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 Hollow Tree Creek watershed, the Hollow Tree Watershed Analysis Unit (Hollow Tree WAU). Hollow Tree WAU consists of MRC's ownership in the Upper Hollow Tree Creek, Middle Hollow Tree Creek, Lower Hollow Tree Creek, Low Gap Creek and Jack of Hearts Creek planning watersheds. 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 mass wasting processes are concentrated.
4) Partition the ownership into zones of relative mass wasting potential (terrain stability units) 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 Point Source Erosion module are used to produce a sediment input summary for the Hollow Tree 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 (Table A-1). The data for these products are the interpretation of three sets of aerial photographs, field observations during the summer of 1999, and interpretation of SHALSTAB predictions. The analysis was done without the use of older aerial photographs (pre-1970s). Therefore the analysis presented is considered representative for recent mass wasting conditions (last 32 years).

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.

LANDSLIDE TYPES AND PROCESSES IN THE HOLLOW TREE 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 Hollow Tree WAU were described using the following names: debris slides, debris torrents, rockslides, and earth flows. These names are described in Cruden and Varnes (1996) with the exception of our use of debris torrent.

Shallow-Seated Landslides

Debris slides and debris torrents are terms used to identify shallow-seated landslide processes through out Mendocino Redwood Company's ownership. The material composition of debris slides or torrents is considered to be soil with a significant proportion of coarse material; 20 to 80 percent of the particles larger than 2 mm as stated in 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 or torrents involve the soil mantle, these are landslide types that can be significantly influenced by forest practices.

Debris slides are, by far, 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 be defined as a 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.

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 scours the channel. As the debris torrent moves downslope and erodes 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.

Sediment Input from Shallow-Seated Landslides

The overall time period used for mass wasting interpretation and sediment budget analysis is thirty-two years. Sediment input to stream channels by mass wasting is quantified for two time periods (1969-1978 and1979-2000 based on photos from 1978, 1996 and 2000; additional details regarding aerial photography are presented in the Methods section). The evaluation assumes that the last 10 years of mass wasting can be observed in aerial photographs. This is because landslide surfaces can re-vegetate quickly, making mass wasting older than about 10 years difficult to see. Hence, the record of mass wasting for Hollow Tree presented in this analysis probably underestimates total sediment inputs by mass wasting because smaller landslides in the first several years of the time period 1979-2000 may have been obscured by regrowth of vegetation. Nevertheless, this analysis meets its central objective of mapping areas of elevated landslide hazard, despite the potential gap in photo inventory of landslides for the period 1979-1987. A comprehensive review of 1987 aerial photos for the analysis area revealed that many of the same slides documented in 1978 were still visible, and, more importantly, that landslide hazard areas are accurately delineated based on interpretation of the 1978, 1996 and 2000 photos. We acknowledge that we have likely missed some 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. It is the large mass wasting events that provide the greatest sedimentation impacts. In the case of the landslides observed in the Hollow Tree WAU, landslides greater than 300 cubic yards in size represented over 60% of the sediment delivery estimated. Landslides greater than 200 and 100 cubic yards in size represented approximately 71% and 93%, respectively of the sediment delivery estimated.

Sediment delivery estimates from mapped shallow-seated landslides were used to produce the total mass wasting sediment input. 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.

Deep-Seated Landslides

The two deep-seated landslide processes identified in the Hollow Tree WAU are rockslides and earth flows. The failure dates of the deep-seated landslides generally could not be estimated with confidence and the landslides are likely to be of varying age with some landslides 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 in some landslides is likely to have occurred over time in response to seismic shaking or frequent high rainfall events. Deep-seated landslides can be very large, exceeding tens to hundreds of acres.

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 can 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. 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 consist of 80% or more of the particles smaller than 2mm as stated in Cruden and Varnes (1996). Materials in an earth flow also commonly contain boulders, some very large, which move downslope 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.

Sediment Delivery from Deep-Seated Landslides

A large, active deep-seated slide can 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 Hollow Tree 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 of the deep-seated landslide are difficult to determine without in-depth geotechnical observations that were not conducted in the analysis. Sediment delivery to watercourses from deep-seated landslides (landslides typically $\geq$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 soil is developed.

Clearly, movement of a portion or all of a deep-seated landslide can result in delivery of sediment to a watercourse. To determine this the slide surface should be carefully explored for 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.

Use of SHALSTAB by Mendocino Redwood Company and for the Hollow Tree 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. A detailed description of the model is available in Dietrich and Montgomery (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. Aerial photographs from 2000, 1996 and 1978 were used to interpret mass wasting processes. 1987 photos were reviewed and compared to landslide maps prepared from the previously mentioned photo sets to verify that no significant changes in mass wasting hazard area interpretation and mapping would result from conducting the full mass wasting inventory procedure on the 1987 photos as well. The 2000 photographs are at a scale of 1:13000, the 1996 photographs at a scale of 1:12000, and the 1978 photograph are at a scale of 1:15840. MRC collected data regarding characteristics and measurements of the identified landslides. Since mass wasting events were essentially "temporally sampled" based on available aerial photographs, we acknowledge that some landslides may have been missed, particularly small ones that may be obscured by vegetation. A description of select parameters inventoried for each landslide observed in the field and during aerial photograph interpretation is presented in Figure A-1.

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

- Slide I.D. Number: Each landslide is assigned a unique number
- Section Number: Indicates the USGS designated map section number the slide is mapped in.
- Planning Watershed Code:
  - RL = Lower Hollow Tree
  - RM = Middle Hollow Tree
  - RU = Upper Hollow Tree
  - RG = Low Gap Creek
  - RA = Jack of Hearts Creek
  - RI = Mill Creek

- TSU # – Terrain stability unit in which landslide is located.
- Landslide Process:
  - DS = debris slide
  - DT = debris torrent
  - RS = rockslide
  - EF = earth flow
- Certainty: The certainty of identification is recorded.
  D - Definite, P - Probable; Q - Questionable.
- Approximate Failure Date: Minimum failure date is typically the photo year that the slide first appears on or the year observed in the field.
- Physical Characteristics: Includes average length, width, depth, and volume of individual slides.
- Sediment delivery and routing: Includes sediment delivered to streams (N - no sediment delivered; Y - sediment delivered), estimate of the percent of landslide mass delivered, the type of stream that sediment was delivered to (perennial or ephemeral/intermittent).
- Land Use Association: Road, landing, or skid trail association.
- Deep seated landslides morphologic descriptions: toe, body, lateral scarps, and main scarp (see below for descriptions).

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 feature.

Physical and geomorphic characteristics of shallow-seated landslides are categorized in a database including identification number, planning watershed, type of landslide, approximate failure date, slope gradient, length, width, depth, volume, sediment delivery, sediment routing, and associated land use (see Appendix A). Landslide dimensions and depths can be variable, therefore length, width, and depth values recorded are considered to be the estimated average distance of that feature. In converting landslide volumes to mass (tons), we assume a soil bulk density of 1.35 grams per 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 larger 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. However, small landslides cumulatively may not deliver amounts of sediment that would significantly alter total sediment delivery.

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 had some causal influence on the landslide. In this analysis, the effects of silvicultural techniques were not observed. Because the Hollow Tree WAU has been managed, recently and historically, for timber production, 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, landing, or skid trail 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).

The characteristics of deep-seated landslides received less attention in the landslide inventory than shallow-seated landslides mainly due to the fact that complicated geotechnical analyses would have to be done to estimate attributes such as depth, failure date, activity, and sediment delivery. Confidently few of the mapped deep-seated landslides were observed to have recent movement associated with them. Future assessment of deep-seated landslides will occur on a site by site basis in the Hollow Tree WAU, likely during timber harvest plan preparation and review.

Systematic Description of Deep-seated Landslide Features

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 Hollow Tree WAU suggest 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 photographs.

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 either definite, probable, or questionable as defined with respect to interpretations 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 Hollow Tree WAU are only meant to be general characterizations of similar geomorphic and terrain characteristics associated with 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 Hollow Tree 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 (letters designate hazard: L= low, M= moderate, H = high)(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 (Table A-1) 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 367 shallow-seated landslides (debris slides or torrents) were identified and characterized in the Hollow Tree WAU. A total of 34 deep-seated landslides (rockslides or earth flows) were mapped in the Hollow Tree WAU. A considerable effort was made to field verify as many landslides as possible to insure greater confidence in the results. A total of 36% of the identified shallow-seated landslides were field verified. From this level of field observations, extrapolation of landslide depth and sediment delivery is presented with a reasonable level of confidence. To extrapolate depth to the shallow-seated landslides not visited in the field, an average was taken from the depths visited in the field. The mean depth of all shallow-landslides was 3.5 feet. No effort was made to differentiate landslide depths among different shallow landslide types. A mean depth of 3.5 feet was assumed for all landslides not field checked. The mean sediment delivery percentage assigned to shallow landslides determined to deliver sediment, but not visited in the field is 99%. This is due to a large amount of landslides within the inner gorge that deliver 100% making the mean delivery percentage high. Delivery statistics were not calculated for deep-seated landslides.

The temporal distribution of the 367 shallow-seated landslides observed in the Hollow Tree WAU is listed in Table A-2. The distribution by landslide type is shown in Table A-3.

Table A-2. Shallow-Seated Landslide (Debris Slides, Debris Flows, Debris Torrents) Summary for Hollow Tree WAU by Time Periods.

Planning Watershed	Shallow Landslides 1969-1978	Shallow Landslides 1979-2000
Lower Hollow Tree Creek	41	21
Middle Hollow Tree Creek	78	111
Upper Hollow Tree Creek	45	52
Low Gap Creek	10	4
Jack of Hearts	0	0
Mill Creek	*	5

* - No photo for 1978 available for this area

Table A-3. Landslide Summary by Type and Planning Watershed for Hollow Tree WAU.

Planning Watershed	Debris Slides	Debris Torrents	Rock Slides	Earth Flows	Total	Road Assoc.
Lower Hollow Tree Creek	52	10	3	1	66	20
Middle Hollow Tree Creek	158	31	13	0	202	40
Upper Hollow Tree Creek	82	15	7	0	104	34
Low Gap Creek	14	0	3	0	17	2
Jack of Hearts	0	0	1	0	1	0
Mill Creek	5	0	6	0	11	0

The majority of landslides observed in the Hollow Tree WAU are debris slides and debris torrents. Of the 367 shallow-seated landslides in the Hollow Tree WAU, 96 are determined to be road-associated. This is approximately 26% of the total number of shallow-seated landslides. There were 56 debris torrents observed in the Hollow Tree WAU. This is approximately 15 % of the total shallow landslides observed in the Hollow Tree WAU.

A total of 97% of the shallow landslides inventoried were initiated on slopes of 60% gradient or higher. Four landslides occurred on slopes with gradients less than 60%. Of those four, only one was not road associated. 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 subsoil geologic structures. Fewer 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 (TSU) representing areas of similar geomorphology or terrain, 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 TSU 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 1:24000 topographic maps and field observations. Hillslope and landslide morphology vary within each individual terrain stability unit 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 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 terrain stability units 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.
Landform:	Characterized by steep slopes or steep inner gorge topography along low gradient watercourses (typically less than 6-7% channel slope). An inner gorge is considered to be a geomorphic feature created from down cutting of the stream in response to tectonic uplift. Inner gorge slopes extend from either one side or both sides of the stream channel to the first break in slope. Slopes can resemble inner gorge on one side of the channel, but not the other. Inner gorge slope gradients typically exceed 70%. Slopes with lower inclination are locally present. The height of the inner gorge ranges from 20 to 440 feet in the Hollow Tree WAU. Slopes commonly contain areas of multiple, coalescing shallow seated landslide scars of varying age. Steep slopes adjacent to low gradient streams are generally planar in form with slope gradients typically exceeding 70%. The difference between steep streamside slopes and inner gorge topography is the lack of a distinct break in slope. The upper extent of the unit is variable. Where there is not a break in slope, the unit may often extend over 110 feet upslope (based on the range of lengths of landslides observed 22-440 feet, mean length of all landslides in the unit is 107 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:	70% to vertical, (mean slope of observed mass wasting events is 89%, range: 60%-120%)
Total Area:	593 acres; 3% of the total WAU area.
MW Processes:	*32 road-associated landslides* • 30 Debris slides • 2 Debris torrent *113 non-road associated landslides* • 108 Debris slides • 5 Debris torrent
Non Road-related Landslide Density:	0.19 landslides per acre for the past 32 years
Forest Practices Sensitivity:	High sensitivity to road construction due to proximity to watercourses, bedrock underlying inner gorge slopes creates increased stability, high sensitivity to harvesting and forest management practices due to steep slopes with localized colluvial or alluvial soil deposits next 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, all 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.
- 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.
- 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.
- Concentrated drainage from roads can increase groundwater, accelerating movement of rockslides or earth flows and over-steepening inner gorge slopes.
- Removal of vegetation above these slopes can result in loss of evapo-transpiration and thus increase pore water pressures that could create debris slides in this unit.

Confidence: High confidence for susceptibility of landslides and sediment delivery in this unit. Moderate confidence in placement of this unit. This unit is locally variable and exact boundaries are better determined from field observations.

TSU Number: 2

Description: Steep slopes or inner gorge topography 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 slopes or inner gorge topography adjacent to high gradient intermittent or ephemeral watercourses. An inner gorge is considered a geomorphic feature created from down cutting of the stream in response to tectonic uplift. Inner gorge slopes extend from either one side or both sides of the stream channel to the first break in slope. Inner gorge slopes typically exceed 70%. Slopes with lower inclination are locally present. Steep slope form is largely concave or planner with gradients typically greater than 70%. The break in slope in this unit is typically about 70 feet from the watercourse (based on mean observed debris slide length of 71 feet; maximum observed landslide length is 242 feet). Landslides in this unit commonly are debris slides that deposit sediment directly into Class II and III watercourses. Occasionally the debris slides can form debris torrents that can transport material down the slope through and out of this unit. This unit typically extends upstream from TSU 1.

Slope: >70% (mean slope of observed mass wasting events is 92%, range: 87%-95%).

Total Area: 955 acres; 5% of total WAU area

MW Processes: *7 road-associated landslides*

- 6 Debris slides
- 1 Debris torrent

31 non-road associated landslides

- 28 Debris slides
- 3 Debris torrent

Non Road-related Landslide Density: 0.03 landslides per acre for the past 32 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, due to the steep converging topography of the slope in both unmanaged and managed conditions.

Delivery Potential: High

Delivery Criteria Used: Steep slopes adjacent to stream channels, all 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 over-steepen the slope 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 remove support of the toe or expose potential failure planes of rockslides or earth 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.
- Loss of evapo-transpiration from forest harvest can increase groundwater levels initiating or accelerating movement in rockslides or earth flows or aid in the initiation of debris slides, torrents or flows.

Confidence: High confidence for susceptibility of unit to landslides and deliver sediment. 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 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 60%) that have been sculpted over time by repeated debris slide events. The area is characterized primarily by 1) steep convergent and dissected topography located within steep gradient colluvial hollows or headwall swales and small high gradient watercourses, and 2) local very steep slopes, where there is strong evidence of past shallow landslide failures. MRC intends this unit to represent areas of potential high to moderate high risk for shallow landslides that does not occur as a continuous streamside unit, in contrast to continuous streamside occurrence as in TSU 1 and 2. The mapped unit may represent isolated individual "high risk" areas or areas where there is a concentration of "high risk" areas. Boundaries between higher hazard areas and other more stable areas (i.e. divergent and lower gradient slopes) within the unit should be determined based on field verification.

Slope: >60%, (mean slope of observed mass wasting events is 81% range: 70%-110%)

Total Area: 2349 ac., 12% of the total WAU

MW Processes: *10 road associated landslides*

- 8 Debris slides
- 2 Debris torrent

67 non-road associated landslides

- 33 Debris slides
- 34 Debris torrent

Non Road-related Landslide Density: 0.03 landslides per acre for the past 32 years

Forest Practices Sensitivity: Moderate to high sensitivity to road building, moderate to high sensitivity to harvesting and forest management practices due to moderately 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: High

Delivery Criteria Used: The converging topography directs mass wasting down slopes toward watercourses. High delivery potential is based on relatively high number of debris torrents, which often transport sediment directly to larger watercourses downstream from this TSU. Approximately 81% 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 over-steepen the slope creating debris slides in this unit.
- Cut-slope of roads can over-steepen the slope 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 remove support of the toe or expose potential failure planes of rockslides or earth 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.
- Loss of evapo-transpiration from forest harvest can increase groundwater levels initiating or accelerating movement in rockslides or earth flows or aid in the initiation of debris slides, torrents or flows.

Confidence: Moderate confidence in placement of unit. This unit is locally variable and exact boundaries are better 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 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:	Moderately steep hillslopes with planar, divergent, or broadly convergent slope forms with isolated areas of steep topography or strongly convergent slope forms. Unit is generally a midslope region of lesser slope gradient and more variable slope form than unit 3.
Slope:	>40%, (mean slope of observed mass wasting events 81%, range: 50%-99%)
Total Area:	12820 acres, 63% of the total WAU
MW Processes:	*41 road-associated landslides* • 38 Debris slides • 3 Debris torrent *55 non-road associated landslides* • 51 Debris slides • 4 Debris Torrents
Non Road-related Landslide Density:	0.004 landslides per acre for the past 32 years
Forest Practices Sensitivity:	Moderate to low 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:	Moderate
Delivery Criteria Used:	This unit has the largest area, which accounts for the large number of landslides. This unit has a low landslide density, and therefore has a moderate mass wasting hazard. Sediment delivery in this unit is localized to landslides that occur adjacent to watercourses, or have long run-outs to a watercourse. Approximately 77% of landslides in this unit delivered sediment.
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 over-steepen the slope creating debris slides in this unit.
- •Cut-slope of roads can over-steepen the slope 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 remove support of the toe or expose potential failure planes of rockslides or earth 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.
- •Loss of evapo-transpiration from forest harvest can increase groundwater levels initiating or accelerating movement in rockslides or earth flows or aid in the initiation of debris slides, torrents or flows.

Confidence: High confidence in placement of unit. 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, formed from weathered marine sedimentary rocks.

Landforms: Characterized by low gradient slopes generally less than 40%, although in some places slopes can 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: <65% (based on field observations)

Total Area: 3516 acres, 17% of WAU area

MW Processes: *8 road associated landslides*

- 7 Debris slides
- 1 Debris torrent

2 non-road associated landslides

- 2 Debris slides

Non Road-related Landslide Density: 0.0006 landslides per acre for past 32 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: Unknown (no field observations)

Total Area: 81 acres; 0.003% of the total WAU.

MW Processes: 1 *Earth Flow*

3 *non-road associated landslides*

- 2 Debris slides
- 1 Debris torrent

Non Road-related Landslide Density: 0.03 landslides per acre for past 32 years.

Forest Practices Sensitivity: High to moderate sensitivity to roads, moderate sensitivity to harvesting and forest management practices that increase or redistribute water delivery on active earth flow surfaces. Potential forest practices in this unit should be assessed at a fine spatial scale 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 Hollow Tree 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 Hollow Tree WAU. Landslides were determined to have either no sediment delivery or to deliver all or a percentage of their total volume. Of the shallow-seated landslides mapped by MRC in this watershed analysis, 88 percent of the landslides delivered some amount of sediment (Table A-4).

Table A-4. Total Shallow-Seated Landslides Mapped for each Planning Watershed in Hollow Tree WAU.

Planning Watershed	Total Shallow Seated Landslides	Landslides with Sediment Delivery	Landslides with No Sediment Delivery
Lower Hollow Tree Creek	62	52	10
Middle Hollow Tree Creek	189	168	21
Upper Hollow Tree Creek	97	84	13
Low Gap Creek	14	14	0
Jack of Hearts	0	0	0
Mill Creek	5	5	0
sum	***367***	***323***	***44***
Percentage	***100%***	***88%***	***12%***

Mass wasting was separated into two time periods for analysis: 1969-1978 and 1979-2000. The dates for each of the time periods are based on the date of aerial photographs used to interpret landslides (1978, 1996, and 2000) and field observations (1999). These time periods allow for a general evaluation of the relative magnitude of sediment delivery rate estimates across the watershed.

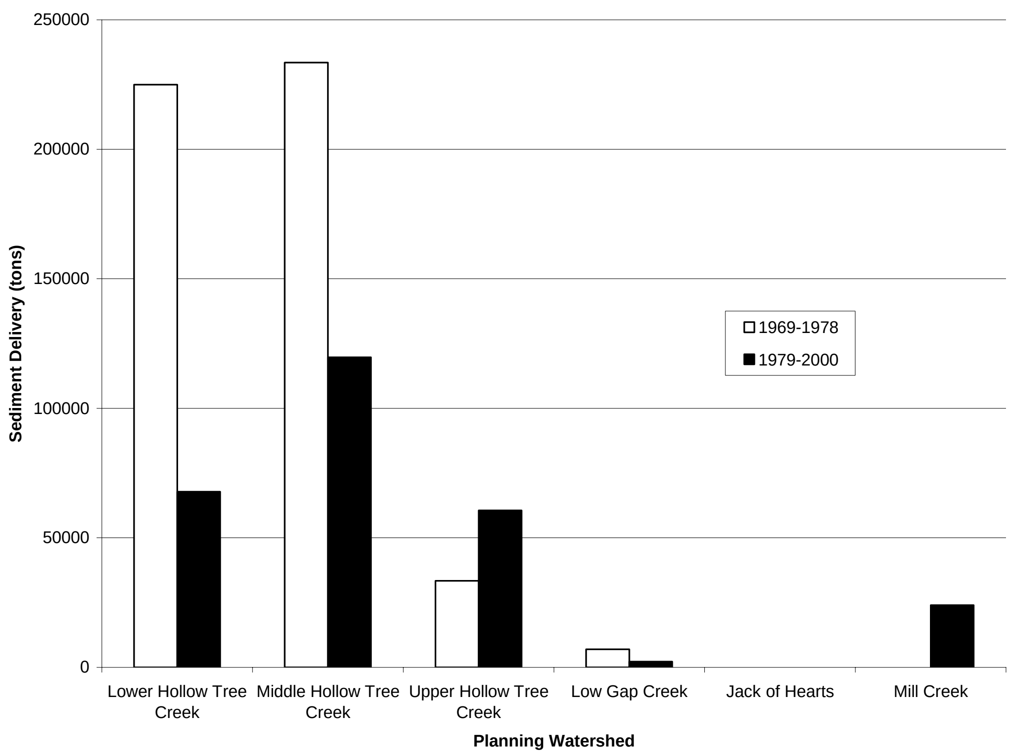
A total of approximately 774,000 tons of mass wasting sediment delivery was estimated for the time period 1969-2000 in the Hollow Tree WAU, resulting in a mean sediment delivery rate of 775 tons/sq. mi./yr. Of the total estimated amount, 500,000 tons (66% of total) occurred from 1969-1978 and 274,000 tons (35% of total) occurred in the 1979-2000 time period (Table A-5). The apparent decrease for the latter time period may in part reflect under-representation of landslides from about 1979 to 1987, which may have been obscured in some cases by vegetation regrowth that occurred prior to 1996 photography.

The highest overall sediment input from mass wasting occurred in the Middle Hollow Tree planning watershed. The large amount of acreage that MRC owns within this planning watershed, along with a large inner gorge along Hollow Tree Creek, contributes to the high sediment input in this planning watershed. In contrast, Jack of Hearts Creek planning watershed has the lowest mass wasting input. The low input for Jack of Hearts Creek on Mendocino Redwood Company property is attributable to relatively gentle terrain within this planning watershed.

Table A-5. Sediment Volume Input by Time Period for Hollow Tree WAU Planning Watersheds. Data Reported in Tons of Sediment Delivered.

Planning Watershed	1969-1978	1979-2000
Lower Hollow Tree Creek	224900	67800
Middle Hollow Tree Creek	233000	119700
Upper Hollow Tree Creek	33400	60500
Low Gap Creek	7000	2200
Jack of Hearts	0	0
Mill Creek	*	24000
Total(rounded to 10000)	***500,000***	***274,000***

Chart A-1. Total Mass Wasting Sediment Input Rate (tons/sq. mi/yr.) from Shallow Seated Landslides for MRC Ownership in Hollow Tree WAU Shown by Watershed and Time Period.



Road associated mass wasting was found to have contributed 300,000 tons (300 tons/sq. mi./yr.) of sediment over the 32 years analyzed (1969-2000) in the Hollow Tree WAU (Table A-6). This represents approximately 39% of the total mass wasting inputs for the Hollow Tree WAU for 1969-2000. In Lower Hollow Tree Creek planning watershed, road associated landslide sediment delivery was a major sediment source, contributing 67% of the sediment delivered. However, the rest of planning watershed within Hollow Tree WAU had a low percentage of road associated mass wasting delivery, due to the large amount of sediment delivered from mass wasting along the inner gorge and relatively low road density.

Table A-6. Road Associated Sediment Delivery for Shallow-Seated Landslides for Hollow Tree WAU by Planning Watershed, 1969-2000.

Planning Watershed	Road Associated Mass Wasting Sediment Delivery (tons)	Percent of Total Sediment Delivery of Planning Watershed
Lower Hollow Tree Creek	201000	67%
Middle Hollow Tree Creek	78000	26%
Upper Hollow Tree Creek	20000	7%
Low Gap Creek	2000	<1%
Jack of Hearts	0	0
Mill Creek	0	0

Sediment Input by Terrain Stability Unit

Total mass wasting sediment delivery for the Hollow Tree WAU was separated into six respective terrain stability units. These data are summarized in Table A-7. It should be noted that not all planning watersheds contain all six TSUs.

The terrain stability unit with the highest sediment delivery is TSU 1, which is estimated to deliver 46% of the total sediment input for the Hollow Tree WAU. This is due to the steep slopes of the inner gorge along Hollow Tree Creek. Combining all streamside units (TSU 1, 2, 3) would yield 69% of the total sediment input. TSU 5 is estimated to have delivered less than 0.5% of the total sediment input. TSU 4 delivered 30% of the total estimated sediment inputs, primarily due to the high number of road-related slides occurring in this unit. The total percent of road related slides sediment delivery in TSU 4 was 52%. The total sediment delivered from non-road related slides in TSU 1, 2, and 3 was 83%, while TSU 4 delivered 17% of the total non-road related delivery.

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. High values of this ratio indicate high landslide rates in a concentrated area. The unit with the highest ratio of delivery percent per percent area was TSU six with a ratio 167. This high ratio number is due to landslides delivering sediment in a very small area. The second highest ratio number was TSU 1 with a ratio of 15, indicating concentrated sediment delivery from this portion of the landscape. The ratio for TSU 3 is also relatively high (1.7), but is an order of magnitude lower than in TSU 1. The ratio for TSU 2 (0.6) is substantially lower than in TSU 3, and is comparable to TSU 4 (0.5). This suggests that TSU 2 may have somewhat lower hazard than TSU 3, despite the high mass wasting and delivery potential ratings assigned to these units. The adaptive management process should evaluate whether TSU 2 hazards might be comparable to the moderate hazard assigned to TSU 4. The lowest ratio was TSU 5 with a ratio of 0.003, which is consistent with the low landslide hazard and density in this landscape element.

Table A-7. Total Sediment Delivery by Terrain Stability Unit in the Hollow Tree WAU (1969-2000).

TSU	1	2	3	4	5	6
Road Related Sediment Delivered (tons)	106000	4000	32500	158000	1500	0
Non-Road Related Sediment Delivered (tons)	252000	18500	124500	74000	500	2000
Total Sediment Delivered (tons)	358,000	23000	157000	232000	2000	2000
% road related delivery	35%	1%	11%	52%	1%	0%
% non-road related delivery	53%	4%	26%	17%	0.1%	0.3%
% of total delivered	46%	3%	20%	30%	~<0.5%	~<0.5%
% of Watershed	3%	5%	12%	63%	17%	0.003%
% Ratio: Delivery %/Area %	15	0.6	1.7	0.5	0.003	167

CONCLUSIONS

In natural forest environments of the California Coast Range, mass wasting is a common occurrence. In the Hollow Tree WAU this is due to steep slopes, the condition of weathered marine sedimentary rocks (interbedded sandstone and shale), locally thick colluvial soils, substantial evidence of inactive or dormant rockslides and earth flows, a history of timber harvest practices, and the occurrence of high intensity rainfall events. Mass wasting events are episodic and many landslides can happen in a short time frame. Mass wasting features of variable age and stability are observed throughout the Hollow Tree WAU. The vast majority of the landslides visited in the field during this assessment occurred on slopes greater than 60%, in areas of convergent or very steep planar topography. Groundwater was evident in the evacuated cavity at many sites. Particular concern should be considered when conducting any type of forest management activity in areas with convergent or locally steep topography.

Almost 37% of the number of shallow-seated landslides and 46% of the total sediment delivery occurred within the TSU 1 of Hollow Tree Creek in the Hollow Tree WAU.

The steep streamside areas of TSU 1, 2, and 3 are contributing the highest amount of the sediment delivery per TSU area in the watershed. In the moderate hazard unit of TSU 4, road construction is a significant causative factor of shallow-seated mass wasting events. Improved road construction practices combined with design upgrades of old roads should lower sediment input rates.

Mass wasting sediment input is estimated to be at least 775-tons/sq. mi./yr. during the 1969-2000 time period for the entire Hollow Tree WAU. Overall in the Hollow Tree WAU, sediment delivery from mass wasting was highest in Middle Hollow Tree Creek and Lower Hollow Tree Creek planning watersheds. Middle Hollow Tree Creek and Lower Hollow Tree Creek planning watersheds have the longest stretch of inner gorge along Hollow Tree Creek in the Hollow Tree WAU, providing a high amount of mass wasting sediment delivery for these planning watersheds.

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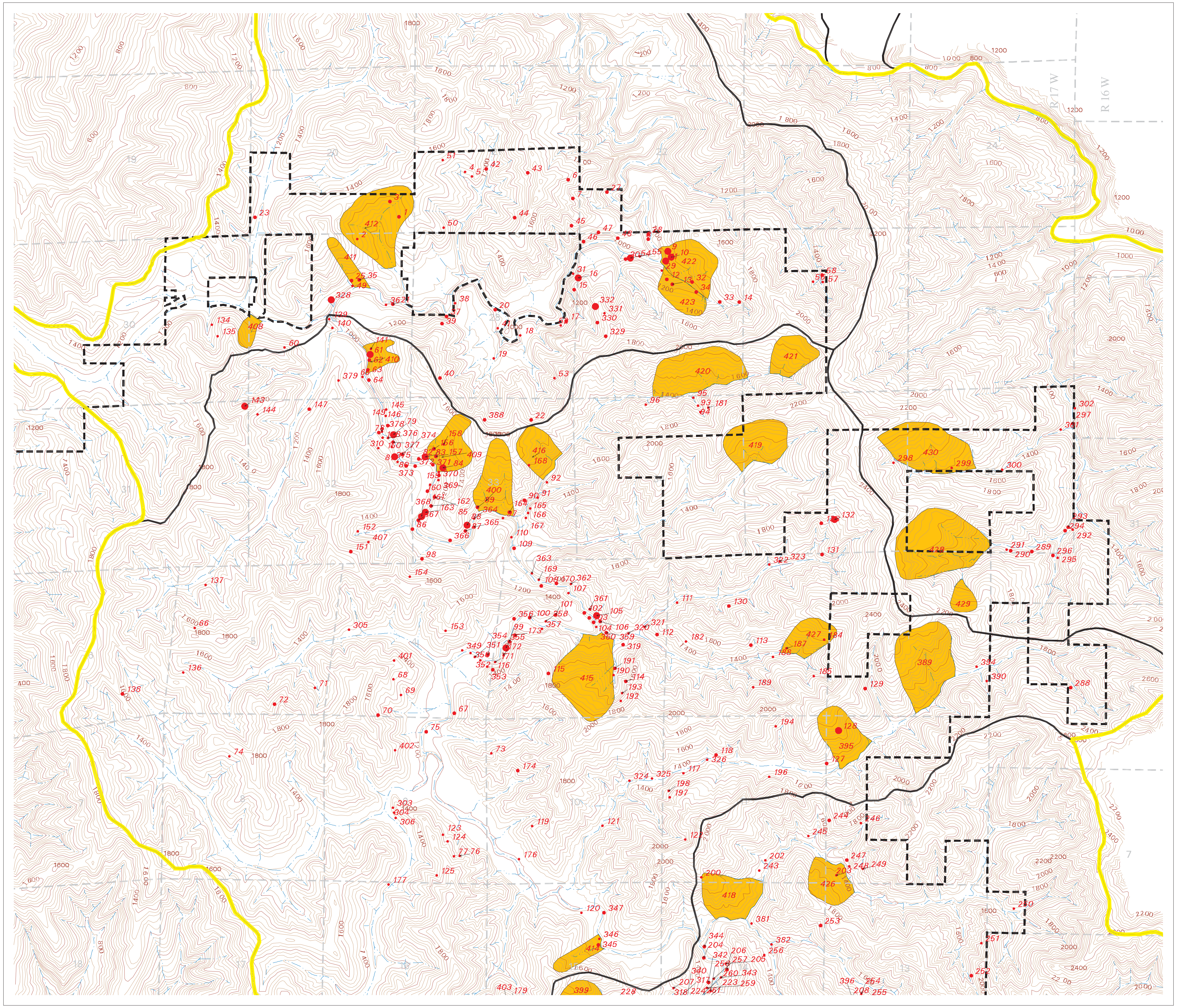
APPENDIX A

Mass Wasting



Hollow Tree 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 Hollow Tree Creek watershed. The mass wasting features were developed from an interpretation of aerial photographs from the 1970's-2000 with field observations taken in 1999 and 2001. 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 Hollow Tree watershed analysis.

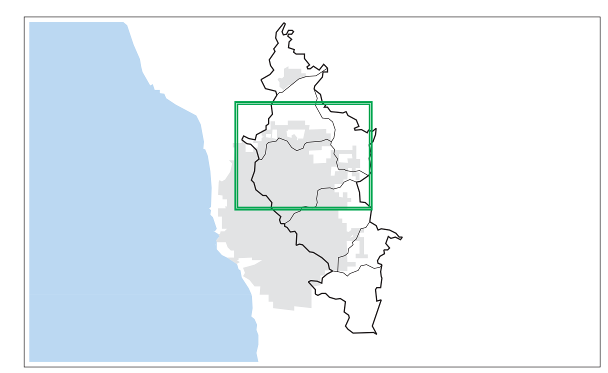
Deep-Seated Landslides

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

MRC Ownership
Planning Watershed Boundary
Hollow Tree Creek Watershed Analysis Unit Boundary

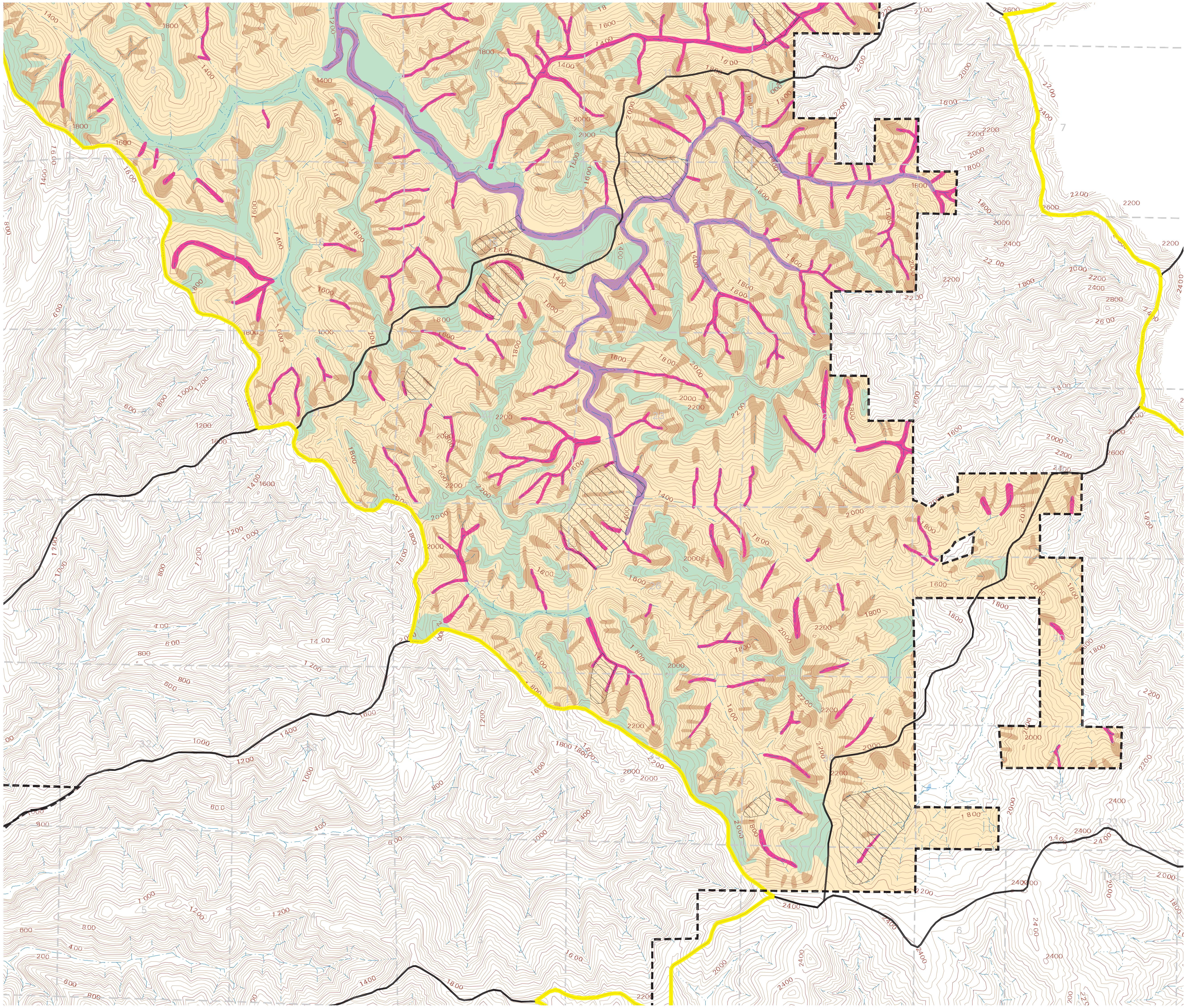
Flow Class
- Class I
- Class II
- Class III

Sheet 1



0 1/2 1 Mile

December 2003



Hollow Tree Creek Watershed Analysis Unit

Map A-2 Terrain Stability Units

This map presents an interpretation of the terrain stabitity units (TSUs) delineated for the Hollow Tree WAU. The TSUs characterize the landscape by similar geomorphic attributes, shallow-seated landslide potential, and sediment delivery potential. The TSU designations for the Hollow Tree 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 Hollow Tree 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. Field observations will over-ride unit boundaries of this map.

Unit 1: Inner Gorge or Steep Slopes adjacent to Low Gradient Watercourses

Unit 2: Steep slopes or inner gorge topography adjacent to high gradient intermittent or ephemeral watercourses

Unit 3: Dissected and convergent topography

Unit 4: Non-dissected topography

Unit 5: Low relief topography

Unit 6: Identified earthflow complexes

Deep Seated Landslides

MRC Ownership

Planning Watershed Boundary

Hollow Tree Creek Watershed Analysis Unit Boundary

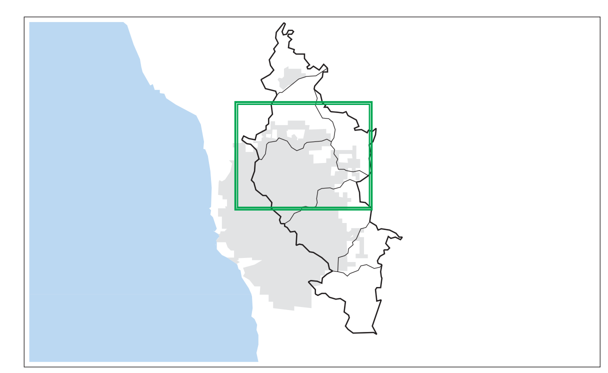
Flow Class

Class I

Class II

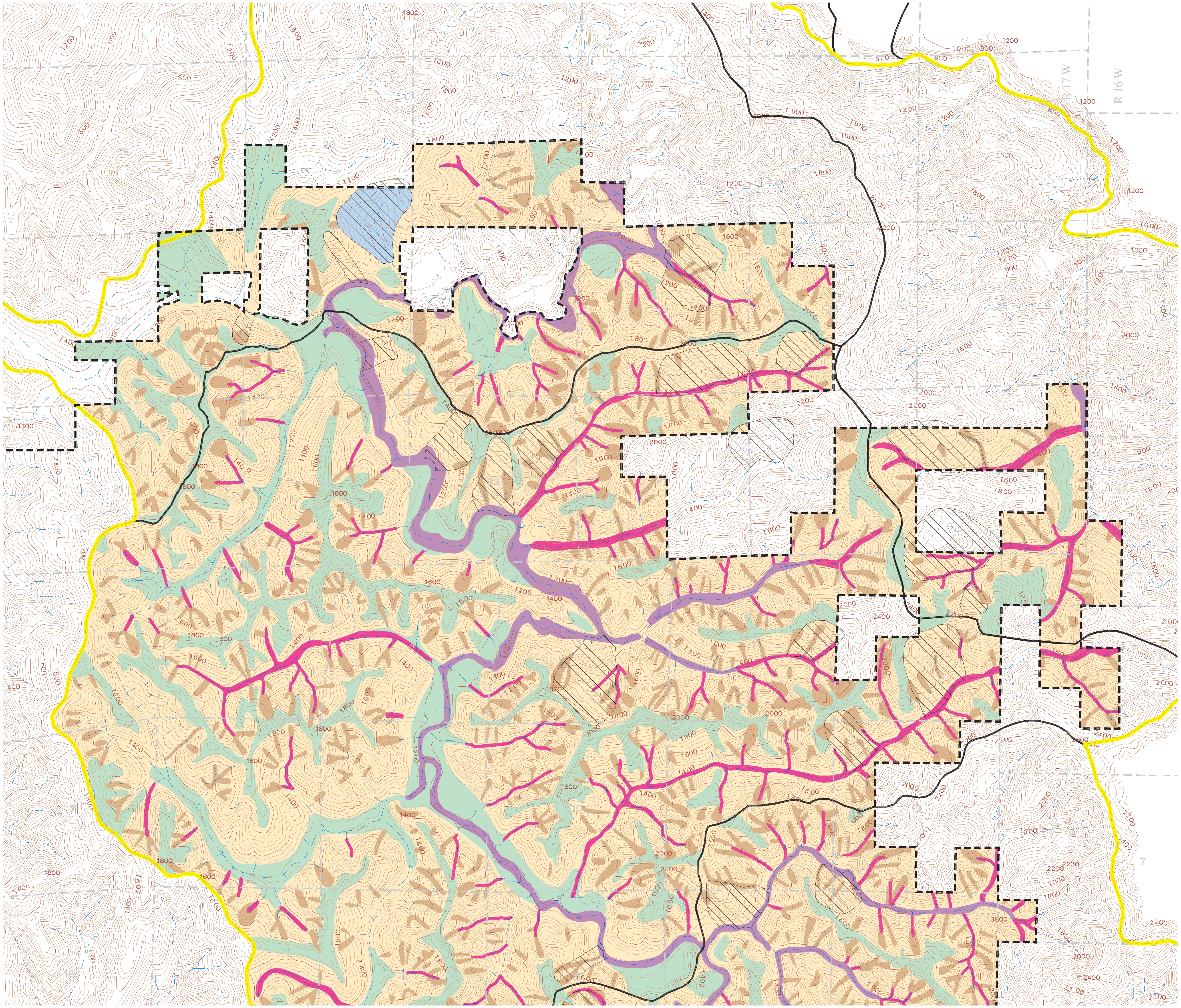
Class III

Sheet 2



0 1/2 1 Mile

December 2003



Hollow Tree Creek Watershed Analysis Unit

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Deep Seated Landslides

MRC Ownership

Planning Watershed Boundary

Hollow Tree Creek Watershed Analysis Unit Boundary

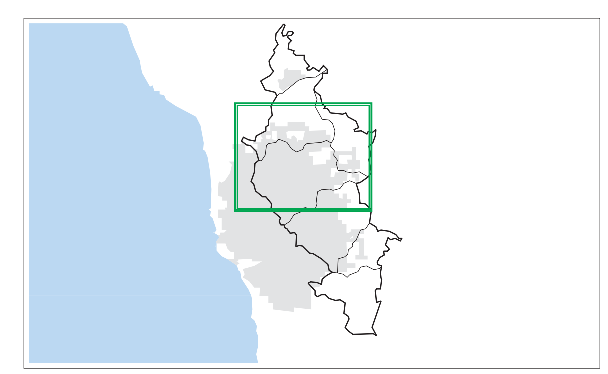
Flow Class

Class I

Class II

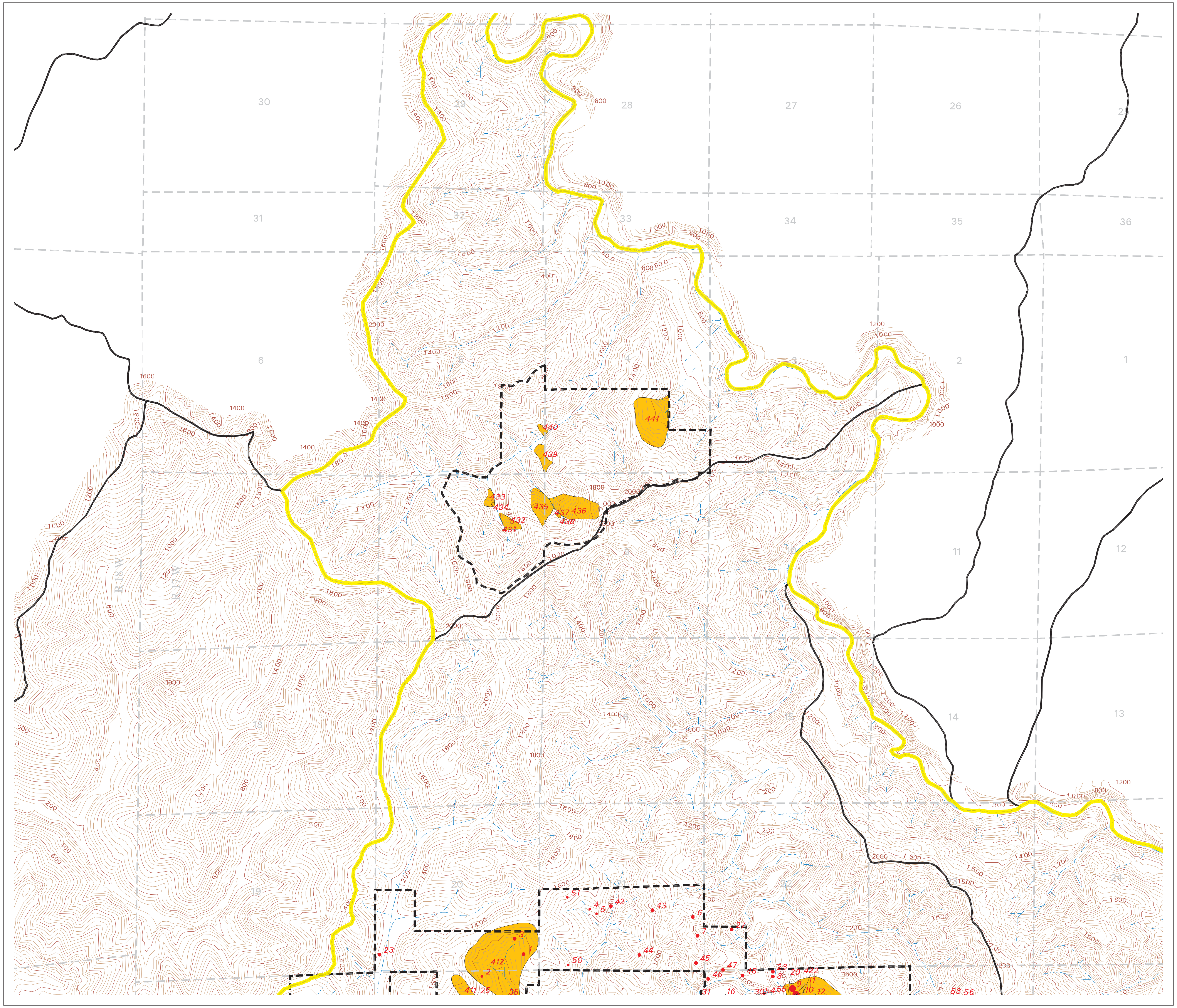
Class III

Sheet 1



0 1/2 1 Mile

December 2003



Hollow Tree 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 Hollow Tree Creek watershed. The mass wasting features were developed from an interpretation of aerial photographs from the 1970's-2000 with field observations taken in 1999 and 2001. 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 Hollow Tree watershed analysis.

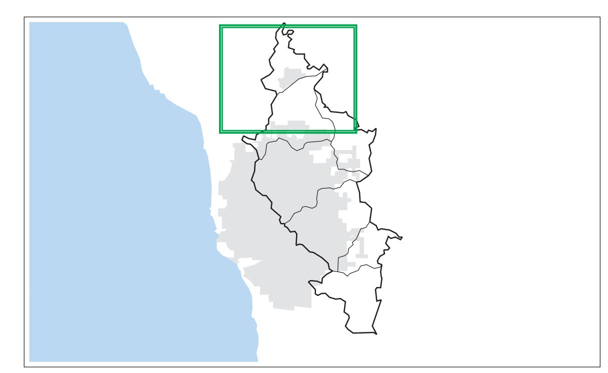
Deep-Seated Landslides

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

MRC Ownership
Planning Watershed Boundary
Hollow Tree Creek Watershed Analysis Unit Boundary

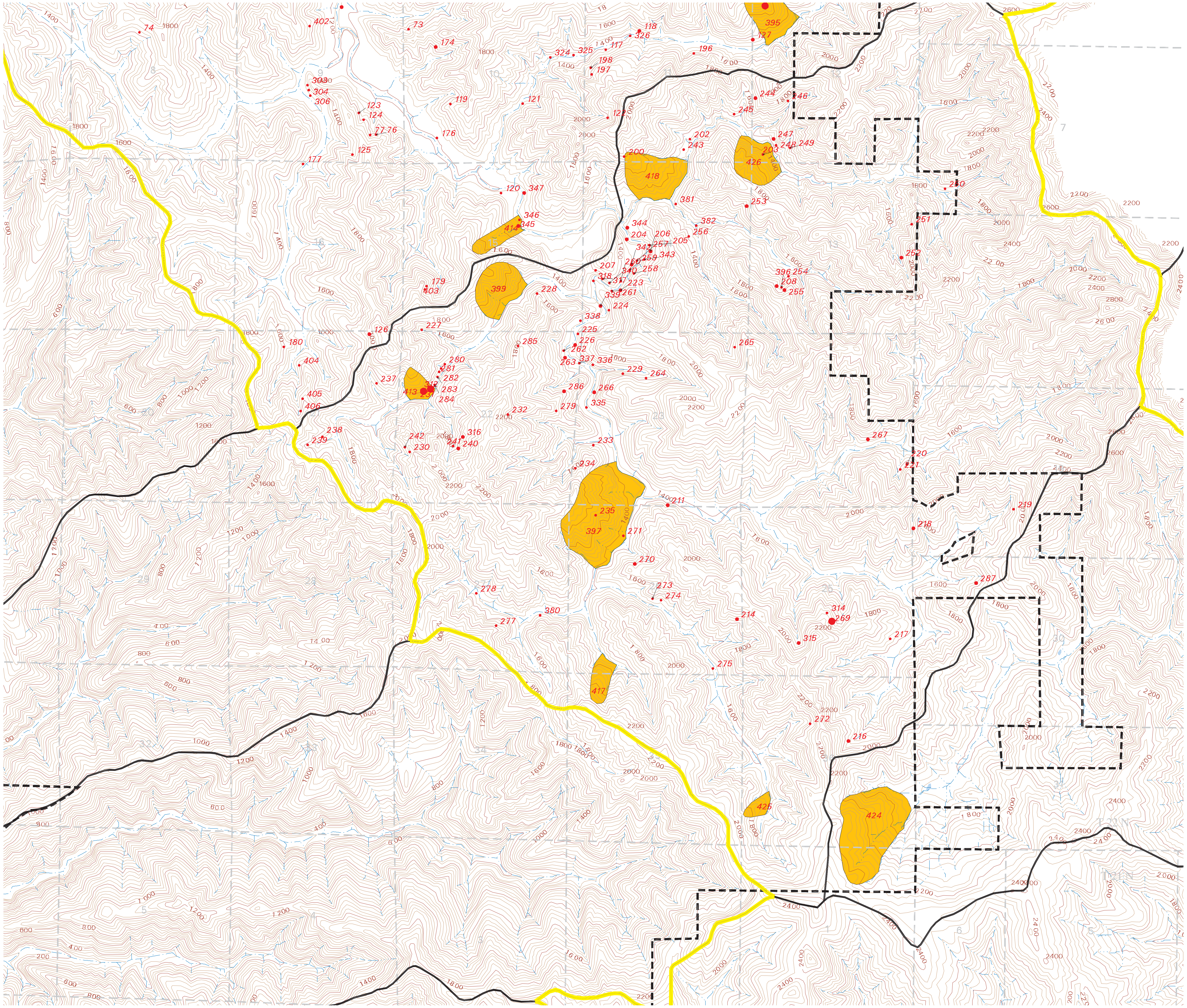
Flow Class
- Class I
- Class II
- Class III

Sheet 3



0 1/2 1 Mile

December 2003



Hollow Tree 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 Hollow Tree Creek watershed. The mass wasting features were developed from an interpretation of aerial photographs from the 1970's-2000 with field observations taken in 1999 and 2001. 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 landslide features are categorized in a database in the mass wasting section of the Hollow Tree watershed analysis.

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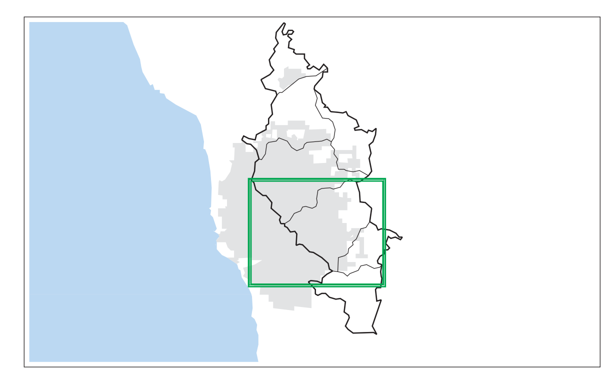
MRC Ownership
Planning Watershed Boundary
Hollow Tree Creek Watershed Analysis Unit Boundary

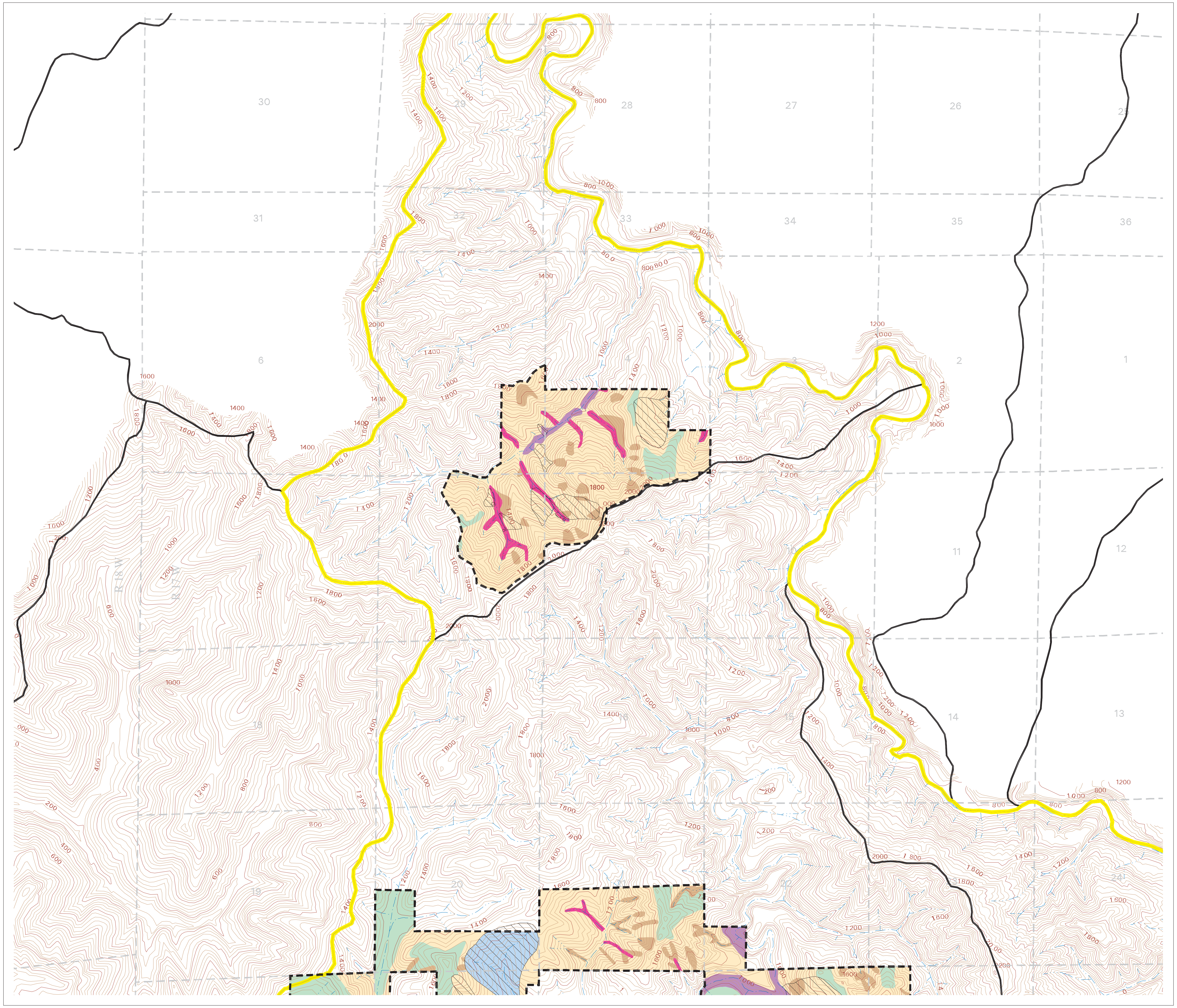
Flow Class
- Class I
- Class II
- Class III

Sheet 2



0 1/2 1 Mile

December 2003



Hollow Tree Creek Watershed Analysis Unit

Map A-2
Terrain Stability Units

This map presents an interpretation of the terrain stability units (TSUs) delineated for the Hollow Tree WAU. The TSUs characterize the landscape by similar geomorphic attributes, shallow-seated landslide potential, and sediment delivery potential. The TSU designations for the Hollow Tree 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 Hollow Tree 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. Field observations will over-ride unit boundaries of this map.

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Deep Seated Landslides

MRC Ownership

Planning Watershed Boundary

Hollow Tree Creek Watershed Analysis Unit Boundary

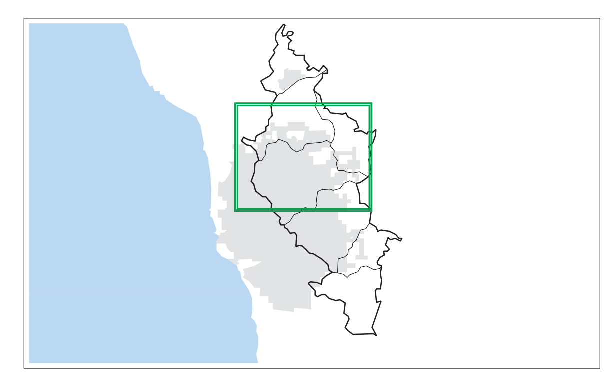
Flow Class

Class I

Class II

Class III

Sheet 3



0 1/2 1 Mile

December 2003

Id #	PWS	Section #	TSU	Landslide Type	Landslide Certainty	Approx. Failure Date	Slope Gradient (%) Field	Average Landslide Dimensions (feet) Length	Width	Depth	Volume (yd^3)	Sediment Delivery	Delivery (%)	Delivery Volume (yd^3)	Delivery Mass (tons)	Sediment Routing	Land Use Assoc.	Deep Seated Landslide Morphological Descriptions Toe	Body	Lat. Scarps	Main Scarps	Veg.	Complex	Comments
1	RL	20	6	DS	Q	78	0	132	66	3.5	1129	Y	99	1118	1509	Ephem./Int.								
2	RL	29	6	DT	Q	78	0	190	20	3.5	493	N	0	0	0									
3	RL	20	6	DS	P	78	0	130	66	3.5	1112	N	0	0	0									
4	RL	21	4	DT	p	78	0	90	33	3.5	385	Y	99	381	515	Ephem./Int.								
5	RL	21	4	DT	P	78	0	90	33	3.5	385	Y	99	381	515	Ephem./Int.								
6	RL	21	4	DS	D	78	0	300	90	3.5	3500	Y	99	3465	4678	Ephem./Int.								
7	RL	21	3	DS	D	78	0	120	60	3.5	933	Y	99	924	1247	Ephem./Int.								
8	RL	27	1	DS	D	78	0	130	70	3.5	933	Y	99	924	1247	Perrenial								
9	RL	27	3	DS	D	78	0	310	130	3.5	5224	Y	99	5172	6982	Perrenial								
10	RL	27	3	DS	D	78	89	600	300	3.0	20000	Y	100	20000	27000	Perrenial								
11	RL	27	1	DS	D	78	0	250	170	3.5	5509	Y	99	5454	7363	Perrenial								
12	RL	27	3	DS	D	78	90	200	150	4.0	3096	Y	100	3096	4180	Perrenial	ROAD							Still active in 1996
13	RL	27	3	DS	D	78	0	100	60	3.5	778	Y	99	770	1040	Perrenial	ROAD							
14	RL	27	4	DS	D	78	0	130	60	3.5	778	Y	99	770	1040	Ephem./Int.								
15	RL	28	4	DS	D	78	85	150	100	3.0	1667	Y	100	1667	2250	Perrenial	ROAD							
16	RL	27	4	DS	D	78	99	300	140	6.0	9333	Y	100	9333	125600	Perrenial	ROAD							
17	RL	28	1	DS	D	78	0	130	130	3.5	2191	Y	99	2169	2928	Perrenial								
18	RL	28	4	DS	Q	78	0	50	50	3.5	324	Y	99	321	433	Perrenial								
19	RL	28	5	DT	D	78	65	50	70	3.0	389	Y	100	389	525	Perrenial	ROAD							
20	RL	28	1	DS	D	78	0	70	90	3.5	817	Y	99	809	1091	Perrenial								
21	RL	29	1	DS	D	78	0	90	130	3.5	1517	N	0	0	0									
22	RL	33	3	DT	D	78	0	160	130	3.5	2696	N	0	0	0									
23	RL	20	5	DS	D	89<	25	110	50	3.0	611	Y	100	611	825	Perrenial	ROAD							
25	RL	29	4	DS	D	96	84	250	100	4.0	3704	Y	100	3704	5000	Perrenial	ROAD							
27	RL	22	1	DS	Q	96	0	150	50	3.5	972	Y	99	963	1299	Perrenial								
28	RL	27	1	DS	D	96	0	150	100	3.5	1944	Y	99	1925	2599	Perrenial								
29	RL	27	1	DS	D	96	0	50	50	3.5	324	Y	99	321	433	Ephem./Int.								
30	RL	27	1	DS	D	96	94	250	150	3.0	4167	Y	100	4167	5625	Perrenial	ROAD							
31	RL	28	1	DS	P	96	0	50	30	3.5	194	Y	99	193	260	Perrenial								
32	RL	27	4	DS	D	78	0	150	120	3.5	2333	Y	99	2310	3119	Perrenial								
33	RL	27	2	DS	D	78	0	80	150	3.5	1556	Y	99	1540	2079	Perrenial								
34	RL	27	2	DS	P	78	0	66	70	3.5	599	Y	99	593	800	Perrenial	LANDING							off of landing in inner gorge
35	RL	29	4	DS	D	78	85	150	110	4.0	2444	Y	100	2444	3300	Perrenial	ROAD							
36	RL	29	1	DS	Q	78	0	50	50	3.5	324	Y	99	321	433	Perrenial								
37	RL	28	1	DS	D	78	0	110	60	3.5	856	Y	99	847	1143	Perrenial								
38	RL	28	1	DS	P	78	0	60	50	3.5	389	Y	99	385	520	Perrenial								
39	RL	28	1	DS	Q	78	0	68	70	3.5	617	Y	99	611	825	Perrenial	ROAD							
40	RL	28	3	DT	Q	78	0	220	44	3.5	1255	N	0	0	0									
41	RL	28	4	DS	Q	78	0	45	45	3.5	263	Y	99	260	351	Perrenial	ROAD							
42	RL	21	4	DT	Q	78	0	154	30	3.5	599	Y	99	593	800	Perrenial								
43	RL	21	4	DT	Q	78	0	220	30	3.5	599	N	0	0	0									
44	RL	21	3	DT	Q	78	0	176	40	3.5	913	N	0	0	0									
45	RL	21	3	DS	Q	78	0	90	45	3.5	525	Y	99	520	702	Perrenial								
46	RL	27	1	DS	D	78	0	176	110	3.5	2510	Y	99	2485	3354	Perrenial								
47	RL	22	4	DS	P	78	0	110	44	3.5	2510	Y	99	2485	3354	Perrenial								
48	RL	27	1	DS	Q	78	0	90	70	3.5	817	Y	99	809	1091	Perrenial								
49	RL	29	1	DS	D	96	90	50	40	3.0	222	Y	100	222	300	Perrenial	ROAD							
50	RL	21	4	DS	Q	96	0	50	51	3.5	331	N	0	0	0									
51	RL	21	4	DS	Q	96	0	65	16	3.5	135	N	0	0	0									
52	RL	28	1	DS	P	96	0	50	17	3.5	110	Y	99	109	147	Perrenial								
53	RL	28	2	DS	Q	96	0	46	17	3.5	101	N	0	0	0		ROAD							
54	RL	27	1	DS	D	96	90	250	110	10.0	10185	Y	100	10185	13750	Perrenial	ROAD							
55	RL	27	1	DS	D	96	0	38	32	3.5	158	Y	99	156	211	Perrenial								
56	RL	26	2	DS	D	96	0	40	32	3.5	166	Y	99	164	222	Perrenial								
57	RL	26	2	DS	Q	96	0	35	30	3.5	136	Y	99	135	182	Perrenial								
58	RL	26	2	DS	P	78	0	242	154	3.5	4831	Y	99	4783	6457	Perrenial								
60	RM	29	4	DT	P	78	0	110	22	3.5	314	Y	99	311	419	Perrenial								
61	RM	29	1	DS	D	78	76	264	242	10.0	23662	Y	100	23662	6389	Perrenial	ROAD							
62	RM	29	1	DS	P	78	0	90	66	3.5	770	Y	99	762	1029	Perrenial								
63	RM	29	1	DS	D	78	0	220	132	3.5	3764	Y	99	3727	5031	Perrenial	ROAD							
64	RM	29	1	DS	D	78	0	132	176	3.5	3012	Y	99	2981	4025	Perrenial								
65	RM	29	1	DS	Q	78	0	66	20	3.5	171	Y	99	169	229	Perrenial								

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66	RM	5	4	DT	Q	78	0	45	20	3.5	117	Y	99	116	156	Perrenial								
67	RM	4	4	DS	Q	78	0	176	88	3.5	2008	Y	99	1988	2683	Perrenial								
68	RM	4	4	DS	P	78	0	50	20	3.5	130	N	0	0	0									
69	RM	4	4	DS	Q	78	0	66	22	3.5	188	Y	99	186	252	Perrenial								
70	RM	4	3	DS	P	78	0	88	66	3.5	753	Y	99	745	1006	Perrenial								
71	RM	5	4	DS	Q	78	0	44	66	3.5	376	Y	99	373	503	Perrenial								
72	RM	5	3	DS	Q	78	0	90	66	3.5	770	Y	99	762	1029	Perrenial								
73	RM	10	3	DT	Q	78	0	110	22	3.5	314	N	0	0	0									
74	RM	8	4	DT	Q	78	0	88	22	3.5	251	Y	99	248	335	Perrenial								
75	RM	9	1	DS	P	78	0	154	66	3.5	1318	Y	99	1304	1761	Perrenial								
76	RM	9	3	DS	P	78	0	45	45	3.5	263	Y	99	260	351	Ephem./Int.								
77	RM	9	2	DT	Q	78	0	90	20	3.5	233	Y	99	231	312	Ephem./Int.								
78	RM	32	1	DS	D	78	110	136	77	4.0	1551	Y	100	1551	2094	Perrenial								
79	RM	32	1	DS	D	78	96	250	600	4.0	21867	Y	100	21867	29520	Perrenial								
80	RM	32	1	DS	D	78	0	440	330	3.5	18822	Y	99	18634	25156	Perrenial	ROAD							still active in '96
81	RM	32	1	DS	Q	78	0	60	20	3.5	156	Y	99	154	208	Perrenial								
82	RM	33	1	DS	D	78	0	110	44	3.5	627	Y	99	621	839	Perrenial								
83	RM	33	1	DS	D	78	0	374	198	3.5	9599	Y	99	9503	12830	Perrenial								
84	RM	33	1	DS	D	78	60	250	400	8.0	21807	Y	100	21807	29440	Perrenial								inner gorge,recent activity
85	RM	33	1	DS	D	78	84	110	80	4.0	1304	Y	100	1304	1760	Perrenial								
86	RM	32	1	DS	D	78	84	100	200	4.0	2963	Y	100	2963	4000	Perrenial								
87	RM	33	1	DS	D	78	103	250	120	6.0	4613	Y	100	4613	6228	Perrenial								
88	RM	33	1	DS	D	78	101	200	200	4.0	5926	Y	100	5926	8000	Perrenial								
89	RM	33	4	DS	D	78	90	50	50	3.5	1556	Y	100	1556	2100	Perrenial	ROAD							
90	RM	33	1	DS	P	78	0	70	70	3.5	635	Y	99	629	849	Perrenial	ROAD							
91	RM	33	1	DS	P	78	0	50	22	3.5	143	Y	99	141	191	Perrenial	ROAD							
92	RM	33	4	DS	Q	78	0	40	70	3.5	363	Y	99	359	485	Perrenial								
93	RM	34	2	DS	Q	78	0	40	20	3.5	104	Y	99	103	139	Ephem./Int.								
94	RM	34	2	DS	Q	78	0	40	20	3.5	104	Y	99	103	139	Ephem./Int.								
95	RM	34	2	DS	Q	78	0	30	30	3.5	117	Y	99	116	156	Perrenial								
96	RM	34	3	DT	Q	78	0	66	22	3.5	188	Y	99	186	252	Perrenial								
97	RM	33	1	DS	P	78	0	44	22	3.5	125	Y	99	124	168	Perrenial								
98	RM	33	4	DS	P	78	0	88	44	3.5	502	Y	99	497	671	Perrenial								
99	RM	3	1	DS	Q	78	0	90	90	3.5	1050	Y	99	1040	1403	Perrenial								
100	RM	3	1	DS	D	78	98	200	100	6.0	4089	Y	100	4089	5520	Perrenial								
101	RM	3	4	DS	D	78	86	100	100	3.0	1111	Y	100	1111	1500	Perrenial	ROAD							
102	RM	3	1	DS	D	78	90	90	100	2.0	1111	Y	100	1111	1500	Perrenial								
103	RM	3	1	DS	D	78	102	70	100	3.0	778	Y	100	778	1050	Perrenial								
104	RM	3	1	DS	D	78	90	150	120	3.0	2000	Y	100	2000	2700	Perrenial								
105	RM	3	1	DS	D	78	80	400	200	3.0	8889	Y	100	8889	12000	Perrenial	ROAD							
106	RM	3	1	DS	D	78	70	100	30	10.0	1111	Y	100	1111	1500	Perrenial	ROAD							
107	RM	3	1	DS	D	78	86	100	35	3.0	389	Y	100	389	525	Perrenial								
108	RM	3	1	DS	D	78	0	90	110	3.5	1283	Y	99	1271	1715	Perrenial								
109	RM	33	1	DS	P	78	0	45	90	3.5	525	Y	99	520	702	Perrenial								
110	RM	33	1	DS	P	78	0	66	22	3.5	188	Y	99	186	252	Perrenial								
111	RM	2	1	DS	Q	78	0	44	20	3.5	114	Y	99	113	152	Perrenial								
112	RM	3	4	DS	P	78	0	110	44	3.5	627	Y	99	621	839	Perrenial								
113	RM	2	4	DS	Q	78	0	88	44	3.5	502	Y	99	497	671	Perrenial								
114	RM	3	3	DT	Q	78	0	88	100	3.5	1141	Y	1129	1525	2059	Ephem./Int.								
115	RM	3	4	DS	P	78	0	88	110	3.5	1255	Y	99	1242	1677	Ephem./Int.								
116	RM	3	4	DS	P	78	0	132	33	3.5	565	Y	99	559	755	Perrenial	ROAD							Still actine in 1996
117	RM	11	3	DT	Q	78	0	60	34	3.5	264	Y	99	262	353	Perrenial								
118	RM	11	4	DS	D	78	80	200	150	3.0	3333	Y	100	3333	4500	Perrenial	ROAD							
119	RM	10	4	DT	Q	78	0	44	22	3.5	125	Y	99	124	168	Perrenial								
120	RM	15	1	DS	P	78	0	44	22	3.5	125	Y	99	124	168	Perrenial								
121	RM	10	2	DS	D	78	90	60	35	3.0	233	Y	100	233	315	Perrenial	ROAD							
122	RM	11	3	DS	Q	78	0	33	44	3.5	188	N	0	0	0									
123	RM	9	4	DS	Q	78	0	88	22	3.5	251	Y	99	248	335	Ephem./Int.								
124	RM	9	3	DS	Q	78	0	66	33	3.5	282	Y	99	280	377	Ephem./Int.								
125	RM	9	3	DT	Q	78	0	90	30	3.5	350	Y	99	347	468	Ephem./Int.								
126	RM	21	4	DT	Q	78	0	176	22	3.5	502	N	0	0	0									
127	RM	12	4	DS	P	78	0	176	66	3.5	1506	Y	99	1491	2012	Perrenial								

Id #	PWS	Section #	TSU	Landslide Type	Landslide Certainty	Approx. Failure Date	Slope Gradient (%) Field	Average Landslide Dimensions (feet) Length	Width	Depth	Volume (yd^3)	Sediment Delivery	Delivery (%)	Delivery Volume (yd^3)	Delivery Mass (tons)	Sediment Routing	Land Use Assoc.	Deep Seated Landslide Morphological Descriptions Toe	Body	Lat. Scarps	Main Scarps	Veg.	Complex	Comments
128	RM	12	4	DT	D	78	0	858	110	3.5	12234	Y	99	12112	16351	Perrenial								
129	RM	1	3	DS	P	78	0	66	66	3.5	565	Y	99	559	755	Perrenial								
130	RM	2	4	DS	P	78	0	132	110	3.5	1882	Y	99	1863	2516	Perrenial	ROAD							
131	RM	2	4	DS	D	78	0	154	110	3.5	2196	Y	99	2174	2935	Perrenial								
132	RM	35	4	1	D	78	0	550	132	3.5	9411	Y	99	9317	12578	Perrenial								
133	RM	35	3	DT	P	78	0	110	88	3.5	1255	Y	99	1242	1677	Ephem./Int.								
134	RM	30	4	DS	P	96	0	50	50	3.5	324	Y	99	321	433									
135	RM	30	3	DS	Q	96	0	33	33	3.5	141	Y	99	140	189	Perrenial								
136	RM	5	3	DT	Q	96	0	83	15	3.5	161	Y	99	160	216	Perrenial								
137	RM	5	4	DT	P	96	0	83	17	3.5	183	N	0	0	0									
138	RM	6	5	DS	P	96	0	66	66	3.5	565	N	0	0	0		ROAD							
139	RM	29	1	DS	D	96	0	67	25	3.5	217	Y	99	215	290	Perrenial								
140	RM	29	5	DS	P	96	0	66	50	3.5	428	Y	99	424	572	Perrenial								
141	RM	29	1	DS	D	96	0	83	32	3.5	344	Y	99	341	460	Perrenial								
143	RM	31	3	DS	D	96	0	349	183	3.5	8279	Y	99	8196	11065	Ephem./Int.								
144	RM	32	4	DT	D	96	0	40	20	3.5	104	N	0	0	0									
145	RM	32	1	DS	P	96	0	66	16	3.5	137	Y	99	136	183	Perrenial								
146	RM	32	1	DS	P	96	0	50	24	3.5	156	Y	99	154	208	Perrenial								
147	RM	32	4	DS	Q	96	0	34	17	3.5	754	Y	99	74	100	Perrenial								
148	RM	32	1	DT	Q	96	0	34	17	3.5	75	Y	99	74	100	Perrenial								
149	RM	32	1	DT	D	96	101	50	15	1.0	28	Y	100	28	37	Perrenial								
150	RM	32	1	DS	D	96	95	90	40	2.0	267	Y	100	267	360	Perrenial								
151	RM	32	4	DT	D	96	0	382	50	3.5	2476	Y	99	2451	3309	Ephem./Int.								
152	RM	32	3	DS	Q	96	0	66	31	3.5	265	Y	99	263	354	Ephem./Int.								
153	RM	4	4	DS	Q	96	0	32	17	3.5	71	N	0	0	0									
154	RM	4	4	DS	P	96	0	33	50	3.5	214	Y	99	212	269	Ephem./Int.								
156	RM	33	1	DS	D	96	0	270	250	2.0	5000	Y	100	5000	6750	Perrenial	ROAD							
157	RM	33	1	DS	D	96	0	200	90	5.0	3333	Y	100	3333	4500	Perrenial								
158	RM	33	4	DS	D	96	95	70	30	2.0	156	Y	100	156	210	Perrenial	ROAD							
159	RM	33	1	DS	D	96	75	100	20	3.0	222	Y	100	222	300	Perrenial								
160	RM	33	1	DS	D	96	67	40	50	3.0	222	Y	100	222	300	Perrenial								
161	RM	33	1	DS	D	96	65	150	200	3.0	3333	Y	100	3333	4500	Perrenial								
162	RM	33	1	DS	D	89-99	90	100	200	4.0	2963	Y	100	2963	4000	Perrenial								
163	RM	33	1	DS	D	89<	90	200	200	4.0	5926	Y	100	5926	8000	Perrenial								
164	RM	33	1	DS	D	96	90	150	70	5.0	1944	Y	100	1944	2625	Perrenial								
165	RM	33	1	DS	D	96	0	83	32	3.5	344	Y	99	341	460	Perrenial	ROAD							
166	RM	33	1	DS	D	96	0	83	17	3.5	183	Y	99	181	244	Perrenial	ROAD							
167	RM	33	1	DS	D	96	0	100	32	3.5	415	Y	99	411	554	Perrenial	ROAD							
168	RM	33	3	DT	P	96	0	33	25	3.5	107	Y	99	106	143	Ephem./Int.								
169	RM	3	1	DS	D	96	85	45	90	4.0	600	Y	99	594	802	Perrenial								
170	RM	3	1	DS	D	96	110	150	50	2.0	556	Y	100	556	750	Perrenial								
171	RM	3	1	DS	D	96	90	100	25	2.0	185	Y	100	185	250	Perrenial	ROAD							
172	RM	3	1	DS	D	96	83	66	50	2.0	244	Y	100	244	330	Perrenial								
173	RM	3	1	DS	D	96	81	180	40	2.0	533	Y	100	533	720	Perrenial	ROAD							
174	RM	10	3	DS	Q	96	0	50	83	3.5	538	Y	99	533	719	Ephem./Int.								
176	RM	10	5	DS	P	96	0	20	16	3.5	41	Y	99	41	55	Perrenial								
177	RM	16	4	DS	D	96	50	26	26	7.0	175	Y	100	175	237	Perrenial	ROAD							
179	RM	15	4	DT	P	96	0	83	16	3.5	172	N	0	0	0									
180	RM	21	3	DT	Q	96	0	182	20	3.5	472	N	0	0	0									
181	RM	34	4	DS	P	78	0	50	20	3.5	130	N	0	0	0									
182	RM	2	4	DS	Q	96	0	16	16	3.5	33	N	0	0	0									
184	RM	2	4	DS	Q	96	0	30	10	3.5	39	Y	99	39	52	Perrenial								
185	RM	2	4	DT	D	96	0	70	16	3.5	145	Y	99	144	194	Perrenial								
187	RM	2	4	DS	D	96	0	50	16	3.5	104	Y	99	103	139	Perrenial								
188	RM	2	4	DT	P	96	0	30	16	3.5	62	Y	99	62	83	Perrenial								
189	RM	2	4	DS	P	96	0	30	16	3.5	62	Y	99	62	83	Perrenial								
190	RM	3	2	DS	D	96	0	33	67	3.5	287	Y	99	284	383	Perrenial								
191	RM	3	2	DS	D	96	94	45	90	5.0	750	Y	100	750	1013	Perrenial								
192	RM	3	4	DT	D	96	0	50	16	3.5	104	Y	99	103	139	Perrenial								
193	RM	3	3	DS	D	96	0	20	40	3.5	104	Y	99	103	139	Perrenial								
194	RM	11	4	DS	D	96	75	50	25	2.0	93	Y	100	93	125	Ephem./Int.								
196	RM	11	4	DS	P	96	0	50	30	3.5	194	N	0	0	0									

Id #	PWS	Section #	TSU	Landslide Type	Landslide Certainty	Approx. Failure Date	Slope Gradient (%) Field	Average Landslide Dimensions (feet) Length	Width	Depth	Volume (yd^3)	Sediment Delivery	Delivery (%)	Delivery Volume (yd^3)	Delivery Mass (tons)	Sediment Routing	Land Use Assoc.	Deep Seated Landslide Morphological Descripitions Toe	Body	Lat. Scarps	Main Scarps	Veg.	Complex	Comments
197	RM	11	3	DS	Q	96	0	26	35	3.5	118	Y	99	117	158	Perrenial								
198	RM	11	3	DS	Q	96	0	28	33	3.5	120	Y	99	119	160	Perrenial								
200	RU	11	4	DS	P	96	0	48	24	3.5	149	N	0	0	0									
202	RU	11	2	DS	P	78	0	64	24	3.5	199	Y	99	197	266	Perrenial								
203	RU	12	3	DS	P	96	0	20	16	3.5	41	Y	99	41	55	Perrenial								
204	RU	14	1	DS	D	96	100	120	40	5.0	889	Y	100	889	1200	Perrenial	ROAD							
205	RU	14	1	DS	D	96	0	42	30	3.5	163	Y	99	162	218	Perrenial								
206	RU	14	1	DS	D	96	118	150	125	7.0	4861	Y	100	4861	6563	Perrenial								
207	RU	14	4	DS	D	96	90	70	40	3.0	311	Y	100	311	420	Perrenial	ROAD							
208	RU	13	3	DT	D	96	0	320	32	3.5	1327	Y	99	1314	1774	Perrenial								
211	RU	23	3	DS	P	78	0	96	64	3.5	796	Y	99	788	1064	Perrenial								
214	RU	26	3	DS	Q	78	0	256	112	3.5	3717	Y	99	3680	4967	Perrenial								
216	RU	36	4	DT	D	96	90	150	80	3.0	1333	Y	100	1333	1800	Ephem./Int.	ROAD							
217	RU	25	4	DS	P	96	0	48	32	3.5	199	Y	99	197	266	Perrenial								
218	RU	19	4	DS	P	96	0	80	64	3.5	664	N	0	0	0									
219	RU	19	4	DS	Q	96	0	64	48	3.5	398	Y	99	394	532	Perrenial								
220	RU	24	4	DS	P	96	0	48	48	3.5	299	N	0	0	0									
221	RU	24	2	DS	P	96	0	48	64	3.5	398	Y	99	394	532	Ephem./Int.								
223	RU	14	1	DS	D	96	93	50	80	3.5	519	Y	100	519	700	Perrenial								
224	RU	14	1	DS	Q	96	0	22	64	3.5	183	Y	99	181	244	Perrenial								
225	RU	22	1	DS	D	96	110	80	16	3.0	142	Y	100	142	192	Perrenial	ROAD							
226	RU	22	1	DS	D	96	85	100	60	3.0	667	Y	100	667	900	Perrenial								
227	RU	15	2	DT	D	96	0	64	20	3.5	166	Y	99	164	222	Ephem./Int.								
228	RU	15	4	DS	Q	96	0	25	16	3.5	52	Y	99	51	69	Perrenial								
229	RU	23	1	DS	P	96	0	55	20	3.5	143	Y	99	141	191	Perrenial								
230	RU	22	3	DS	Q	96	0	80	20	3.5	207	Y	99	205	277	Perrenial								
231	RU	22	4	DS	D	96	94	200	175	4.0	5185	Y	100	5185	7000	Perrenial								formed due to 313
232	RU	22	3	DS	P	96	0	48	16	3.5	100	N	0	0	0									
233	RU	23	2	DS	Q	96	0	32	32	3.5	133	Y	99	131	177	Perrenial								
234	RU	23	4	DS	P	96	0	64	48	3.5	398	Y	99	394	532	Perrenial								
235	RU	26	3	DS	P	96	0	32	16	3.5	66	Y	99	66	89	Ephem./Int.								
237	RU	21	3	DS	D	96	0	32	16	3.5	66	Y	99	66	89	Perrenial								
238	RU	21	4	DS	Q	96	0	32	32	3.5	133	N	0	0	0		ROAD							
239	RU	21	4	DS	Q	96	0	48	16	3.5	100	N	0	0	0		ROAD							
240	RU	22	3	DS	D	96	70	120	80	6.0	2133	Y	100	2133	2880	Ephem./Int.	LANDING							fill failure
241	RU	22	2	DS	P	96	0	32	16	3.5	66	Y	99	66	89	Ephem./Int.								
242	RU	22	4	DS	D	96	0	22	16	3.5	46	Y	99	45	61	Ephem./Int.								
243	RU	11	4	DS	P	78	0	40	44	3.5	228	Y	99	226	305	Perrenial	ROAD							
244	RU	12	3	DT	Q	78	0	154	44	3.5	878	Y	99	870	1174	Ephem./Int.								
245	RU	11	4	DS	P	78	0	44	66	3.5	376	Y	99	373	503	Perrenial								
246	RU	12	3	DS	Q	78	0	44	66	3.5	376	Y	99	373	503	Perrenial								
247	RU	12	4	DS	D	78	0	90	45	3.5	525	Y	99	520	702	Perrenial								
248	RU	12	4	DS	D	78	0	75	30	3.5	292	Y	99	289	390	Perrenial								
249	RU	12	3	DS	Q	78	0	50	22	3.5	143	Y	99	141	191	Ephem./Int.								
250	RU	7	4	DT	P	78	0	50	20	3.5	130	Y	99	128	173	Perrenial								
251	RU	13	3	DS	P	78	0	50	40	3.5	259	N	0	0	0									
252	RU	13	3	DS	P	78	0	70	66	3.5	599	Y	99	593	800	Ephem./Int.								
253	RU	14	3	DT	P	78	0	176	30	3.5	684	Y	99	678	915	Ephem./Int.								
254	RU	13	3	DS	D	78	0	44	66	3.5	376	Y	99	373	503	Ephem./Int.								
255	RU	13	3	DS	D	78	0	88	66	3.5	753	Y	99	745	1006	Ephem./Int.								
256	RU	14	4	DS	P	78	0	66	44	3.5	376	N	0	0	0		ROAD							CUT BANK
257	RU	14	1	DS	D	78	0	44	22	3.5	125	Y	99	124	168	Perrenial								
258	RU	14	1	DS	D	78	90	66	88	2.0	430	Y	100	430	581	Perrenial	ROAD							
259	RU	14	1	DS	D	96	91	66	25	2.0	122	Y	100	122	165	Perrenial								
260	RU	14	1	DS	D	78	95	70	60	3.0	467	Y	100	467	630	Perrenial								
261	RU	14	1	DS	D	78	93	88	44	3.0	430	Y	100	430	581	Perrenial	ROAD							
262	RU	22	1	DS	D	78	0	44	22	3.5	125	Y	99	124	168	Perrenial	ROAD							
263	RU	22	1	DS	D	78	90	88	88	4.0	1147	Y	100	1147	1549	Perrenial	ROAD							
264	RU	23	4	DS	Q	78	0	75	44	3.5	428	Y	99	424	572	Perrenial								
265	RU	23	4	DT	Q	78	0	66	15	3.5	128	Y	99	127	172	Ephem./Int.								
266	RU	23	1	DS	D	78	0	120	100	3.0	1333	Y	100	1333	1800	Perrenial	ROAD							
267	RU	24	4	DS	D	78	50	110	90	3.0	1011	Y	99	1001	1351	Perrenial	ROAD							

Id #	PWS	Section #	TSU	Landslide Type	Landslide Certainty	Approx. Failure Date	Slope Gradient (%) Field	Average Landslide Dimensions (feet) Length	Width	Depth	Volume (yd^3)	Sediment Delivery	Delivery (%)	Delivery Volume (yd^3)	Delivery Mass (tons)	Sediment Routing	Land Use Assoc.	Deep Seated Landslide Morphological Descriptions Toe	Body	Lat. Scarps	Main Scarps	Veg.	Complex	Comments
269	RU	25	3	DT	D	78	0	440	88	3.5	5019	Y	99	4969	6708	Ephem./Int.								
270	RU	26	3	DT	Q	78	0	154	35	3.5	699	Y	99	692	934	Ephem./Int.								
271	RU	26	4	DS	P	78	0	44	44	3.5	251	Y	99	248	335	Perrenial	ROAD							
272	RU	36	3	DT	D	78	0	70	44	3.5	399	Y	99	395	534	Ephem./Int.	ROAD							
273	RU	26	4	DS	D	78	0	30	110	3.5	428	Y	99	424	572	Perrenial	ROAD							
274	RU	26	4	DS	D	78	0	40	22	3.5	114	Y	99	113	152	Perrenial	ROAD							
275	RU	26	4	DS	P	78	0	35	22	3.5	100	Y	99	99	133	Perrenial	ROAD							
277	RU	27	4	DT	D	78	0	110	22	3.5	314	N	0	0	0									
278	RU	27	5	DS	Q	78	0	44	22	3.5	125	Y	99	124	168	Perrenial	ROAD							
279	RU	22	4	DT	P	78	0	88	30	3.5	342	Y	99	339	457	Perrenial	ROAD							
280	RU	22	4	DS	P	78	0	30	20	3.5	78	Y	99	77	104	Perrenial	ROAD							
281	RU	22	4	DS	D	78	0	30	20	3.5	78	Y	99	77	104	Perrenial	ROAD							
282	RU	22	4	DS	D	78	0	30	20	3.5	78	Y	99	77	104	Perrenial	ROAD							
283	RU	22	4	DS	D	78	0	30	20	3.5	78	Y	99	77	104	Perrenial	ROAD							
284	RU	22	4	DS	D	78	0	40	30	3.5	156	Y	99	154	208	Perrenial	ROAD							
285	RU	22	4	DS	P	78	0	35	22	3.5	324	N	0	0	0	Perrenial	ROAD							
286	RU	22	4	DS	D	78	0	66	66	3.5	565	N	0	0	0									
287	RU	30	4	DS	D	78	0	170	60	3.5	1322	Y	99	1309	1767	Ephem./Int.								
288	RM	6	4	DS	D	78	0	88	50	3.5	570	Y	99	565	762	Perrenial								
289	RG	36	2	DS	P	78	0	154	66	3.5	1318	Y	99	1304	1761	Perrenial	ROAD							
290	RG	36	2	DS	D	78	0	90	44	3.5	513	Y	99	508	686	Perrenial								
291	RG	36	2	DS	D	78	0	50	22	3.5	143	Y	99	141	191	Perrenial								
292	RG	36	2	DS	P	78	0	44	44	3.5	251	Y	99	248	335	Perrenial								
293	RG	36	2	DS	Q	78	0	110	44	3.5	627	Y	99	621	839	Perrenial								
294	RG	36	2	DS	Q	78	0	110	44	3.5	627	Y	99	621	839	Perrenial								
295	RG	31	2	DS	P	78	0	44	44	3.5	251	Y	99	248	335	Perrenial								
296	RG	31	2	DS	P	78	0	80	88	3.5	913	Y	99	903	1220	Perrenial								
297	RG	36	1	DS	D	78	0	40	30	3.5	156	Y	99	154	208	Perrenial	LANDING							
298	RG	35	2	DS	D	78	0	66	50	3.5	428	Y	99	424	572	Ephem./Int.								
299	RG	36	4	DS	D	96	0	35	25	3.5	113	Y	99	112	152	Ephem./Int.								
300	RG	36	2	DS	P	96	0	64	32	3.5	265	Y	99	263	355	Perrenial								
301	RG	36	2	DS	P	96	0	38	16	3.5	79	Y	99	78	105	Perrenial								
302	RG	30	1	DS	D	96	0	112	80	3.5	1161	Y	99	1150	1552	Perrenial								
303	RM	9	4	DS	D	78	0	132	22	3.5	376	N	0	0	0		SKID							
304	RM	9	5	DS	D	78	0	88	22	3.5	251	N	0	0	0		SKID							
305	RM	4	4	DS	Q	96	0	44	22	3.5	265	N	0	0	0		ROAD							
306	RM	9	5	DS	D	96	0	64	32	3.5	265	N	0	0	0		ROAD							
310	RM	32	4	DS	D	96	90	200	3	3.0	67	N	0	0	0		ROAD							CUT BANK
312	RU	22	4	DS	D	96	94	250	125	10.0	11574	Y	100	11574	15625	Perrenial								formed by 313
314	RU	25	4	DS	D	94<	55	140	80	1.0	415	N	0	0	0									mass wasteing by road
315	RU	25	3	DT	D	89<	88	250	60	3.0	1667	Y	100	1667	2250	Ephem./Int.	ROAD							old road blow out, road rebuilt over old road
316	RU	22	4	DS	D	96	65	200	75	3.0	1667	Y	75	1250	1688	Ephem./Int.	ROAD							
317	RU	14	1	DS	D	96	90	100	50	2.0	370	Y	100	370	500	Perrenial	ROAD							
318	RU	14	1	DS	D	96	90	70	50	2.0	259	Y	100	259	350	Perrenial	ROAD							
319	RM	3	4	DS	D	96	60	100	50	3.0	556	Y	100	556	750	Perrenial	ROAD/SKID							starts on Skid then goes over Rd
320	RM	3	1	DS	D	96	70	30	40	2.0	89	Y	100	89	120	Perrenial	ROAD							
321	RM	3	4	DS	D	96	90	30	30	2.0	67	Y	100	67	90	Perrenial	ROAD							
322	RM	2	1	DT	D	96	65	30	10	2.0	22	Y	100	22	30	Perrenial	ROAD							
323	RM	2	1	DS	D	96	95	100	30	4.0	444	Y	100	444	600	Perrenial	ROAD							
324	RM	10	2	DS	D	96	95	70	50	2.0	259	Y	100	259	350	Perrenial	ROAD							
325	RM	10	2	DS	D	96	90	125	50	2.0	463	Y	100	463	625	Perrenial	ROAD							
326	RM	11	2	DT	D	96	87	150	30	1.0	167	Y	100	167	225	Perrenial	ROAD							
328	RL	29	1	DS	D	96	88	200	350	5.0	12963	Y	100	12963	17500	Perrenial	ROAD							
329	RL	27	3	DS	D	96	90	110	30	6.0	733	Y	100	733	990	Perrenial	ROAD							
330	RL	27	3	DS	D	96	73	150	100	3.0	1667	Y	100	1667	2250	Perrenial	ROAD							
331	RL	27	4	DT	D	96	85	110	20	4.0	326	Y	100	326	440	Perrenial	ROAD							
332	RL	27	3	DS	D	96	110	450	200	3.5	11667	Y	100	11667	15750	Perrenial	ROAD							
335	RU	23	1	DS	P	96	0	32	16	3.5	66	Y	99	66	89	Ephem./Int.								
336	RU	23	1	DS	D	96	100	130	30	2.0	289	Y	100	289	390	Perrenial								
337	RU	22	1	DS	D	96	90	70	30	3.0	233	Y	100	233	315	Perrenial								
338	RU	15	1	DT	D	96	83	50	100	1.0	185	Y	100	185	250	Perrenial	ROAD							(surface erosion of road)
339	RU	14	1	DS	D	96	105	50	100	3.0	556	Y	100	556	750	Perrenial								

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340	RU	14	1	DS	D	96	85	50	20	2.0	74	Y	100	74	100	Perrenial								
342	RU	14	1	DS	D	89<	83	50	75	6.0	833	Y	100	833	1125	Perrenial								
343	RU	14	1	DS	D	96	98	80	50	1.0	148	Y	100	148	200	Perrenial								
344	RU	14	1	DS	D	96	95	100	50	3.0	556	Y	100	556	750	Perrenial								
345	RM	15	1	DS	D	96	100	90	30	7.0	700	Y	100	700	945	Perrenial								
346	RM	15	1	DS	D	96	115	85	20	4.0	252	Y	100	252	340	Perrenial								
347	RM	15	1	DS	D	89<	85	150	70	8.0	3111	Y	100	3111	4200	Perrenial								
349	RM	4	1	DS	D	96	65	50	50	3.0	278	Y	100	278	375	Perrenial								
350	RM	4	1	DT	D	96	100	25	10	3.0	28	Y	100	28	38	Perrenial								
351	RM	4	1	DS	D	96	90	100	20	2.0	148	Y	100	148	200	Perrenial								
352	RM	4	1	DS	D	96	90	110	25	2.0	204	Y	100	204	275	Perrenial								
353	RM	4	1	DS	D	96	85	30	40	2.0	89	Y	100	89	120	Perrenial								
354	RM	4	1	DS	D	96	90	150	30	6.0	1000	Y	100	1000	1350	Perrenial								
355	RM	3	1	DS	D	98	100	200	150	6.0	6667	Y	99	6667	9000	Perrenial								
356	RM	3	1	DS	D	96	90	150	50	2.0	556	Y	100	556	750	Perrenial								
357	RM	3	1	DS	D	96	90	90	30	2.0	200	Y	100	200	270	Perrenial								
358	RM	3	1	DS	D	96	60	70	50	1.0	130	Y	100	130	175	Perrenial								
359	RM	3	1	DS	D	96	80	90	50	3.0	500	Y	100	500	675	Perrenial								
360	RM	3	1	DT	D	96	85	110	20	2.0	163	Y	100	163	220	Perrenial								
361	RM	3	1	DS	D	96	90	25	90	2.0	167	Y	100	167	225	Perrenial								
362	RM	3	1	DS	D	96	95	120	30	3.0	400	Y	100	400	540	Perrenial								
363	RM	3	1	DT	D	96	75	90	20	5.0	333	Y	100	333	450	Perrenial								
364	RM	33	1	DS	D	96	110	40	60	3.0	267	Y	100	267	360	Perrenial								
365	RM	33	1	DS	D	96	103	200	20	3.0	444	Y	100	444	600	Perrenial								
366	RM	33	1	DS	D	96	96	90	200	3.0	2000	Y	100	2000	2700	Perrenial								
367	RM	33	1	DS	D	96	85	100	200	4.0	2963	Y	100	2963	4000	Perrenial								
368	RM	33	1	DS	D	96	90	200	250	4.0	7407	Y	100	7407	10000	Perrenial								
369	RM	33	1	DS	D	96	92	70	200	3.0	1556	Y	100	1556	2100	Perrenial								
370	RM	33	1	DS	D	96	60	70	30	5.0	389	Y	100	389	525	Perrenial								
371	RM	33	1	DS	D	96	66	150	80	2.0	889	Y	100	889	1200	Perrenial								
372	RM	33	1	DS	D	96	86	90	100	2.0	667	Y	100	667	900	Perrenial								
373	RM	32	1	DS	D	96	91	70	100	2.0	519	Y	100	519	700	Perrenial								
374	RM	32	1	DS	D	89<	85	100	50	3.0	556	Y	100	556	750	Perrenial								
375	RM	32	1	DS	D	98	90	30	15	4.0	67	Y	100	67	90	Perrenial								
376	RM	32	1	DS	D	96	71	90	35	2.0	233	Y	100	233	315	Perrenial								
377	RM	32	1	DS	D	96	90	120	50	3.0	533	Y	100	533	720	Perrenial								
378	RM	32	1	DS	D	96	96	90	80	3.0	800	Y	100	800	1080	Perrenial								
379	RM	29	4	DS	D	96	76	100	25	4.0	370	Y	30	111	150	Perrenial	ROAD							
380	RU	27	4	DS	D	96	90	40	50	2.0	148	N	0	0	0		ROAD							
381	RU	14	1	DS	D	89<	120	60	60	2.0	267	Y	100	267	360	Perrenial								
382	RU	14	1	DS	D	96	0	64	40	2.0	190	Y	100	190	256	Perrenial								
388	RL	33	3	DS	P	78	0	242	154	3.5	4831	Y	99	4783	6457	Perrenial								
389	RM	1		RS	Q			3160	960	0		Y				Perennial		3	3	3	3	4	N	
390	RM	1	4	DS	P	2000	0	60	40	3.5	311	Y	99	308	416	Ephem./Int.								
394	RM	1	4	DS	P	2000	0	370	65	3.5	3118	Y	99	3086	4167	Perrenial								
395	RM	12		RS	Q			3320	1300	0		Y				Perennial		3	3	3	3	4	N	
396	RU	13	3	DT	D	2000	0	600	80	3.5	622	Y	99	6160	8316	Ephem./Int.								Head Wall Swale
397	RU	23		RS	Q			2010	910	0		Y				Perennial		3	3	3	3	3	N	
399	RU	15		RS	Q			1900	1040	0		Y				Perennial		3	3	3	3	3	N	
401	RM	4	3	DS	P	2000	0	120	70	3.5	1089	N	0	0	0		ROAD							
402	RM	9	4	DS	Q	2000	0	60	20	3.5	156	N	0	0	0									
403	RM	15	4	DS	D	2000	0	160	100	3.5	2074	Y	99	2053	2772	Ephem./Int.	SKID							
404	RM	21	4	DS	D	2000	0	100	30	3.5	389	N	0	0	0		ROAD							
405	RM	21	4	DS	D	2000	0	140	20	3.5	363	Y	99	359	485	Ephem./Int.	ROAD							
406	RM	21	2	DS	Q	2000	0	80	25	3.5	259	Y	99	257	347	Ephem./Int.								
407	RM	32	4	DF	D	2000	0	370	80	3.5	3837	Y	99	3799	5128	Perrenial								
400	RM	33		RS	P			2660	1140	0		Y				Perennial		2	3	3	3	4	N	
408	RM	29		RS	Q			880	640	0		Y				Perennial		4	3	3	3	5	N	
409	RM	33		RS	Q			1360	1340	0		Y				Perennial		2	3	3	3	5	N	
410	RM	29		RS	Q			1050	960	0		Y				Perennial		2	3	3	3	5	N	
411	RL	29		RS	Q			1860	480	0		Y				Perennial		4	3	3	3	5	N	
412	RL	20		EF	Q			1930	1970	0		Y				Ephem./Int.		3	4	3	3	5	N	

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413	RU	22		RS	D			520	430	0		Y				Perennial		2	3	3	3	5	Y	
414	RM	15		RS	Q			1760	510	0		Y				Perennial		3	3	3	3	5	N	
415	RM	3		RS	Q			1930	2240	0		Y				Perennial		4	3	3	3	5	N	
416	RM	33		RS	Q			1620	1060	0		Y				Perennial		2	3	3	4	5	N	
417	RU	26		RS	Q			1090	610	0		Y				Ephem./Int.		3	3	3	3	5	N	
418	RU	14		RS	Q			1660	1280	0		Y				Perennial		3	3	3	3	5	N	
419	RM	35		RS	D			2150	1280	0		Y				Ephem./Int.		2	3	3	3	5	N	
420	RM	27		RS	Q			1120	220	0		Y				Ephem./Int.		2	3	3	3	5	N	
421	RM	26		RS	Q			1050	130	0		Y				Ephem./Int.		2	3	3	3	5	N	
422	RL	27		RS	P			1500	1460	0		Y				Perennial		2	3	3	3	5	N	
423	RL	27		RS	Q			560	1410	0		Y				Ephem./Int.		2	3	3	3	5	N	
424	RA	36		RS	Q			3710	2400	0		Y				Ephem./Int.		4	3	3	3	5	N	
425	RU	36		RS	Q			920	350	0		Y				Ephem./Int.		3	3	3	3	5	N	
426	RU	12		RS	Q			1560	1120	0		Y				Ephem./Int.		3	3	3	4	5	N	
427	RM	2		RS	Q			1600	1120	0		Y				Ephem./Int.		3	3	3	3	5	N	
428	RG	36		RS	P			2930	1440	0		Y				Ephem./Int.		4	3	3	3	5	N	
429	RG	1		RS	Q			980	500	0		Y				Ephem./Int.		4	3	3	3	5	N	
430	RG	36		RS	P			2250	2800	0		Y				Ephem./Int.		3	3	3	3	5	N	
431	RI	8		DS	P			60	40	3.5	311.111111		100	311.11111	420	Ephem./Int.								
432	RI	8		RS	D			700	450					0	0	Ephem./Int.		4	3	5	4	4	Y	
433	RI	8		RS	D			250	500					0	0	Ephem./Int.		2	3	3	3	3	N	
434	RI	8		DS	D			70	60	3.5	544.444444		100	544.44444	735	Ephem./Int.								
435	RI	8		RS	P			700	800					0	0	Ephem./Int.		4	4	3	4	3	N	
436	RI	9		RS	P			1300	800					0	0	Ephem./Int.		3	3	3	4	4	N	
437	RI	9		DS	D			120	110	3.5	1711.11111		100	1711.1111	2310	Ephem./Int.								
438	RI	9		DS	D			70	70	3.5	635.185185		100	635.18519	857.5	Ephem./Int.								
439	RI	5		RS	D			700	300					0	0	Perrenial		2	2	3	3	3	N	
440	RI	5		DS	D	1980s		450	175	5	14583.3333		100	14583.333	19687.5	Perrenial								
441	RI	4		RS	P			2200	1200							Ephem./Int.		4	3	3	4	3	N	