated landslides are occurring, suggesting the need to make improvements on roads within the Greenwood Creek WAU.

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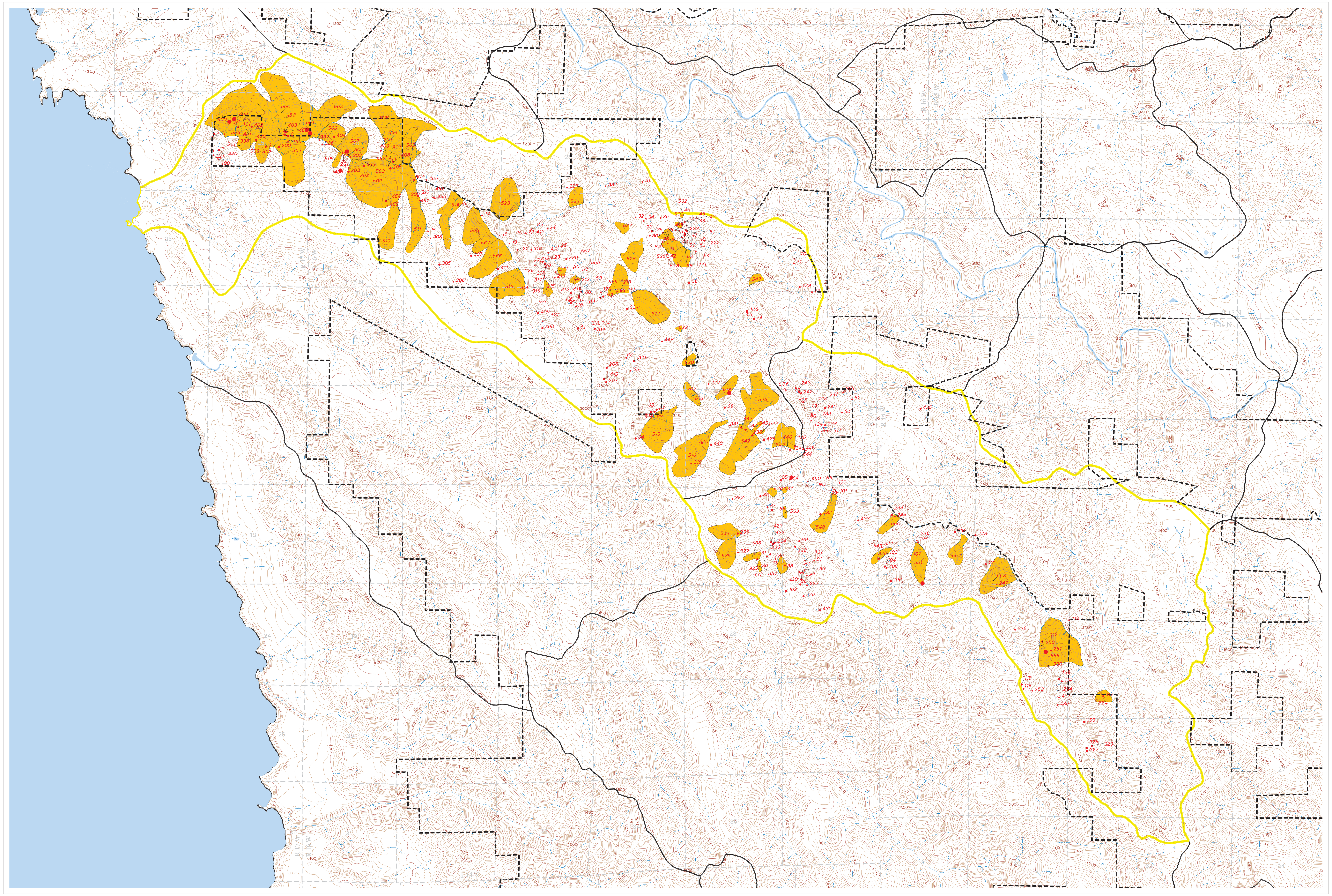
Greenwood Creek Mass Wasting Inventory
Appendix A



Greenwood Creek Watershed Analysis Unit

Map A-1 Mass Wasting Inventory

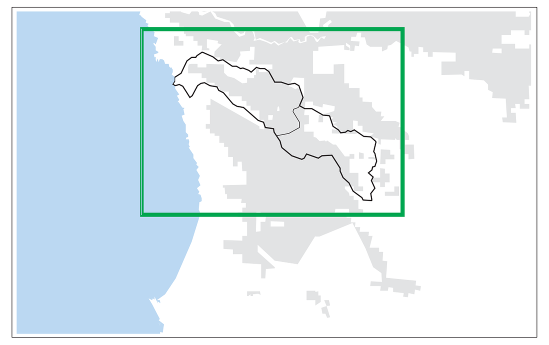
This map presents the location of mass wasting features identified on the MRC land in the Greenwood Creek watershed. The mass wasting features were developed from an interpretation of aerial photographs from the 1960's-2000 with field observations taken in 2003. All shallow-seated landslides are identified as a point plotted on the map at the interpreted head scarp of the failure. Deep-seated landslides are represented as a polygon representing the interpreted perimeter of the landslide feature. Physical and geomorphic characteristics of the landslides are categorized in a database in the mass wasting section of the Greenwood watershed analysis.

Deep-Seated Landslides

Shallow-Seated Landslides
- < 500 cubic yards
- 500 - 5000 cubic yards
- > 5000 cubic yards

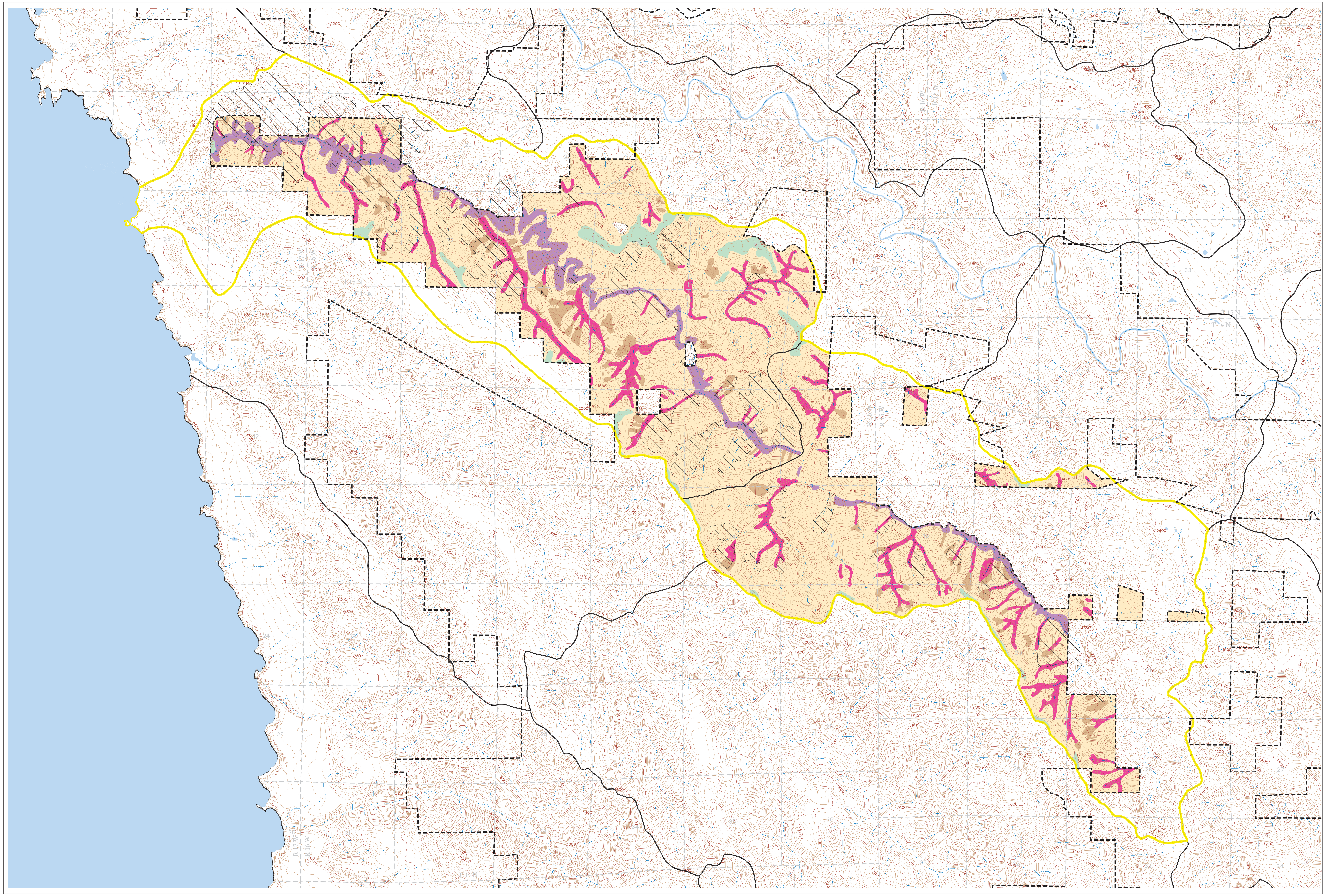
MRC Ownership
Planning Watershed Boundary
Greenwood Creek Watershed Boundary

Flow Class
- Class I
- Class II
- Class III



0 1/2 1 Miles

July 2004



Greenwood Creek Watershed Analysis Unit

Map A-2 Terrain Stability Units

This map presents an interpretation of the terrain stability units (TSUs) delineated for the Greenwood WAU. The TSUs characterize the landscape by similar geomorphic attributes, shallow-seated landslide potential, and sediment delivery potential. The TSU designations for the Greenwood WAU are only meant to be general characterizations of similar geomorphic and terrain characteristics related to shallow seated landslides. Deep-seated landslides are also shown on this map. The deep-seated landslides have been included to provide land managers with supplemental information to guide evaluation of harvest planning and subsequent needs for geologic review. The landscape and geomorphic setting in the Greenwood WAU is more complex than generalized TSUs delineated for this evaluation. The TSUs are only meant to be a starting point for gauging the need for site-specific field assessments. Field observations will over-ride unit boundaries of this map.

Unit 1: Inner gorge or steep slopes adjacent to low gradient watercourses

Unit 2: Inner gorge or steep slopes adjacent to high gradient intermittent or ephemeral watercourses

Unit 3: Dissected and convergent topography

Unit 4: Non-dissected topography

Unit 5: Low relief topography

Deep Seated Landslides

MRC Ownership

Planning Watershed Boundary

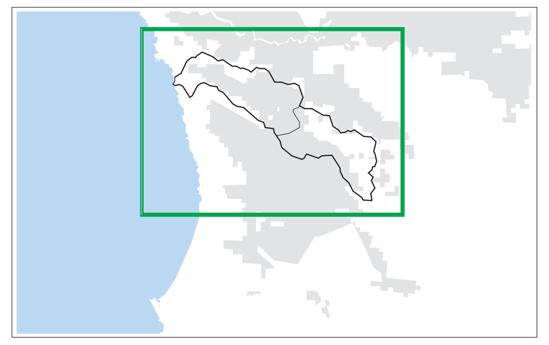
Greenwood Creek Watershed Boundary

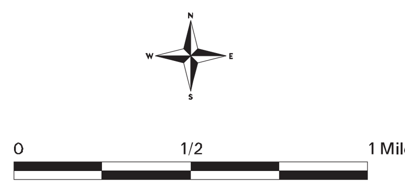
Flow Class

Class I

Class II

Class III





July 2004

Watershed: Greenwood Creek

Mendocino Redwood Company, LLC

Unique ID#	PWS	T & R Sec. #	Air Photo year	Air Photo frame	Landslide Type	MWMU	Certainty	Size Length	Size Width	Size Depth	Slide Vol.	Sed. Routing	Sed. Del. Ratio	Sed. Delivery	Sed. Delivery	Slope (field)	Age	Slope Form	Slide Loc.	Road Assoc.	Toe Activity	Body Morph.	Lat. Scarps	Main Scarps	DS Veg.	Complex	Field Obs.	Comments
													Shallow-seated landslides								*Deep-seated landslides*							
					DS DF DT EF RS	1 2 3 4 5 6	D P Q	feet	feet	feet	yd^3	P I N	25 50 75 100 (%)	yd^3	tons	(%)	N R O	C D P	H S I N	R S L N I	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4	Y N	Y N	
1	CG	25	1964	3-14	DS	1	D	66	33	5.5	444	I	60	266	359		R	P	N	R								
2	CG	25	1964	3-14	DS	1	D	132	66	5.5	1775	P	60	1065	1437		R	P	N	R								
3	CG	25	1964	3-14	DS	1	D	100	45	4	667	P	75	500	675	85	R	P	S	R							Y	
4	CG	25	1964	3-14	DS	1	D	60	40	5	444	P	100	444	600	90	R	P	S	R							Y	
5	CG	25	1964	3-14	DS	1	D	45	40	5	333	P	100	333	450	90	R	P	S	N							Y	
6	CG	25	1964	3-14	DS	1	D	132	99	5.5	2662	P	60	1597	2156		O	C	S	R								
7	CG	25	1964	3-14	DS	1	D	132	33	5.5	887	P	60	532	719		N	P	S	R								
8	CG	25	1969	1-3	DS	1	D	132	66	5.5	1775	P	60	1065	1437		O	C	S	R								
9	CG	25	1969	1-3	DS	2	D	264	132	5.5	7099	P	60	4259	5750		O	C	S	R								
10	CG	25	1969	1-3	DS	4	D	215	120	10	9556	P	50	4778	6450	75	O	C	S	R							Y	
11	CG	30	1969	1-3	DS	1	D	120	100	8	3556	P	100	3556	4800	85	O	P	S	R							Y	
12	CG	30	1969	1-3	DF	4	D	105	70	8	2178	P	75	1633	2205	70	N	P	S	R							Y	198 foot torrent track
13	CG	30	1969	1-3	DS	4	D	528	264	5.5	28395	P	60	17037	23000		N	C	S	R								
14	CG	30	1969	1-3	DS	1	D	66	33	4.7	379	P	60	227	307		N	P	S	N								
15	CG	32	1969	1-3	DS	2	P	66	33	4.7	379	P	60	227	307		N	P	S	N								
16	CG	32	1969	2-4	DF	4	D	132	66	4.7	1517	P	60	910	1228		N	C	S	N								330 foot torrent track
17	CG	32	1969	2-4	DS	1	D	66	33	4.7	379	P	60	227	307		N	P	S	N								
18	CG	33	1969	2-4	DS	2	D	33	16	4.7	92	P	60	55	74		N	P	H	I								
19	CG	33	1969	2-4	DS	3	D	66	33	5.5	444	I	60	266	359		N	P	I	S								
20	CG	33	1969	2-4	DS	3	D	50	25	8	370	N	0	0	0	95	N	C	H	N							Y	
21	CG	33	1969	2-4	DS	3	D	60	40	6	533	I	100	533	720	75	N	C	H	N							Y	
22	CG	33	1969	2-4	DS	4	D	66	33	5.5	444	I	60	266	359		N	C	H	R								
23	CG	33	1969	2-4	DS	1	D	66	33	5.5	444	I	60	266	359		N	C	H	R								
24	CG	33	1969	2-4	DS	1	D	66	33	4.7	379	P	60	227	307		N	P	S	N								
25	CG	33	1969	2-4	DS	1	D	66	33	5.5	444	P	60	266	359		N	C	S	R								
26	CG	33	1969	2-4	DS	4	D	50	30	6	333	P	50	167	225	80	N	C	H	S							Y	
27	CG	33	1969	2-4	DS	1	D	30	18	7	140	N	0	0	0	80	N	C	H	S							Y	
28	CG	33	1969	2-4	DS	1	D	99	66	5.5	1331	P	60	799	1078		N	C	S	S								
29	CG	33	1969	2-4	DS	1	D	33	16	4.7	92	P	60	55	74		N	C	S	N								
30	CG	33	1969	2-4	DS	1	D	66	33	4.7	379	P	60	227	307		N	C	S	N								
31	CG	27	1969	3-3	DF	4	D	66	33	5.5	444	I	60	266	359		N	P	N	R								462 foot torrent track
32	CG	34	1969	3-3	DF	4	D	66	33	4.7	379	I	60	227	307		N	C	N	N								
33	CG	34	1969	3-3	DS	2	D	30	12	3	40	I	50	20	27	65	N	C	N	N							Y	
34	CG	34	1969	3-3	DS	2	D	35	18	4	93	I	50	47	63	65	N	C	H	N							Y	
35	CG	34	1969	3-3	DS	4	D	66	66	4.7	758	I	60	455	614		O	C	H	N								
36	CG	34	1969	3-3	DS	2	D	33	16	4.7	92	I	60	55	74		N	C	S	N								
37	CG	34	1969	3-3	DS	4	D	33	16	4.7	92	I	60	55	74		O	C	H	N								
38	CG	34	1969	3-3	DS	4	D	40	30	4	178	I	50	89	120	70	N	C	H	N							Y	
39	CG	34	1969	3-3	DS	4	D	55	25	4	204	I	100	204	275	75	N	P	S	N							Y	failure off toe of possible DSL block
40	CG	34	1969	3-3	DS	4	D	45	20	4	133	I	50	67	90	80	N	C	N	N							Y	
41	CG	34	1969	3-3	DS	4	D	66	33	4.7	379	I	60	227	307		N	C	H	N								
42	CG	34	1969	3-3	DS	4	D	33	16	4.7	92	N	0	0	0		N	C	H	N								
43	CG	35	1969	3-3	DF	4	D	33	16	5.5	108	N	0	0	0		N	C	H	R								396 foot torrent track
44	CG	34	1969	3-3	DS	4	D	66	33	4.7	379	I	60	227	307		N	P	S	N								
45	CG	34	1969	3-3	DS	4	D	60	55	4	489	I	100	489	660	80	N	P	S	N							Y	failure off toe of possible DSL block
46	CG	34	1969	3-3	DS	4	D	66	33	4.7	379	I	60	227	307		R	P	S	N								
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50	CG	34	1969	3-3	DS	4	D	70	35	4	363	I	50	181	245	68	R	C	S	N							Y	
51	CG	34	1969	3-3	DS	4	D	60	30	4	267	I	50	133	180	70	R	C	S	N							Y	
52	CG	34	1969	3-3	DS	4	D	75	35	5	486	I	50	243	328	85	N	C	S	N							Y	

Watershed: Greenwood Creek

Mendocino Redwood Company, LLC

Unique ID#	PWS	T & R Sec. #	Air Photo year	Air Photo frame	Landslide Type	MWMU	Certainty	Size Length	Size Width	Size Depth	Slide Vol.	Sed. Routing	Sed. Del. Ratio	Sed. Delivery	Sed. Delivery	Slope (field)	Age	Slope Form	Slide Loc.	Road Assoc.	Toe Activity	Body Morph.	Lat. Scarps	Main Scarps	DS Veg.	Complex	Field Obs.	Comments
													Shallow-seated landslides								*Deep-seated landslides*							
					DS DF DT EF RS	1 2 3 4 5 6	D P Q	feet	feet	feet	yd^3	P I N	25 50 75 100 (%)	yd^3	tons	(%)	N R O	C D P	H S I N	R S L N I	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4	Y N	Y N	
53	CG	34	1969	3-3	DS	4	D	100	55	6	1222	I	25	306	413	85	N	C	S	N							Y	
54	CG	34	1969	3-3	DS	4	D	30	14	3	47	I	100	47	63	85	N	C	S	N							Y	
55	CG	34	1969	3-3	DF	4	D	40	20	5	148	I	50	74	100	80	N	C	S	N							Y	
56	CG	34	1969	3-3	DS	2	D	99	99	4.7	1706	P	60	1024	1382		N	P	S	N								
57	CG	4	1969	3-5	DS	2	D	55	35	5	356	I	50	178	241	105	N	P	S	R							Y	
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59	CG	4	1969	3-5	DS	2	D	99	66	4.7	1137	I	60	682	921		N	P	S	I								
60	CG	4	1969	3-5	DS	2	D	70	55	3	428	I	100	428	578	85	N	C	S	S							Y	
61	CG	4	1969	3-5	DF	3	D	99	66	4.7	1137	I	60	682	921		N	C	N	N								792 foot torrent track
62	CG	3	1969	3-5	DS	2	D	33	16	5.5	108	I	60	65	87		N	P	S	R								
63	CG	3	1969	3-5	DS	2	D	30	14	3	47	I	100	47	63	95	N	C	S	R							Y	
64	CG	10	1969	3-5	DS	2	P	66	99	5.5	1331	I	60	799	1078		N	P	S	S								
65	CG	10	1969	3-5	DS	1	D	99	66	4.7	1137	I	60	682	921		N	P	S	N								
66	CG	10	1969	3-5	DS	1	D	99	66	4.7	1137	I	60	682	921		N	P	S	N								
67	CG	10	1969	3-5	DS	1	D	132	66	4.7	1517	I	60	910	1228		N	P	S	N								
68	CG	11	1969	3-5	DS	4	D	132	99	5.5	2662	P	60	1597	2156		N	P	S	R								
69	CG	11	1969	3-5	DF	3	D	264	165	4.7	7583	P	60	4550	6142		N	C	H	I								429 foot torrent track
70	CG	35	1969	4-4	DF	4	D	66	33	5.5	444	I	60	266	359		N	C	S	R								99 foot torrent track
71	CG	35	1969	4-4	DF	4	D	33	16	5.5	108	I	60	65	87		N	C	S	R								99 foot torrent track
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76	CU	2	1969	4-4	DF	4	D	66	33	4.7	379	I	60	227	307		R	C	N	N								
77	CU	1	1969	4-4	DF	2	P	66	33	4.7	379	I	60	227	307		O	C	N	N								99 foot torrent track
78	CU	12	1969	4-6	DS	2	P	55	25	5	255	I	50	127	172	85	R	C	N	N							Y	
79	CU	12	1969	4-6	DS	2	P	60	40	7	622	I	50	311	420	80	R	P	N	N							Y	
80	CU	12	1969	4-6	DF	4	D	66	33	4.7	379	I	60	227	307		N	C	H	N								165 foot torrent track
81	CU	12	1969	4-6	DS	4	D	66	33	4.7	379	N	0	0	0		N	C	H	N								
82	CU	12	1969	4-6	DS	3	D	33	16	4.7	92	I	60	55	74		N	C	H	N								
83	CU	12	1969	4-6	DS	4	D	350	80	7	7259	P	75	5444	7350	75	N	P	S	R							Y	
84	CU	12	1969	4-6	DS	2	D	225	55	6	2750	P	75	2063	2784	73	N	P	S	R							Y	
85	CU	11	1969	4-6	DS	2	D	275	60	6	3667	P	75	2750	3713	67	N	P	N	R							Y	
86	CU	14	1969	4-6	DF	4	D	198	83	5.5	3348	P	60	2009	2712		N	C	H	S								333 foot torrent track
87	CU	14	1969	4-6	DF	2	D	66	33	5.5	444	P	60	266	359		N	P	S	R								99 foot torrent track
88	CU	14	1969	4-6	DS	2	D	99	66	4.7	1137	P	60	682	921		R	P	S	N								
89	CU	14	1969	4-6	DS	4	D	66	33	5.5	444	I	60	266	359		N	P	S	S								
90	CU	13	1969	4-6	DS	4	D	132	66	5.5	1775	I	60	1065	1437		N	P	S	S								
91	CU	13	1969	4-6	DS	4	D	33	16	5.5	108	I	60	65	87		N	P	S	S								
92	CU	13	1969	4-6	DS	4	D	66	16	5.5	215	I	60	129	174		N	P	S	S								
93	CU	13	1969	4-6	DS	4	D	33	16	5.5	108	I	60	65	87		N	P	S	R								
94	CU	13	1969	4-6	DS	4	P	66	33	5.5	444	I	60	266	359		N	C	S	S								
95	CU	13	1969	4-6	DF	4	D	99	33	5.5	666	I	60	399	539		N	C	S	S								165 foot torrent track
96	CU	13	1969	4-6	DF	4	D	99	50	5.5	1008	I	60	605	817		N	P	S	S								264 foot torrent track
97	CU	12	1969	4-6	DS	4	D	66	66	5.5	887	P	60	532	719		N	C	S	R								
98	CU	13	1969	4-6	DS	4	D	66	33	5.5	444	P	60	266	359		N	C	S	R								
99	CU	13	1969	4-6	DS	4	D	66	33	5.5	444	P	60	266	359		N	C	S	R								
100	CU	13	1969	4-6	DS	4	D	66	33	5.5	444	P	60	266	359		N	P	S	R								
101	CU	13	1969	4-6	DS	4	D	33	33	5.5	222	P	60	133	180		N	P	S	R								
102	CU	24	1969	4-8	DS	4	D	99	66	4.7	1137	I	60	682	921		O	C	S	N								
103	CU	18	1969	5-3	DS	2	D	33	16	5.5	108	I	60	65	87		N	P	S	S								
104	CU	18	1969	5-3	DS	4	D	99	50	5.5	1008	I	60	605	817		N	P	S	S								

Watershed: Greenwood Creek

Mendocino Redwood Company, LLC

Unique ID#	PWS	T & R Sec. #	Air Photo year	Air Photo frame	Landslide Type DS DF DT EF RS	MWMU 1 2 3 4 5 6	Certainty D P Q	Size Length feet	Size Width feet	Size Depth feet	Slide Vol. yd^3	Sed. Routing P I N	Sed. Del. Ratio 25 50 75 100 (%)	*Shallow-seated landslides* Sed. Delivery yd^3	Sed. Delivery tons	Slope (field) (%)	Age N R O	Slope Form C D P	Slide Loc. H S I N	Road Assoc. R S L N I	*Deep-seated landslides* Toe Activity 1 2 3 4 5	Body Morph. 1 2 3 4 5	Lat. Scarps 1 2 3 4 5	Main Scarps 1 2 3 4 5	DS Veg. 1 2 3 4	Complex Y N	Field Obs. Y N	Comments
105	CU	18	1969	5-3	DS	4	D	66	33	5.5	444	I	60	266	359		N	P	S	S								
106	CU	18	1969	5-3	DS	4	D	132	99	5.5	2662	I	60	1597	2156		N	C	S	S								
107	CU	18	1969	5-3	DS	2	D	66	33	5.5	444	I	60	266	359		N	C	S	S								
108	CU	18	1969	5-3	DS	2	D	33	16	5.5	108	I	60	65	87		N	C	S	R								
109	CU	18	1969	5-3	DT	4	D	333	99	5.5	6716	I	60	4029	5440		N	C	H	S								990 foot torrent track
110	CU	18	1969	5-3	DS	1	D	198	132	4.7	4550	P	60	2730	3685		O	C	S	N								
111	CU	17	1969	5-3	DS	2	D	99	66	4.7	1137	N	0	0	0		N	C	H	N								
112	CU	20	1969	5-5	DF	4	D	110	55	5	1120	I	100	1120	1513	75	N	C	S	R							Y	231 foot torrent track
113	CU	20	1969	5-5	DS	1	P	66	33	4.7	379	N	0	0	0		N	C	N	N								
114	CU	20	1969	5-5	DS	2	D	99	66	4.7	1137	I	60	682	921		R	P	S	N								
115	CU	20	1969	5-5	DF	4	P	83	50	4.7	722	I	60	433	585		R	C	H	N								
116	CU	20	1969	5-5	DF	2	P	66	16	4.7	184	I	60	110	149		R	C	H	N								
117	CU	21	1969	6-5	DF	4	D	231	99	4.7	3981	P	60	2389	3225		N	P	S	N								
118	CU	12	1969	field obs	DS	2	D	50	30	6	333	P	100	333	450	75	O	C	S	R							Y	
119	CG	3	1969	field obs	DS	1	D	80	30	7	622	P	25	156	210	90	O	C	S	R							Y	
120	CG	3	1969	field obs	DS	1	D	80	70	7	1452	P	100	1452	1960	90	O	C	S	R							Y	
200	CG	25	1978	1-7	DS	1	D	132	99	4.7	2275	P	60	1365	1843		N	C	S	N								
201	CG	30	1978	1-7	DS	4	D	75	35	8	778	I	50	389	525	70	N	C	S	L							Y	
202	CG	30	1978	1-7	DS	2	D	60	30	5	333	I	75	250	338	80	N	C	S	R							Y	
203	CG	30	1978	1-7	DS	2	D	99	66	5.5	1331	I	60	799	1078		N	C	S	R								
204	CG	30	1978	2-17	DS	4	D	65	35	4	337	I	100	337	455	90	N	C	S	S							Y	
205	CG	30	1978	2-17	DS	1	D	99	66	5.5	1331	P	60	799	1078		N	C	S	S								
206	CG	3	1978	3-12	DS	3	D	99	99	5.5	1997	I	60	1198	1617		R	C	H	S								
207	CG	3	1978	3-12	DS	3	D	99	66	5.5	1331	I	60	799	1078		N	C	H	S								
208	CG	4	1978	3-14	DS	2	D	165	132	4.7	3791	I	60	2275	3071		N	P	S	N								
209	CG	4	1978	3-14	DS	2	D	99	66	5.5	1331	I	60	799	1078		N	C	S	S								
210	CG	4	1978	3-14	DS	2	D	33	33	5.5	222	I	60	133	180		N	C	S	S								
211	CG	4	1978	3-14	DS	4	D	66	33	5.5	444	I	60	266	359		N	C	S	S								
212	CG	4	1978	3-14	DS	2	D	100	60	4	889	I	100	889	1200	95	N	C	S	S							Y	
213	CG	3	1978	3-14	DS	1	D	120	85	5	1889	P	100	1889	2550	100	R	C	S	R							Y	
214	CG	3	1978	3-14	DS	1	D	80	40	6	711	P	75	533	720	80	N	C	S	R							Y	
215	CG	33	1978	3-14	DS	2	D	33	16	5.5	108	I	60	65	87		N	C	S	S								
216	CG	33	1978	3-14	DS	4	D	50	33	5.5	336	I	60	202	272		N	C	S	S								
217	CG	33	1978	3-14	DS	1	D	33	16	5.5	108	P	60	65	87		N	C	S	S								
218	CG	33	1978	3-14	DS	1	D	99	33	5.5	666	P	60	399	539		N	C	S	S								
219	CG	33	1978	3-14	DS	1	D	66	33	4.7	379	P	60	227	307		N	C	S	N								
220	CG	33	1978	3-14	DS	4	D	99	66	5.5	1331	P	60	799	1078		N	C	S	S								
221	CG	35	1978	3-14	DS	4	D	33	16	5.5	108	I	60	65	87		N	C	S	R								
222	CG	35	1978	3-14	DS	4	D	33	16	5.5	108	I	60	65	87		N	C	S	R								
223	CG	34	1978	3-14	DF	4	D	65	25	4	241	I	50	120	163	75	R	C	H	N							Y	failure off toe of possible DSL block
224	CG	34	1978	3-14	DF	4	D	100	40	4	593	I	50	296	400	75	R	C	H	N							Y	failure off toe of possible DSL block
225	CG	28	1978	3-14	DS	2	D	66	33	4.7	379	N	0	0	0		N	C	H	N								
226	CU	24	1978	4-8	DS	4	P	99	66	5.5	1331	I	60	799	1078		N	C	H	R								
227	CU	24	1978	4-8	DS	4	D	66	33	5.5	444	I	60	266	359		N	C	N	S								
228	CU	13	1978	4-8	DS	4	D	66	66	5.5	887	I	60	532	719		N	C	S	R								
229	CU	14	1978	4-8	DS	2	D	132	116	5.5	3119	I	60	1871	2526		N	C	S	S								
230	CU	14	1978	4-8	DF	4	D	66	33	4.7	379	I	60	227	307		N	C	N	I								
231	CU	14	1978	4-8	DF	4	D	99	66	4.7	1137	I	60	682	921		N	C	N	I								
232	CU	14	1978	4-8	DS	2	D	33	16	5.5	108	I	60	65	87		N	C	N	R								
233	CU	14	1978	4-8	DS	2	D	33	16	5.5	108	I	60	65	87		N	C	N	R								
234	CU	14	1978	4-8	DS	2	D	66	33	5.5	444	I	60	266	359		N	C	N	R								
235	CU	14	1978	4-8	DS	4	D	66	50	5.5	672	N	0	0	0		N	P	N	S								

Watershed: Greenwood Creek

Mendocino Redwood Company, LLC

Unique ID#	PWS	T & R Sec. #	Air Photo year	Air Photo frame	Landslide Type	MWMU	Certainty	Size Length feet	Width feet	Depth feet	Slide Vol. yd^3	Sed. Routing	Sed. Del. Ratio	*Shallow-seated landslides* Sed. Delivery yd^3	Sed. Delivery tons	Slope (field) (%)	Age	Slope Form	Slide Loc.	Road Assoc.	*Deep-seated landslides* Toe Activity	Body Morph.	Lat. Scarps	Main Scarps	DS Veg.	Complex	Field Obs.	Comments
					DS DF DT EF RS	1 2 3 4 5 6	D P Q					P I N	25 50 75 100 (%)				N R O	C D P	H S I N	R S L N I	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4	Y N	Y N	
236	CG	11	1978	4-10	DS	1	D	100	70	3	778	P	100	778	1050	90	N	P	S	N							Y	
237	CG	11	1978	4-10	DS	1	D	150	85	6	2833	P	50	1417	1913	70	N	P	S	N							Y	deposited several pieces of LWD
238	CU	12	1978	4-10	DS	2	D	140	100	10	5185	P	75	3889	5250	95	N	P	N	R							Y	cut-slope failure that took out the road
239	CU	12	1978	4-10	DS	4	P	70	40	5	519	I	50	259	350	78	R	C	N	N							Y	
240	CU	12	1978	4-10	DS	4	D	75	40	6	667	I	50	333	450	80	R	C	N	N							Y	
241	CU	12	1978	4-10	DS	4	D	66	33	4.7	379	I	60	227	307		N	C	N	N								
242	CU	12	1978	4-10	DS	2	D	99	33	4.7	569	I	60	341	461		N	P	S	N								
243	CU	12	1978	4-10	DS	2	D	99	99	4.7	1706	I	60	1024	1382		N	P	S	N								
244	CU	18	1978	5-8	DS	1	D	99	66	4.7	1137	P	60	682	921		N	P	S	N								
245	CU	18	1978	5-8	DS	1	D	66	33	4.7	379	P	60	227	307		R	P	S	N								
246	CU	18	1978	5-8	DS	2	D	66	33	5.5	444	I	60	266	359		N	P	S	R								
247	CU	17	1978	5-8	DS	4	P	33	16	5.5	108	I	60	65	87		N	C	N	S								
248	CU	17	1978	5-8	DS	4	D	66	99	5.5	1331	P	60	799	1078		N	C	S	R								cut-slope failure that overtopped the road
249	CU	20	1978	6-6	DS	2	D	30	12	4	53	I	75	40	54	80	N	C	S	R							Y	
250	CU	20	1978	6-6	DS	4	D	75	45	4	500	I	100	500	675	75	N	P	S	R							Y	
251	CU	20	1978	6-6	DF	2	D	66	16	5.5	215	I	60	129	174		N	C	S	R								
252	CU	20	1978	6-6	DS	3	D	231	132	5.5	6211	I	60	3727	5031		R	C	H	S								
253	CU	20	1978	6-6	DS	4	D	33	16	5.5	108	I	60	65	87		N	C	N	S								
254	CU	20	1978	6-6	DS	2	D	33	66	5.5	444	I	60	266	359		N	P	S	R								
255	CU	28	1978	6-6	DS	3	P	66	132	4.7	1517	N	0	0	0		N	C	H	N								
300	CG	25	1990	104-2	DS	4	D	120	100	15	6667	N	0	0	0	65	N	P	N	R							Y	possible DSL instability
301	CG	25	1990	104-2	DS	1	D	50	25	3	139	I	50	69	94	80	N	P	N	R							Y	failure off toe of possible DSL block
302	CG	30	1990	105-3	DS	1	D	75	100	5	1389	P	100	1389	1875	85	N	C	S	N							Y	
303	CG	30	1990	105-3	DS	1	D	50	25	4	185	P	50	93	125	90	N	C	S	N							Y	
304	CG	29	1990	105-3	DS	1	D	75	75	4.7	979	P	60	588	793		N	C	S	N								
305	CG	32	1990	106-14	DS	2	D	75	50	4.7	653	N	0	0	0		N	P	N	N								
306	CG	32	1990	106-14	DS	2	D	50	25	5.5	255	P	60	153	206		N	P	N	R								
307	CG	32	1990	106-16	DS	4	D	75	50	8	1111	I	25	278	375	70	N	P	N	R							Y	
308	CG	32	1990	106-16	DS	2	P	25	50	4.7	218	P	60	131	176		R	C	S	N								
309	CG	32	1990	106-16	DS	2	D	75	50	5	694	I	75	521	703	80	N	P	S	R							Y	adjacent to gully on failed crossing
310	CG	32	1990	106-16	DS	4	D	50	25	4	185	N	0	0	0	80	N	C	N	R							Y	
311	CG	4	1990	107-15	DS	2	D	50	50	4.7	435	P	60	261	353		N	C	S	N								
312	CG	3	1990	107-15	DS	2	D	100	25	5.5	509	P	60	306	413		N	P	S	S								
313	CG	3	1990	107-15	DS	2	D	50	25	5.5	255	P	60	153	206		N	P	S	S								
314	CG	3	1990	107-15	DS	2	D	50	50	4.7	435	N	0	0	0		N	P	N	N								
315	CG	33	1990	107-17	DS	2	D	25	25	5.5	127	P	60	76	103		N	C	S	S								
316	CG	33	1990	107-17	DS	2	D	25	25	5.5	127	P	60	76	103		N	C	S	S								
317	CG	33	1990	107-17	DS	1	D	50	100	4.7	870	P	60	522	705		R	P	S	N								
318	CG	33	1990	107-17	DS	4	D	75	25	5.5	382	I	60	229	309		N	C	H	S								
319	CG	11	1990	108-17	DS	4	P	50	25	5.5	255	I	60	153	206		N	P	N	S								
320	CG	11	1990	108-17	DS	4	P	75	50	4.7	653	I	60	392	529		R	P	N	N								
321	CG	3	1990	108-19	DS	2	D	100	100	5	1852	P	100	1852	2500	90	N	P	S	S							Y	
322	CU	14	1990	109-12	DS	4	P	75	25	5.5	382	I	60	229	309		N	P	N	S								
323	CU	14	1990	109-12	DS	4	D	75	25	5.5	382	I	60	229	309		N	P	N	S								
324	CU	18	1990	110-16	DS	3	D	50	50	4.7	435	I	60	261	353		N	C	N	N								
325	CU	12	1990	110-18	DS	2	D	50	50	5	463	P	75	347	469	80	N	P	S	N							Y	
326	CU	13	1990	111-10	DS	2	D	75	50	5.5	764	I	60	458	619		N	P	N	S								
327	CU	28	1990	112-8	DS	4	D	75	50	5.5	764	I	60	458	619		R	C	H	S								
328	CU	28	1990	112-8	DS	4	D	75	50	5.5	764	I	60	458	619		R	C	H	S								
329	CU	28	1990	112-8	DS	4	P	75	50	5.5	764	I	60	458	619		R	C	H	S								
330	CU	20	1990	112-10	DS	2	P	50	25	5.5	255	I	60	153	206		N	C	S	L								
331	CG	11	1990	field obs	DS	1	D	35	12	3	47	P	100	47	63	90	O	P	S	R							Y	

Watershed: Greenwood Creek

Mendocino Redwood Company, LLC

Shallow-seated landslides | *Deep-seated landslides*

Unique ID#	PWS	T & R Sec. #	Air Photo year	Air Photo frame	Landslide Type	MWMU	Certainty	Size Length	Width	Depth	Slide Vol.	Sed. Routing	Sed. Del. Ratio	Sed. Delivery	Sed. Delivery	Slope (field)	Age	Slope Form	Slide Loc.	Road Assoc.	Toe Activity	Body Morph.	Lat. Scarps	Main Scarps	DS Veg.	Complex	Field Obs.	Comments
					DS DF DT EF RS	1 2 3 4 5 6	D P Q	feet	feet	feet	yd^3	P I N	25 50 75 100 (%)	yd^3	tons	(%)	N R O	C D P	H S I N	R S L N I	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4	Y N	Y N	
332	CG	28	1990	field obs	DS	4	D	16	30	4	71	P	50	36	48	45	O	C	N	R							Y	possibly caused by bank erosion
333	CG	25	1990	field obs	DS	1	D	50	40	5	370	I	25	93	125	90	O	P	S	R							Y	
334	CG	3	1990	field obs	DS	4	D	150	80	4	1778	N	0	0	0	95	O	P	S	R							Y	cut-slope failure that took out the road
335	CG	30	1990	field obs	DS	4	D	80	50	4	593	P	25	148	200	95	O	P	S	R							Y	
336	CG	30	1990	field obs	DS	1	D	60	20	6	267	P	25	67	90	95	O	C	S	R							Y	
337	CG	30	1990	field obs	DS	1	D	50	45	5	417	P	50	208	281	90	O	P	S	R							Y	
338	CG	25	1990	field obs	DS	1	D	40	25	4	148	I	50	74	100	110	O	C	H	R							Y	
400	CG	25	2000	5A-2	DS	1	D	50	25	3	139	N	0	0	0	80	N	P	N	R							Y	
401	CG	25	2000	6-7	DS	1	D	300	75	5	4167	P	25	1042	1406	85	N	P	N	R							Y	possible DSL instability
402	CG	25	2000	6-7	DS	1	D	100	100	6	2222	I	25	556	750	90	N	P	N	R							Y	
403	CG	25	2000	6-7	DS	1	D	300	50	5	2778	P	75	2083	2813	95	N	P	S	R								
404	CG	30	2000	6-7	DS	1	D	100	75	8	2222	P	25	556	750	75	N	P	N	N							Y	
405	CG	30	2000	6-7	DS	1	D	50	25	5	231	I	25	58	78	75	N	C	N	S							Y	
406	CG	30	2000	7B-16	DS	1	D	50	25	5.5	255	P	60	153	206		R	C	S	R								
407	CG	30	2000	7B-16	DS	1	D	50	25	5.5	255	P	60	153	206		R	C	S	R								
408	CG	30	2000	7B-16	DS	1	D	50	50	6	556	P	100	556	750	80	R	C	S	N							Y	possible DSL instability
409	CG	4	2000	8B-18	DS	2	P	75	50	4.7	653	P	60	392	529		N	C	S	N								
410	CG	4	2000	8B-18	DS	2	P	50	25	4.7	218	P	60	131	176		N	P	S	N								
411	CG	33	2000	8B-20	DF	4	D	125	75	5.5	1910	I	60	1146	1547		N	C	N	R								
412	CG	33	2000	8B-20	DS	1	D	50	25	4.7	218	P	60	131	176		N	C	S	N								
413	CG	33	2000	8B-20	DS	1	D	50	25	4.7	218	P	60	131	176		N	C	S	N								
414	CG	10	2000	9B-16	DS	4	P	50	25	5.5	255	I	60	153	206		N	P	N	R								
415	CG	3	2000	9B-16	DS	4	D	75	50	6	833	N	0	0	0	75	N	C	H	R							Y	
416	CG	4	2000	9B-18	DS	4	D	75	50	5.5	764	I	60	458	619		N	P	S	S								
417	CG	4	2000	9B-18	DS	3	D	100	50	5.5	1019	I	60	611	825		N	C	S	S								
418	CG	3	2000	9B-18	DS	4	D	50	25	5.5	255	P	60	153	206		N	P	N	R								
419	CG	34	2000	9B-18	DF	4	D	50	25	4.7	218	I	60	131	176		N	C	H	N								
420	CU	13	2000	10B-12	DS	4	D	25	25	5.5	127	I	60	76	103		N	P	N	R								
421	CU	14	2000	10B-12	DS	4	D	50	25	4.7	218	I	60	131	176		N	P	N	N								
422	CU	14	2000	10B-12	DS	2	D	100	50	5.5	1019	I	60	611	825		N	P	S	R								
423	CU	14	2000	10B-12	DS	4	D	50	50	5.5	509	I	60	306	413		R	P	S	R								
424	CG	12	2000	10B-14	DS	1	D	75	50	5	694	P	25	174	234	65	R	P	S	N							Y	
425	CG	12	2000	10B-14	DS	4	D	100	50	8	1481	P	50	741	1000	70	N	C	S	R							Y	
426	CG	11	2000	10B-14	DS	4	D	75	75	4	833	P	50	417	563	65	N	P	S	S							Y	cut-slope failure that overtopped the road
427	CG	2	2000	10B-14	DS	1	D	50	25	4.7	218	P	60	131	176		N	C	H	N								
428	CG	2	2000	10B-16	DS	4	D	75	50	4.7	653	I	60	392	529		N	C	H	N								
429	CG	35	2000	10B-16	DS	4	D	75	50	5.5	764	I	60	458	619		N	P	N	S								
430	CU	24	2000	11B-14	DS	4	P	50	25	5.5	255	I	60	153	206		N	P	N	S								
431	CU	13	2000	11B-14	DS	4	D	75	25	5.5	382	P	60	229	309		R	P	N	R								
432	CU	13	2000	11B-16	DS	4	P	75	50	5.5	764	I	60	458	619		N	C	S	R								
433	CU	13	2000	11B-16	DS	2	D	50	25	4.7	218	I	60	131	176		N	P	S	N								
434	CU	12	2000	11B-16	DS	4	D	50	25	4.7	218	I	60	131	176		N	P	H	N								
435	CU	7	2000	12C-11	DS	4	D	100	75	4.7	1306	I	60	783	1058		N	C	N	N								
436	CU	20	2000	13B-7	DS	2	D	50	25	4.7	218	I	60	131	176		N	P	N	N								
437	CU	20	2000	13B-8	DS	2	D	50	25	4.7	218	I	60	131	176		N	P	N	N								
438	CU	20	2000	13B-9	DS	2	D	75	50	5.5	764	I	60	458	619		N	P	S	S								
439	CG	25	2000	field obs	DS	1	D	60	40	6	533	P	100	533	720	85	R	P	S	R							Y	
440	CG	25	2000	field obs	DS	1	D	30	20	3	67	P	25	17	23	110	R	P	S	N							Y	
441	CG	25	2000	field obs	DS	4	D	45	30	5	250	P	75	188	253	120	R	P	S	R							Y	
442	CU	12	2000	field obs	DS	2	D	25	50	5	231	I	100	231	313	75	O	P	S	R							Y	
443	CU	12	2000	field obs	DS	4	D	20	20	4	59	I	100	59	80	80	R	P	N	S							Y	
444	CU	12	2000	field obs	DS	4	D	20	45	4	133	P	100	133	180	90	R	P	N	R							Y	

Watershed: Greenwood Creek

Mendocino Redwood Company, LLC

													Shallow-seated landslides									*Deep-seated landslides*						
Unique ID#	PWS	T & R Sec. #	Air Photo year	Air Photo frame	Landslide Type	MWMU	Certainty	Size Length	Size Width	Size Depth	Slide Vol.	Sed. Routing	Sed. Del. Ratio	Sed. Delivery	Sed. Delivery	Slope (field)	Age	Slope Form	Slide Loc.	Road Assoc.	Toe Activity	Body Morph.	Lat. Scarps	Main Scarps	DS Veg.	Complex	Field Obs.	Comments
					DS DF DT EF RS	1 2 3 4 5 6	D P Q	feet	feet	feet	yd^3	P I N	25 50 75 100 (%)	yd^3	tons	(%)	N R O	C D P	H S I N	R S L N I	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4	Y N	Y N	
445	CU	12	2000	field obs	DS	4	D	80	35	6	622	N	0	0	0	50	R	P	N	R							Y	
446	CG	12	2000	field obs	DS	4	D	40	70	4	415	P	100	415	560	85	R	P	N	R							Y	
447	CG	11	2000	field obs	DS	1	D	150	50	5	1389	P	50	694	938	75	R	P	S	N							Y	
448	CG	3	2000	field obs	DS	2	D	35	50	6	389	P	75	292	394	90	N	P	N	L							Y	
449	CG	11	2000	field obs	DS	4	D	80	50	5	741	P	25	185	250	90	R	C	N	R							Y	
450	CU	12	2000	field obs	DS	4	D	70	35	4	363	P	50	181	245	70	O	P	S	R							Y	
451	CG	32	2000	field obs	DS	2	D	35	20	4	104	P	100	104	140	90	R	C	S	S							Y	
452	CG	32	2000	field obs	DS	4	D	20	12	3	27	N	0	0	0	85	R	P	N	R							Y	
453	CG	32	2000	field obs	DS	1	D	20	15	3	33	N	0	0	0	85	R	P	N	R							Y	
454	CG	31	2000	field obs	DS	3	D	80	45	8	1067	N	0	0	0	70	R	P	N	R							Y	cut-slope failure that overtopped the road
455	CG	31	2000	field obs	DS	3	D	40	30	7	311	I	25	78	105	75	R	P	N	R							Y	possible DSL instability
456	CG	29	2000	field obs	DS	1	D	40	50	5	370	P	100	370	500	100	R	P	S	R							Y	
457	CG	25	2000	field obs	DF	3	D	200	75	10	5556	P	25	1389	1875	70	R	P	N	R							Y	
458	CG	25	2000	field obs	DS	1	D	300	50	5	2778	P	75	2083	2813	95	N	P	S	N							Y	
459	CG	25	2000	field obs	DS	1	D	250	50	5	2315	P	75	1736	2344	95	N	P	S	N							Y	
460	CG	25	2000	field obs	DS	1	D	35	25	3	97	P	100	97	131	90	N	P	S	N							Y	
500			1990	104-2	RS		P	2500	2200			P									2	2	3	3	2	Y		
501			1990	104-2	RS		D	700	700			P									2	2	3	2	4	N		
502			1990	104-2	RS		D	800	400			P									3	3	4	4	4	N		
503			1990	104-2	RS		P	2000	1000			I									3	3	4	3	4	N		
504			1990	104-2	RS		D	2000	1000			P									2	2	3	2	4	N		
505			1990	105-3	RS		D	1100	500			P									2	2	3	2	4	N		
506			1990	105-3	RS		P	1000	1000			P									3	3	4	3	4	N		
507			1990	105-3	RS		D	1500	1300			P									3	2	4	3	4	Y		
508			2000	7B-16	RS		D	2200	1700			P									2	2	3	3	2	Y		
509			1990	105-3	RS		Q	2300	2500			P									2	2	2	4	4	Y		
510			1990	105-3	RS		P	2200	800			I									4	2	4	3	4	N		
511			1990	106-16	RS		P	3000	600			P									4	3	4	2	4	Y		
512			1990	106-16	RS		P	2500	700			P									3	3	4	3	4	N		
513			1990	107-17	RS		P	1800	1200			P									2	3	3	2	4	N		
514			1990	107-17	RS		Q	800	400			I									4	3	4	3	4	N		
515			1990	108-17	RS		P	2000	1500			I									4	3	3	3	4	Y		
516			1990	108-17	RS		P	3000	1200			P									4	3	3	4	4	Y		
517			1990	108-17	RS		Q	500	400			P									4	4	4	4	4	N		
518			1990	108-17	RS		Q	500	300			P									4	4	4	3	4	N		
519			1990	108-17	RS		P	1700	500			P									3	3	4	3	4	N		
520			1990	108-19	RS		D	800	400			P									3	3	4	3	4	N		
521			1990	108-19	RS		P	1000	2000			P									4	2	3	3	4	Y		
522			1990	108-19	RS		Q	300	200			P									3	3	4	3	4	N		
523			2000	8B-20	RS		P	2000	1500			P									3	4	4	3	4	Y		
524			2000	8B-20	RS		P	900	700			P									3	2	4	2	3	N		
525			2000	9B-18	RS		D	1200	700			P									3	2	3	2	4	N		
526			2000	9B-18	RS		P	1300	1000			I									4	2	2	4	2	Y		
527			2000	9B-18	EF		D	700	400			N									4	1	4	4	4	N		
528			2000	9B-18	RS		D	1300	1000			P									2	3	3	2	4	N		
529			2000	9B-18	RS		P	700	600			I									2	2	4	3	4	N		
530			2000	9B-18	RS		Q	400	200			I									2	2	4	3	4	N		
531			2000	9B-18	RS		Q	700	300			I									2	2	4	2	4	N		
532			2000	9B-18	RS		P	350	250			I									3	3	4	4	4	N		
533			2000	9B-18	RS		Q	300	200			I									2	2	4	3	4	N		
534			1990	109-12	RS		P	1500	700			P									2	3	3	3	4	N		
535			1990	109-12	RS		P	1500	900			P									3	3	3	3	4	N		

Watershed: Greenwood Creek

Mendocino Redwood Company, LLC

Unique ID#	PWS	T & R Sec. #	Air Photo year	Air Photo frame	Landslide Type	MWMU	Certainty	Size Length	Size Width	Size Depth	Slide Vol.	Sed. Routing	*Shallow-seated landslides* Sed. Del. Ratio	Sed. Delivery	Sed. Delivery	Slope (field)	Age	Slope Form	Slide Loc.	Road Assoc.	*Deep-seated landslides* Toe Activity	Body Morph.	Lat. Scarps	Main Scarps	DS Veg.	Complex	Field Obs.	Comments
					DS DF DT EF RS	1 2 3 4 5 6	D P Q	feet	feet	feet	yd^3	P I N	25 50 75 100 (%)	yd^3	tons	(%)	N R O	C D P	H S I N	R S L N I	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4	Y N	Y N	
536			1990	109-12	RS		Q	800	300			P									3	2	4	4	4	N		
537			1990	109-12	RS		P	200	600			P									3	4	4	4	4	N		
538			1990	109-12	RS		P	700	400			I									3	3	3	2	4	N		
539			1990	109-12	RS		P	700	200			I									4	4	3	2	4	N		
540			1990	109-12	RS		Q	400	300			P									2	2	4	3	4	N		
541			1990	109-12	RS		Q	300	400			P									2	3	4	3	4	N		
542			1990	109-14	RS		D	2600	1000			P									1	3	3	3	4	Y		
543			1990	109-14	RS		P	900	1000			P									2	2	2	3	4	N		
544			1990	109-14	RS		D	550	150			P									2	3	2	2	4	N		
545			1990	109-14	RS		D	600	200			P									2	3	3	3	4	N		
546			1990	109-14	RS		P	2000	1000			P									2	2	3	2	4	Y		
547			1990	109-16	RS		D	400	600			I									2	2	3	2	4	N		
548			1990	110-16	RS		P	2000	500			P									3	2	3	3	4	Y		
549			1990	110-16	RS		P	1100	300			I									3	3	3	2	4	N		
550			1990	111-10	RS		Q	1000	400			P									4	4	4	3	4	N		
551			1990	111-10	RS		P	1500	700			I									2	3	3	4	4	N		
552			1990	111-10	RS		P	1300	600			P									2	3	3	3	4	N		
553			1990	111-10	RS		Q	1900	1000			P									3	4	4	4	4	N		
554			1990	112-8	RS		P	700	600			P									2	2	4	2	4	N		
555			1990	112-10	RS		Q	2200	2000			P									2	4	4	3	4	N		
556			1990	107-17	RS		D	400	250			P									3	3	4	3	4	N		
557			1990	107-17	RS		P	400	400			P									3	3	4	3	4	N		
558			1990	104-2	RS		P	1700	400			P									2	2	3	2	4	N		
559			1990	104-3	RS		P	700	600			P									2	2	3	3	4	N		
560			1990	104-4	RS		D	3700	1800			P									2	2	3	3	2	Y		
561			1990	104-5	RS		P	1800	1100			P									2	3	4	4	4	N		
562			1990	105-3	RS		D	600	600			P									2	4	4	3	4	N		
563			1990	105-3	RS		P	350	250			P									3	3	4	3	4	N		
564			1990	105-3	RS		P	650	500			I									4	2	4	3	4	N		
565			1990	105-3	RS		P	1500	500			P									3	3	4	2	4	N		
566			1990	107-17	RS		D	2300	1000			P									2	2	3	2	4	Y		
567			1990	107-17	RS		D	1300	500			P									4	2	4	2	4	N		
568			1990	107-17	RS		P	1500	1200			P									3	2	4	2	4	N		