Humboldt Redwood™

March 17, 2014

Mr. Dave Rogers R.P.F.
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EXECUTIVE SUMMARY

Geologic Evaluation of the McDoe Timber Harvesting Plan
Humboldt County, California

The attached report describes the results of our geologic evaluation of slopes within the McDoe Timber Harvesting Plan. Our investigation was conducted in general accordance with California Geologic Survey Note 45 and included a review and analysis of available data and a reconnaissance of the project area. Our report presents specific recommendations relating to the removal of timber from slopes within and adjacent to unstable landforms identified during our assessment. Pertinent elements of the plan, findings, and our proposed recommendations are presented below:

General Findings

- This THP covers approximately 537 acres along the northern valley wall of Elk River between McWhinney Creek and the Little North Fork of the North Branch of Elk River. The plan and associated harvest prescription were developed following Elk River and Salmon Creek Watershed Analysis prescriptions.
- The Elk River is sediment and temperature impaired.
- The project area is underlain underlain by Tertiary to Quaternary aged Undifferentiated Wildcat Group sediments. No active faults are mapped passing through or within 7 miles of the project area.
- Thirty recently active to dormant-historic landslides are in or abutt the plan (refer to Figures 4 through 8). A brief summary of the characteristics of each failure is contained in Appendix A.
- Ground movement in the plan area is dominated by hillslope processes affiliated with translational and rotational failure mechanisms and is concentrated along the inner valley slopes of the deeply entrenched Class I and II watercourse.

- Group selection and variable retention operations are proposed on those slopes identified as unstable that have negligible probability to deliver sediment to nearby waterways.
- All of those failures that pose a risk to aquatic resources are encompassed by either limited-entry Riparian Management Zones (RMZ) and/or Special Treatment Zones (STZ).
- Intermediate/partial cut harvest methods will be applied to those stands encompassed STZs. Harvest levels were determined on a site by site basis with the assistance of the project forester. Refer to Figure 9 for the location of the special management areas discussed below.
- Silvicultural boundaries were modified over several site visits under the supervision of the project forester and geologist.

Recommendations

- No group openings are allowed in STZs. After discussion with the project forester, it was determined it would be appropriate to retain a minimum of 120 sq. ft. of conifer basal area per acre.

A full discussion regarding these findings and recommendations are presented in the attached report. We did not encounter conditions that would preclude the development of the proposed timber harvest plan provided the recommendations contained in our report are implemented in its design. If you have any questions, please call us at 707-764-4224

Sincerely,

HRC/MRC Physical Science Depart.

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Enclosure: Geologic Report

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SUBJECT: Geologic Evaluation of the McDoe Timber Harvesting Plan, Humboldt County, California

INTRODUCTION

This report presents the results of a geologic evaluation of slopes within the proposed McDoe Timber Harvesting Plan (THP) conducted by Humboldt Redwood Company (HRC) LLC GeoScience Department. Our investigation was initiated in response to a request from the HRC Project Forester to asses slope stability with the proposed plan area. The plan is located in the North Fork Elk River Watershed on HRC property. This report documents our geologic consultation on this project. Ultimately, our investigation and proposed mitigations are meant to minimize the potential impacts to local watercourses with regard to landslide-derived sediment.

The scope of our investigation included a review of pertinent and available regional geologic maps and literature, geologic reports and letters attached to adjacent harvest plans, the Mass Wasting Module of the Elk River/ Salmon Creek watershed analysis, a series of site visits, and the preparation of this report and attached figures. In our report, we use the landslide terminology presented in California Geological Survey (CGS) Note 50 (1997) and in Cruden and Varnes (1996). Landslide age classes used herein are based on the scheme presented in Keaton and DeGraff (1996).

This investigation was conducted in general conformance with the work scope outlined in CGS *Note 45: Guidelines for Engineering Geologic Reports for Timber Harvesting Plans* (1999). As such, our study is inherently focused on documenting existing slope failures within and adjacent to the proposed timber harvesting areas, qualitatively evaluating slope stability conditions (to locate potentially unstable sites), and assessing the potential for sediment delivery to watercourses as a result of mass wasting processes. This report discusses

geomorphic processes as they relate to landslide activity and that we believe are pertinent to delivery of sediment to watercourses.

Our initial reconnaissance of the plan area was on November 20, 2013. We revisited the project area on several other occasions to complete our field evaluation. Our site evaluations included surveys of the following:

- potential high hazard areas as defined in HRC Habitat Conservation Plan (HCP) Prescriptions based on Watershed Analysis for Elk River and Salmon Creek (ERSC) Watershed (HartCrowser, 2000),
- areas of concern identified by the project forester using the "Hillslope Management Check List for the Elk River Watershed Analysis Unit",
- unstable areas identified by previous investigations (SGD, 2005a; SGD, 2005b; BGC, 2002; SGD, 2001; SHN, 2001; SHN, 2000; Huber, 1998).

To the best of our knowledge, this THP conforms to the Forest Practice Rules and the hill slope management mass-wasting strategy that applies to HRC's ownership under the prescriptions developed based on the Elk River/ Salmon Creek watershed analysis.

GENERAL SETTING

The McDoe THP covers approximately 537 acres along the northern valley wall of Elk River between McWhinney Creek and the Little North Fork of the North Branch of Elk River sub-basins. Several un-named Class II and Class III tributaries extend into the units. Elk River, a fish bearing watercourse, is listed as sediment and temperature impaired under Section 303(d) of the Federal Clean Water Act.

Elevations within the reviewed areas of the plan range from a minimum of approximately 200 feet above Mean Sea Level (MSL) to a maximum of 1380 feet above MSL. Refer to Figure 1 for harvest boundary locations as currently proposed and their relationship to mapped watercourses, roadways, and property lines. Pertinent regional location information is presented below in Table 1.

TABLE 1

PERTINENT LOCATION INFORMATION

Legal Description	Sections 25, 26, 27, 34, 35, and 36 T1N, R4E; HB&M.
USGS Quadrangle	McWhinney Creek 7.5-minute quadrangle.
Cal Watershed	Lower N. Fork Elk (1110.000201) and Upper N. Fork Elk (1110.000202)

Logging operations will be conducted in accordance with prescriptions instituted based on the watershed analysis for the ERSC watersheds (HRC, 2005). Slopes adjacent to watercourses will be managed in accordance with prescriptions required for Class I, II, and III Riparian Mitigation Zones (RMZs). Group selection and variable retention silvicultures are proposed outside of the watercourse buffers. Refer to Section II item 14 of the THP for a description of the retention standards required for each of the proposed silivcultural practices.

There are no domestic water supplies identified within 1,000 feet of the THP area. No public resources or infrastructure facilities are located within 1,000 feet of the plan area, consequently operations as proposed do not pose a significant hazard to public safety.

The entire plan area is accessible by existing roadways, consequently only very limited amounts of road construction and/ or reconstruction are necessary. Most of the road construction is affiliated with short spurs that follow existing road prisms. Skid trails are present throughout the project area, and will be re-used for ground based operations as feasible.

GENERAL SITE CONDITIONS AND HISTORY

The dispersed nature of this plan has resulted in the occupation of a broad range of slope aspects and geomorphologies. The upland portions of the THP occupy broad, well-rounded ridges, with moderate to steep (30% and greater) slopes. Typically, the upland slopes retain convex to semi-planar profiles and in some instances have developed into low gradient (5% to 20%) topographic benches. As upland areas approach the valley floors, they often develop steeper orientations. These "inner valley" slopes often retain a planar profile and are inclined at precipitously steep gradients (near vertical along Class I and Class II watercourses). This inner valley wall terrain extends between 50 and 150 feet upslope of the stream edge and is commonly associated with Class I and larger Class II watercourses.

Timber stands encompassed by this THP are not homogeneous and are comprised of various assortments of conifer with limited amounts of hardwood. Slopes support open to dense, single to multi-tiered stands of second and third growth trees. The conifer component is dominated by second growth redwood and Douglas fir, with infrequent Grand fir. Intermixed with these conifers are groups of indigenous hardwoods, principally tan oak and red alder. Hardwoods are typically confined to slopes along watercourse channels and abandoned road alignments. Scattered residuals are also present, although in very low numbers. Underlying the overstory and sub-canopy is a variably thick shrub layer composed of huckleberry, salal, poison oak, and other common groundcover species. These groundcover species can occur in very dense patches.

This THP overlaps or abuts THP 1-98-038HUM, 1-00-215HUM, THP 1-00-307HUM, THP 1-02-090HUM, THP 1-02-111HUM, THP 1-05-131HUM, and THP 1-05-161HUM. Harvest plans approved after 1999 and prior to August 2005 were laid out in accordance with the interim prescriptions presented in PALCO's Habitat Conservation Plan (HCP) (PALCO, 1999). Under the interim rules outlined in Section 6.3.3.7 (Hillslope Management) of PALCO's HCP, no-cut areas were required around all those slopes identified as being unstable or that attained a Factor Total value in excess of 15 points.

Harvest plans submitted subsequent to August 2005 were laid out in accordance with prescriptions based on watershed analysis for ERSC (HRC, 2005).

Each of the referenced plans has a geologic report attached. These geologic reports provide discussions regarding slope stability within the THPs, as well as site-specific geologic recommendations meant to minimize the impact of proposed timber operations on the identified unstable areas.

This plan is being submitted following prescriptions developed from ERSC Watershed Analysis (HRC, 2005). Under this rules package, trees can be removed from unstable and potentially unstable slopes provided that a California-licensed professional geologist reviews the areas proposed for management. Consequently, a number of the areas of concern omitted from operations in pre-2002 THPs may be subject to various levels of harvest under this entry.

GEOLOGIC SETTING

A compilation geomorphic/ geologic map produced by CGS (2005), that encompasses the project area, is attached as Figure 2a. This map and past studies indicate that the plan is underlain by Tertiary to Quaternary aged Undifferentiated Wildcat Group sediments (SGD, 2000; SHN, 2000; SHN, 2001; CGS, 2005). Undifferentiated Wildcat Group sediments are described as moderately well consolidated silts and fine sands (CGS, 2005; SGD, 2001). We observed predominantly massive sandy siltstone bedrock capped with about 1 to 6 feet of silty to sandy silt (ML to SM) soil underlying the units within the unstable areas identified in this report.

Refer to the GEOLOGY section on pages 3 and 4 of the Cumulative Watershed Effects Assessment (CWEA) module for discussions relating to the origin and composition of the sediments underlying the plan area. The CWE module can be found at:

(www.mendocinoredwoodcompany.com/pdf/WatershedAnalysis/HRC/Elk%20River Salmon%20Creek%20-%20Cummulative%20Effects.pdf).

SEISMIC CONDITIONS

No active faults are mapped passing through the project area, and no part of the plan lies within and/or adjacent to an Alquist-Priolo Earthquake Fault Zone. The harvest plan does fall in-between the Little Salmon and Freshwater Fault Zones, both of which are considered northwest-trending, high angle thrust faults (Hart and Bryant, 1997). The mapped trace of the Little Salmon fault is approximately 7 miles southwest of the plan area, while traces of the Freshwater Fault Zone intersects Units 7 and 8 (McLaughlin and others, 2000 and CGS, 2005). Refer to Figure 2 for unit limits and fault trace relation.

The Freshwater Fault Zone is composed of the Freshwater and Greenwood Heights faults (Knudsen, 1993), which are inferred to be parallel northwest-trending, northeast-dipping, high angle thrust faults. In the Freshwater and Elk River watersheds these faults place undifferentiated Wildcat and Yager Formation sediments into contact with Central belt bedrock. This fault is not considered active by the State of California under the provisions of the Alquist-Priolo Earthquake Fault Zone Act. Refer to the Seismic Regime section on pages 4 and 5 of the CWEA module for a more detail discussion of regional tectonics and faulting.

Considering the location of the project, it is possible that slopes proposed for timber operations will be subject to ground shaking. Ground motion affiliated with a large seismic event in this semi-mountainous/steep terrain would likely trigger or reactivate landslides within and adjacent to the plan area. It is well documented that earthquake-induced landslides often occur at localities where slopes are naturally unstable under nonseismic conditions (Keefer, 1984; McPherson and Dengler, 1992; Dunklin, 1992). Consequently, there is the potential that some landslides could be triggered on slopes within and/or immediately adjacent to the plan area following a significant seismic event, regardless of whether management activities occur.

NORTH COAST REGIONAL WATER QUALITY CONTROL BOARD TIER 2

As part of our assessment, we evaluated a series of maps that represent the minimum data review required to harvest in the Elk River watershed under the California Regional Water Quality Control Board, North Coast Region (RWQCB) permits. The RWQCB uses a model to estimate the effect of timber harvesting on peak flows in the Elk River Watershed. This model is based on the instigation of clear cut silvicultural practices and is used to determine allowable harvest limits in the watershed. Because the current landowner is only implementing uneven age silvicultural practices in the watershed, the previously determined harvest limits are considered conservative.

The following items were reviewed to evaluate slope stability in the plan area.

- 10-foot LIDAR contour map
- SHALSTAB model results
- Mass Wasting Potential (MWP) model results
- Geologic and Geomorphic Features Related to Landsliding, Elk River Watershed (Marshall and Mendes, 2005)
- Relative Landslide Potential Map, Elk River Watershed (Marshall and Mendes, 2005)
- Orthophotoquad imagery
- Watershed Analysis Deep-Seated Landslide Inventory (Hart Crowser, 2000)
- THP Operational maps with unit boundaries, creeks, and roads

Our review of CGS maps (CGS, 2005) and the Deep-Seated Landslide Inventory Map (HartCrowser, 2000) reveal that a majority of the mass wasting features portrayed on these maps were not present or of such age as to not be impacted by current land use activities. Those features identified as having potentially negative responses to aggressive (clear-cut) management strategies are illustrated on the landslide maps attached to this report. Refer to Figure 2 for location of dormant-young or older landslide-related features.

A number of regions in the plan area were identified by MWP and SHALSTAB models as having high and extreme landslide hazard potential. The MWP model assesses streamside slopes and is designed around slope gradients, while the SHALSTAB model accounts for gradient and slope convergence. The results of these models are presented on Figure 3.

Those regions identified by these models that correspond to areas of recent or historic instability are mapped as unstable landforms on Figures 4 through 8. A majority of the high hazard areas occur in the plan where we did not find existing instabilities. As such, these areas were compared to adjacent lower hazard modeled slopes with similar slope inclination, convergence, and vegetative coverage to determine if unstable conditions existed. Where field observation suggested that the model was incorrect in assessing the potential for mass wasting, especially in response to selective silviculture, the modeled areas were not considered potentially unstable and are not identified on the landslide maps contained in this report.

SLOPE STABILITY

Overview

In general, the stability of slopes currently proposed for timber operations was not negatively impacted by past land use activities (that is tractor and rail road logging, clear cut, partial cut, and site preparation). We identified only 30 areas of recent/historic instability within this 537-acre plan. There is no indication that past land use operations significantly altered the mass balance of the managed slopes such that it resulted in the renewal or activation of a large number of mass wasting events. The project area, overall, is characterized by very low levels of mass wasting activity.

Our investigation revealed that ground movement is generally confined to streamside slopes associated with Class I and II watercourses. Slope gradients in these areas typically range from 60% to 120%. In this terrain we mapped independent, as well as nested groups of landslides that were usually greater than 30 years in age (dormant-historic). The highest concentration of streamside mass movement in the plan area is associated the down slope extents of Unit 4 along the western harvest boundary.

Ground movement outside the watercourse zones in the upland areas of this THP is much less frequent and commonly associated with road/skid trail building activities. Earthwork affiliated with the construction and/or expansion of a haul road/skid trail systems can decrease the overall stability of a slope by interrupting and diverting overland flow, altering subsurface water movement, and modifying the distribution of earth materials (excavation and sidecasting) on the surface of a slope. These activities, either independently or in combination, can reduce a hill slope's resistance to mass wasting processes and large landslide triggering events (winter storms and earthquakes).

RECENT AND HISTORIC LANDSLIDE CHARACTERISTICS

Ground movement in the plan area is dominated by hill slope processes affiliated with translational and rotational failures. We classified a majority of the mass movements in the plan area as dormant-historic debris slides. Translational/rotational failures comprise a relatively minor percentage of the landslides identified on Figures 4 through 8.

We have not included site-specific descriptions of individual landslide in the text of this report; rather, we provide a brief summary of slide characteristics of each failure in tabular form in Appendix A. Our report does, however, include a generalized description of the landslide types identified within the plan area. A brief description of the landslide types observed in this THP follows.

Debris Slide/Flow

Debris slides in the plan area are usually defined by linear, well-defined debris chutes. Scarps at the heads and along the lateral margins of these older slide paths range from 2 to 6 feet in height and are often steeply inclined. The bodies of these slides, in many instances, have become re-vegetated with groundcover species and second growth conifers (up to 70 years in age). Downed woody debris, buried logs, tilted stumps, and leaning residual trees are common at the toes of these shallow (2- to 8-feet deep) to moderately-deep (up to 15-feet deep) failures. At several locations, we noted where slide debris had encircled and buried the bases of old growth stumps and second growth trees and had overrun legacy skid trails and roads.

Slopes that supported coalescing groups of debris slides and debris flows are classified on our mass wasting maps as debris slide slopes. Debris slide slopes include those aggregates of shallow landslides that were triggered by mechanisms unrelated to fluvial processes. Slope destabilized by fluvial processes influencing the base of a slope are classified as inner gorges.

Translational/Rotational Landslides

These commonly deep-seated failures retain a blocky, stepped surface expression but support undeformed stands of mature (more than 50-year-old) second growth conifers. Only a few pistol-butted trees were observed on the surfaces of these historically active slides. Scarps along their crowns are still steeply inclined, but have more rounded expressions. Most of these secondary scarps retain a subdued and weathered profile but are still readily identifiable as being related to mass-wasting processes.

Typically, the arcuate-shaped scarps observed at the heads of these slides encompass and grade into low (less than 20%) to moderate (55%) gradient slopes that have irregular and uneven surface expressions. We estimate that these slides range from 50 to 100 feet in width and are up to 100 feet in length.

PREVIOUSLY MAPPED LANDSLIDE RELATED LANDFORMS

General

Intermixed with and underlying many of the active and dormant-historic slides on Figures 4 through 8 are large to moderate-sized, geomorphic features identified during previous investigations as being a potential by-product of landslide activity. These geomorphic features are intermittently dispersed across the slopes occupied by this THP. Many of these landforms are multi-acre in size and extend from ridge crest to valley floor.

These landforms were mapped during previous watershed-wide landslide-inventory studies (Kilbourne, 1985: HartCrowser, 2000; CGS, 2005) and were typically classified as either dormant earthflows or translational/rotational failures (Figure 2a). CGS (1997) considers these landforms to be the byproduct of compound-type failures, which involve a combination of roughly circular and linear failure planes. These failures are characterized by either cohesive or disrupted slide masses with relatively deep slide planes.

A significant percentage of the slopes within and adjacent to these large-scale landforms were classified as debris slide slopes or large individual debris slides (Figure 2a). CGS Note 50 (1997) defines a debris slide slope as a geomorphic landform with a surface that has been sculpted over time by numerous debris slide events. Hillsides mapped as debris slide slopes typically have slope gradients greater than 65% and support an aggregate of variously-aged slide paths and debris masses. Mass movement on these slopes typically is translational in origin and occurs in unconsolidated colluvium and highly weathered bedrock.

It is our understanding that the landslide and landslide-related landforms mapped on the geomorphic and geologic maps of the McWhinney Creek 7.5 minute quadrangles and the Elk River Watershed were differentiated from adjacent slopes using standard aerial photographic interpretation techniques. The amount of field review conducted for the verification of these features is uncertain. Consequently, the classification of a hillside as an unstable landform during these previous investigations does not necessarily indicate that it has experienced recent or historic ground movement or is inherently unstable.

Deep-Seat Landslide Characteristics

Most of the landforms identified by Kilbourne (1985) and CGS (2005) extend from the ridgeline down to the valley floor and overlap prominent, v-shaped tributary valleys that contain watercourses (Figure 2a). In plan view, these features have an irregular, lobate-shape with nebulous source areas that transition into broad, fan-shaped accumulation zones with diffuse toe margins.

Our assessment of slopes encompassed by the landforms revealed a general absence of slope morphology directly attributable to historic landslide processes. In some places, the upper reaches of these features correspond to broad, poorly defined, breaks in topography with no distinguishing landslide characteristics. Generally the upland margins of these landforms are vague and virtually undistinguishable from adjacent slopes both in the field and on regional aerial photographs.

Well-defined stream valleys have migrated into and down-cut through toes of these landforms. These roughly sinuous, deeply incised valleys drain well-established dendritic systems of Class II and III watercourses both within and above the mapped extent of the

inferred landforms. Streams associated with the lower reaches of these systems have encroached into the bodies of each landform resulting in the development of a number of moderate-sized hollows and draws.

Slopes within the bodies of these landforms, regardless of their topographic profiles (stepped, concave, convex, or planar), have undergone significant modification by erosional processes, and consequently, now retain a smooth and well-rounded surface expression. In most instances, the surface expressions of these landforms are only remotely recognizable as being related to landslide processes.

Not only is there an absence of youthful appearing slide morphology affiliated with these landforms, but the watercourses that flow down their surfaces appear to have returned to a pre-slide configuration. That is, they have re-established their channels and are no longer being influenced by ground movement associated with the hill slope processes that produced them. Based on the significantly degraded appearance of the features both in the field and on aerial photographs, the mature nature of the drainage pattern of their surfaces, stand conditions, and their overall geomorphic expressions, we concluded that these previously mapped large-scale features are dormant-mature or older in age, if present at all.

Debris Slide Slopes

During our assessment of the previously identified debris-slide slopes and larger scale debris slides, we observed only limited amounts of geomorphic and/or vegetative irregularities indicative of landslide activity (Figure 2a). Although steep, most of the slopes in these areas were void of landslide characteristics that would imply that they have been subject to widespread or localized landslideing, either recently or in the distant past. We did not encounter any scarps (fresh or weathered), slide scars, disturbed soils, deformed trees, or patches of irregular ground in these areas. In the field, there was no distinguishable break in timber type, age, or density between the pre-identified debris-slide slopes and adjacent hillsides. Based on our site evaluation, we concluded that most of the debris-slide slopes mapped by others are dormant-mature in age, if present at all. Those areas that exhibit evidence of having a negative response to past management activities or could be prone to landslide processes are mapped as unstable areas on Figures 4 through 8 of this report.

Uncategorized Slopes

Those areas previously mapped as being potentially unstable (models) or as landslide-related landforms (deep-seat, multi acre landforms) not shown on Figures 4 through 8 lacked evidence of having been altered by mass wasting processes either historically or in the recent past. These pre-identified features underwent intensive management practices in the past (historic tractor operations, clear cut, and burning) and there is no field or aerial

photographic evidence suggesting that these activities had an adverse effect on their overall stability. We anticipate that these features will have a similar response to the uneven age land use practice currently proposed on their surfaces; consequently we did not identify them as potential areas of concern.

DISCUSSION

Overview

Land-use activities proposed under this THP include the removal of timber from slopes near and within a number of the areas of instability mapped on Figures 4 through 8. Prior to our site visit, the project forester had placed a majority of the larger slide areas outside operational limits of plan. Those failures that remain within the operational limits of the THP, that could feasibly discharge sediment into down slope watercourses, were encompassed / buffered by special treatment zones. The areas-of-concern that have not directly delivered sediment to a down slope water body by means of landslide processes will undergo uneven-age management in accordance with group selection silviculture.

Recent and Historic Landslides

The removal of timber as currently proposed in the THP from in and around the areas of instability mapped on Figures 4 through 8 should not have a detrimental impact on slope stability or adversely impact water quality (as it relates to landslide-derived sediment) of the North Fork Elk River.

Approximately 55% of the recent and historic landslides identified during this assessment fall within Class I and Class II RMZs or STZs. RMZs in the plan area included a wide range of timber types, including brush patches, open hardwood stands, and moderately to densely stocked stands of conifer. Within the RMZs, the project forester estimates that approximately 20% of the merchantable timber, in areas that support ample amounts of canopy, will be removed. There is a low probability that reducing the conifer component by this amount will adversely affect the hydrologic regime of the slopes in the RMZs or significantly reduce the resisting (cohesive) forces afforded by roots. Unharvested conifers (approximately 80% retained) and hardwoods (all) within these watercourse-protection zones will continue to provide ample amounts of canopy interception, root strength properties, and evaporation and transpiration mechanisms to the managed and adjoining slopes.

Our survey of the slopes within the RMZs also revealed that a significant number of the trees marked for harvest are situated along the upper margins of the watercourse buffers and are frequently associated with stump clumps. Harvesting timber from the upper edge of the RMZ will minimize the amount of ground disturbance within the buffer as well as reduce the amount of collateral damage to unharvested timber. In addition, because many

of the trees proposed for harvest in these zones are affiliated with dense pockets of timber and brush, we expect that there will be only a minimal impact on canopy coverage and root strength properties.

Timber stands on slides positioned outside the watercourse buffers will be managed in accordance with a group selection siliviculture. No group openings will be placed on or directly adjacent to slides identified as being potential sources of sediment to down slope watercourses. Operations on these particular slides will be conducted in accordance with single-tree selection and identified as Special Treatment Zones (STZs). Vegetation retention areas (such as the ones proposed in this THP) have been found to be an effective management strategy for minimizing the impact of harvesting operations on and around unstable slopes (Sidle, 1992; Sidle and Wu, 2001). Where applicable, the boundaries of limited harvest areas were positioned in a manner that would, in our professional opinion, mitigate and buffer against the anticipated changes in slope hydrology due to upslope land-use activities.

Because the slopes in the STZ portions of the plan area support fairly irregular stands of timber, harvesting levels on the slides in these areas will vary. In the areas where conifers are in limited numbers (less than the required basal area), we anticipate no harvesting operations will occur. In the denser conifer stands that support ample amounts of timber, the project forester estimates that 40% to 60% of the merchantable timber will be harvested. Although these activities will diminish local interception, evaporation, and transpiration rates, they should not significantly influence slope stability (that is, trigger landslides). The performance of recently managed slopes outside the THP suggests that a reduction in stand density and canopy coverage can occur without destabilizing the underlying hillside.

A percentage of the canopy coverage and root mass on slopes within the buffer areas is being provided by the hardwood, mid-story conifer, and the groundcover components of the stands proposed for entry under this harvest. This ground- and mid-level foliage at times makes up more than half of the total canopy within the partial cut zones and is perceived to be a contributor to root strength values in these areas. Decreasing the biomass in the special management areas by removing selected portions of the merchantable conifer element should not have a drastic impact on local or down-slope stability. The mid-story and understory foliage that remains following operations will continue to provide root strength, canopy, and evaporation and transpiration mechanisms. Even though these factors will experience a short-term decrease as a result of harvesting operations, it should not exacerbate the rate of landsliding on the areas of instability.

Studies in Casper Creek suggest that the removal of vegetation alone typically does not trigger new landslides or reactivate dormant features (Bawcom, 2003; Cafferata and Spittler, 1998) but that disturbances associated with ground-based operations and road building have a more significant impact. Because the yarding method proposed for most of the

slopes in and around the landslides does not require the construction of new roadways or skid trails, we expect minimal amounts of ground disturbance to occur in or around the mapped areas of instability under this harvest entry. Therefore, we do not anticipate that operations, as proposed, will alter overland flow patterns or substantially change existing mass-balance forces (resisting and driving) that could significantly decrease a slope's resistance to landslide processes.

We do not anticipate that the removal of timber from slides within the group-selection portions of the THP will have a significantly negative impact on local water quality as it relates to landslide process. The slope position of these failures and/or the configuration of hillsides adjoining them are not readily conducive to the delivery of debris to down slope watercourses. If post-operational landslides were to occur, debris would have to overrun local benches, steep pitches, unmanaged stands, and/or RMZs and STZs prior to entering a watercourse. There is no evidence that past activity at these sites resulted in the degradation of local watercourses. Therefore, considering the physical constraints of the individual sites, we conclude that even if upslope operations have a destabilizing effect on the slide area, the probability of future events contributing a significant volume of sediment to nearby watercourses is negligible.

Dormant-Mature or Older Landslide-Related Landforms

Hillslope processes associated with the dormant-mature or older landslide-related features we observed in the plan area do not appear to have been reactivated by past or recent land use activities (road building, harvest, and so on). Slopes associated with these dormant landforms have been subjected to intensive management practices both recently and in the historic past. During our field visit, we observed no evidence that suggests that these activities had an adverse effect on the stability of the landslide-related landforms. Most of the roads and skid trails observed in the proposed harvest units that date back to the initial harvest entries are generally in fair condition and have not experienced significant deformation by recent or historic ground movement. Watershed analysis also concluded that past clear cutting and road building activities did not significantly impact the stability of these large landforms.

RECOMMENDATIONS

- No group openings are allowed in STZs. After discussion with the project forester, it was determined it would be appropriate to retain a minimum of 120 sq. ft. of conifer basal area per acre.

CONCLUSIONS

Logging operations, as presently proposed under the McDoe THP, have a low probability of accelerating mass wasting activity within or adjacent to the plan area such that it will increase the delivery rate of landslide-derived sediment to local watercourses.

Single tree selection silviculture methods will be implemented on those slopes identified as being unstable and potential sources of sediment to downstream watercourses. The restrictive practices proposed on these slopes will result in the retention of a variably thick assemblage of conifers, hardwoods, and shrubs following the completion of operations. Timber remaining in the no-cut and partial-cut areas will continue to provide canopy coverage, root strength, and transpiration and interception mechanisms. Even though the stabilizing effects provided by canopy coverage and root strength will decrease as a result of harvest operations, the overall reduction should be minor and, in our professional opinion, have a low probability of increasing the rate of landslide-derived sediment to down slope watercourses. This plan appears to conform to the hill slope-management strategy that applies to HRC ownership under the prescription of the HCP. Impacts from sediment delivery are not anticipated to exceed offsetting sediment mitigation required under the terms of HRC's HCP.

Although intermediate harvest methods are proposed for all those unstable areas that could produce sediment delivering events, future failures cannot be prevented from occurring on these slopes. For example, debris-slide slopes and inner-gorge slopes are inherently prone to mass-wasting events; therefore, it is reasonable to assume that the dynamic hill slope process affiliated with these geomorphic features will continue regardless of whether management activities occur or not. It has been demonstrated that unseasonably high intensity/long-duration rainfall events or large magnitude earthquakes can trigger landslides in these types of geologic environments, whether the ground is forested or not. Consequently, restricting logging operations on these slopes does not preclude ground movement from occurring.

LIMITATIONS

The analyses, conclusions, and recommendations contained in this report are based on site conditions that we observed at the time of our investigation, our current understanding of the proposed project, and our experience with similar projects in similar geologic environments. We have assumed that the information obtained from our limited observation is representative of conditions throughout the proposed plan are. If differing conditions are encountered during operations, our department should be notified immediately so that we can reevaluate the applicability of our conclusions and recommendations. Such an evaluation may result in reconsidered and/or amended

recommendations. If proposed harvest unit locations and intended uses change from those described in this report, our recommendations should also be reviewed.

In addition, because the project area is located in a dynamic environment that is subject to large scale, catastrophic events (great earthquakes, large storms, etc.), we cannot preclude changes that may occur in the future that could alter site conditions. Consequently, we reserve the right to make such adjustments to our report that may be required by passage of time, change in condition, or in the consideration of additional or more pertinent data that may become available in the future.

Figures contained within this report are for illustrative proposes only and the location of the landslides and their dimensions are approximate. Any differences that may be noted in dimensions, locations, etc., are not likely to affect the conclusions contained within this report significantly.

The Physical Science Department has prepared this report for your exclusive use on this project in substantial accordance with the generally accepted practice as it exists in the site area at the time of our study, including time and budget constraints. No warranty is expressed or implied.

Lastly, this report applies only to the sites described above. Because of the high degree of variability in geology in this region, it is not possible to extrapolate the results described herein to any other site. This report is to be considered in its entirety. No part, section, paragraph, sentence, or phrase is to be quoted, evaluated, or otherwise used without considering its context and relationship to the entire report.

ATTACHED FIGURES

Figure 1: Location Map
Figure 2a : CGS Geology and Geomorphic Features Related to Landsliding
Figure 2b: Key to CGS Geology and Geomorphic Features Related to Landsliding
Figure 3: SHALSTAB Map
Figure 4: Unit 1: Areas of Concern Map
Figure 5: Unit 2: Areas of Concern Map
Figure 6: Units 4 and 5: Areas of Concern Map
Figure 7: Units 7 and 8: Areas of Concern Map
Figure 8: Units 7 and 8: Areas of Concern Map
Figure 9: Harvest Restrictions Map (STZs)

Appendix A: Areas of Concern Characteristics

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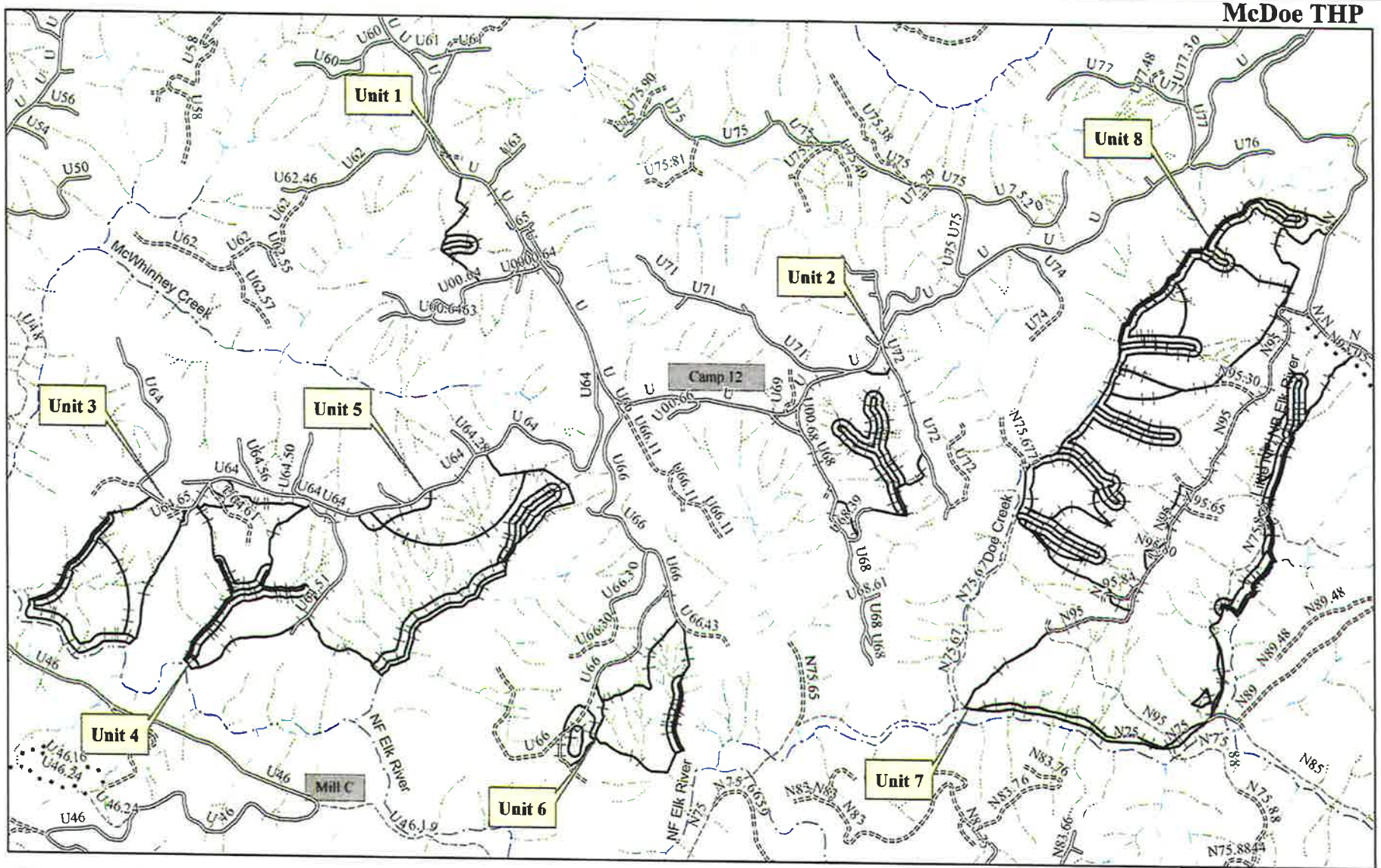
FIGURES

1 THROUGH 9



HRC Physical Science Dept.	N	Feet	**Figure 1**
Drawn by: sbeach		1,500 750 0 1,500	**Location Map**
Date: 3/17/2014			

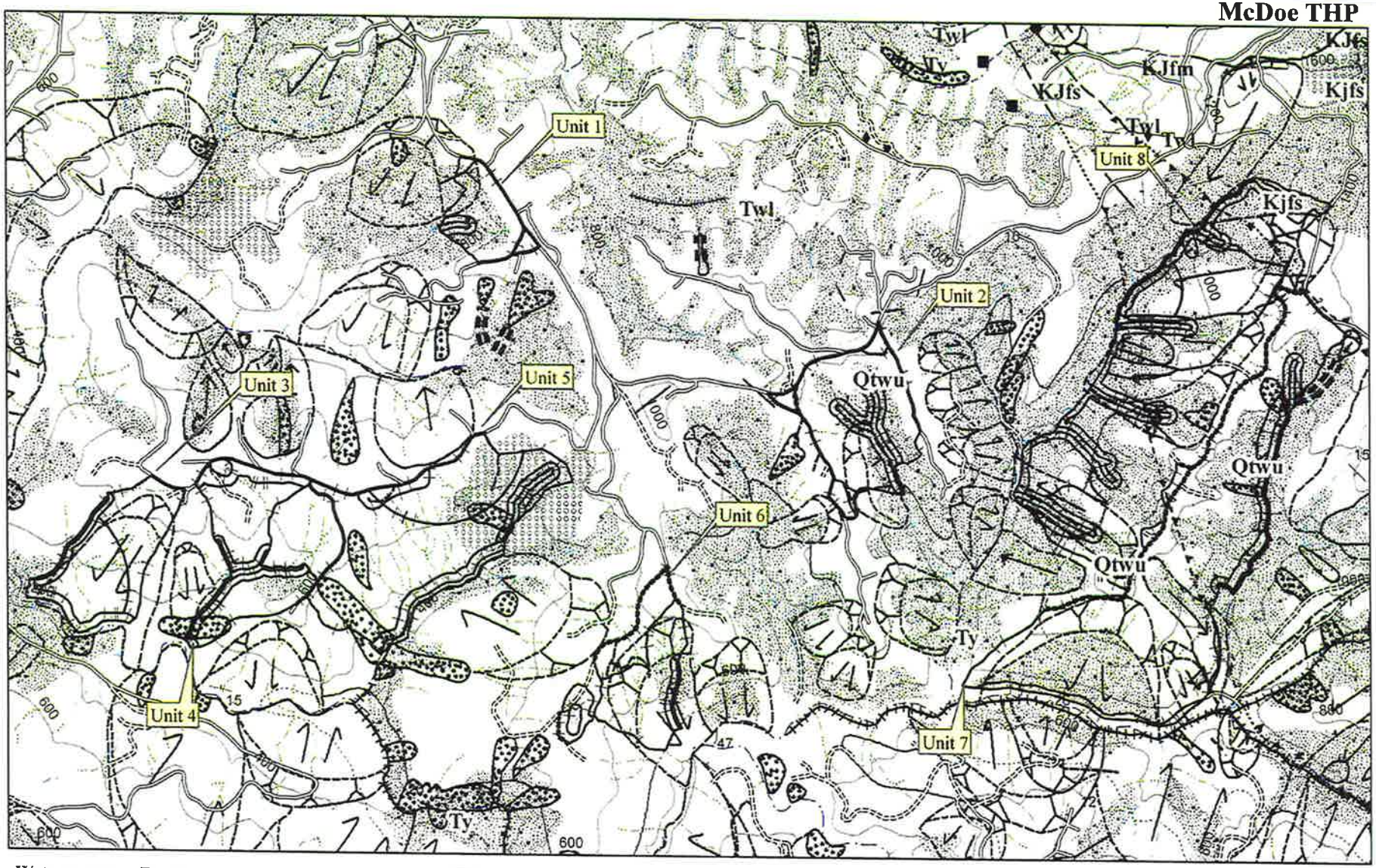
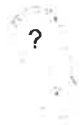


Figure 2a: Geologic and Geomorphic Features Related to Landsliding

Path: S:\SCOPAC\Geology\3-OutputsGeo\THP Reports Final\2013\McDoe\CGS Marshall_Mendes_Map_KEY_(b&w Print).mxd

Mass-Wasting Features

Rock slide: Slope movement with bedrock as its primary source material. This class of failure includes rotational and translational landslides; relatively cohesive slide masses with failure planes that are deep-seated in comparison to those debris slides of similar areal extent. The slide plane is curved in a rotational slide. Movement along a planar joint or bedding surface may be referred to as translational. Complex versions with combinations of rotational heads and translational movement or earthflows downslope are common. Y Indicates a scarp; arrows show direction of movement; queried where the presence of the slide is uncertain; boundary is solid where active, dashed where dormant.



Earthflow: Slow to rapid movement of mostly fine-grained soil with some rocky debris in a semi-viscous, highly plastic state. After initial failure, the mass may flow or creep seasonally in response to changes in groundwater level. These types of slope failures often include complexes of nested rotational slides and deeply incised gullies; boundaries are usually indistinct. Indicates a scarp; arrow indicates direction of movement; queried where the presence of the slide is uncertain.

Debris slide: Mass of unconsolidated rock, colluvium, and coarse-grained soil that has moved slowly to rapidly downslope along a relatively steep, shallow, translational failure plane. Debris slides form steep, unvegetated scars in the head region and possibly irregular, hummocky deposits in the toe region. Scars commonly ravel and remain unvegetated for several seasons depending on slope aspect.

Debris slide slope/source area: A geomorphic feature characterized by steep, usually well vegetated slopes that appear to have been sculpted by numerous debris slides and debris flows. Upper reaches (source areas) of these slopes are often tightly concave and very steep. Soil and colluvium atop bedrock may be disrupted by active debris slides and debris flows. Slopes near the angle of repose may be relatively stable except where weak bedding planes, bedrock joints and fractures parallel the slope.

Debris flow/torrent track: Long stretches of bare ground that have been scoured and eroded to bedrock by extremely rapid movement of water-laden debris. Debris flows are commonly triggered by debris sliding in the source area during high intensity rains. Debris is often deposited downslope as a tangled mass of organic material in a matrix of rock and soil; debris may be reworked and incorporated into subsequent events; lack of vegetation indicates recent activity.

Inner Gorge: A geomorphic feature consisting of steep slopes adjacent to channels. The gorge typically is created by accelerated downcutting in response to regional uplift. It is defined as an area of stream bank between the channel and the first break in slope.

Disrupted Ground: Irregular ground surface that may be caused by complex landsliding processes resulting in features that are indistinguishable or that may be too small to delineate individually at 1:24,000; also may include areas affected by downslope creep, expansive soils, and/or gully erosion; boundaries are usually indistinct.

Geologic Symbols

- Strike and Dip of Bedding
- Quarry
- contact, approx. located, concealed
- contact, approx. located
- anticline, certain
- anticline, approx. located
- anticline, approx. located, concealed
- fault, certain
- fault, approx. located
- thrust fault, approx. located
- thrust fault, concealed
- thrust fault, concealed, queried
- thrust fault, inferred
- map boundary

Topographic Symbols

- Class 1 Watercourse
- Class 2 Watercourse
- Class 3 Watercourse
- US Geological Survey 40-foot Topographic Contours

Geologic Units

Qtwu (Included in Qtw of McLaughlin and others, 2000) Marine and non-marine sedimentary rocks of the Wildcat Group. Typically consists of poorly to moderately consolidated siltstone and fine-grained silty sandstone with some lenses of pebble conglomerate. These deposits are moderately susceptible to deep-seated landsliding, with rotational displacements in massive units and translation along planar weaknesses such as bedding planes, joints and fractures.

Ty (y1 of McLaughlin and others, 2000) Yager terrane of the Franciscan Complex Coastal Belt. In the Elk River Watershed it typically consists of well-indurated and highly folded arkosic sandstone and argillite. The sandstone is typically very strong and often forms cliffs. The argillite is prone to slaking, and deep weathering and is often very sheared. Slopes underlain by this material are often irregular and lack well developed sidehill drainages. The slaking, shearing and deep weathering results in deep-seated flow type failures on moderate slopes.

Timber Harvest Symbols

Harvest Unit Boundaries

(Reproduced from Marshall and Mendes, 2005)

HRC Physical Sciences Depart.	**McDoe THP**	**Figure**
Drawn by: sbeach	Explanation to	**2b**
Date: Mar. 2014	Geologic Features Related to Landsliding	

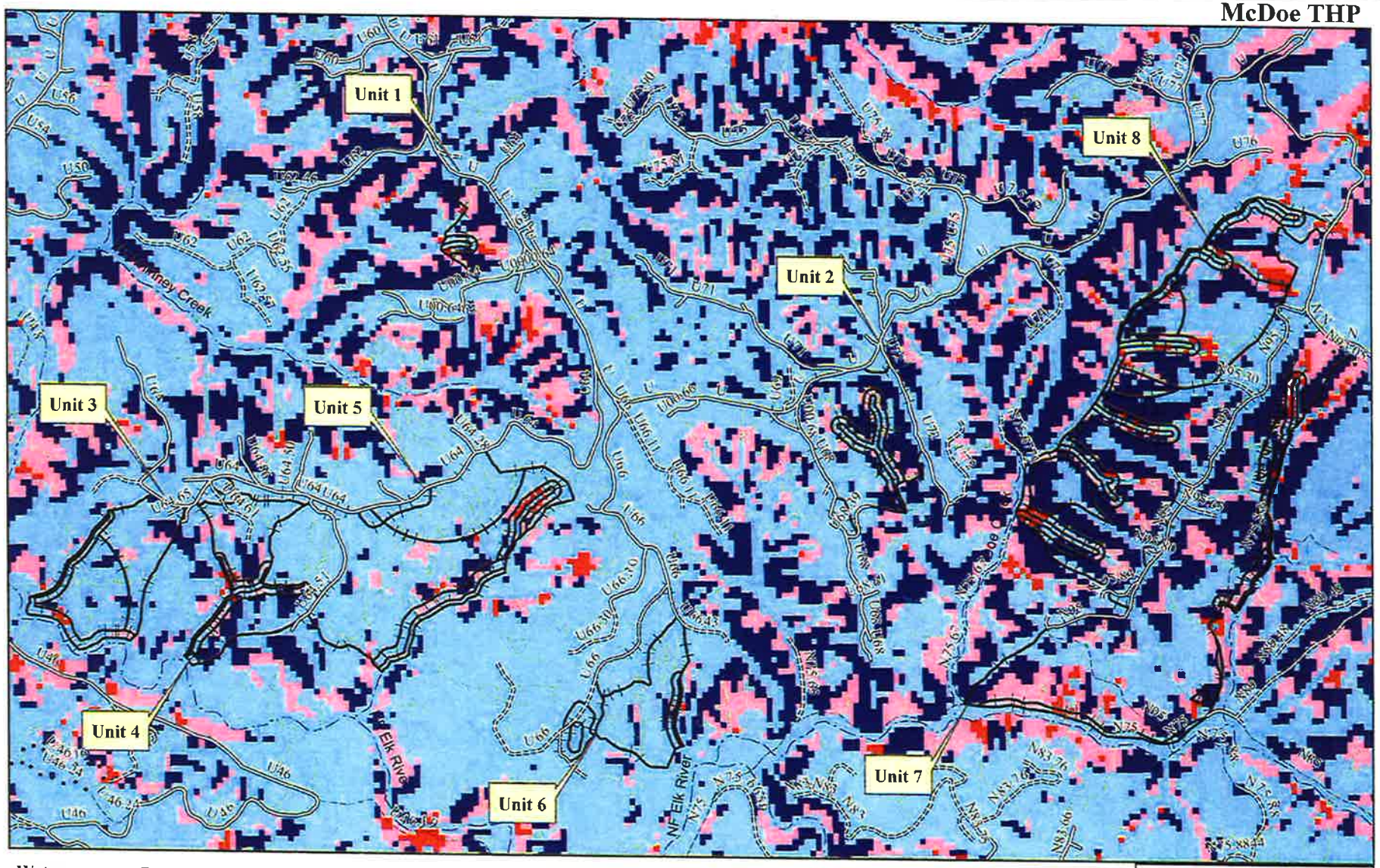
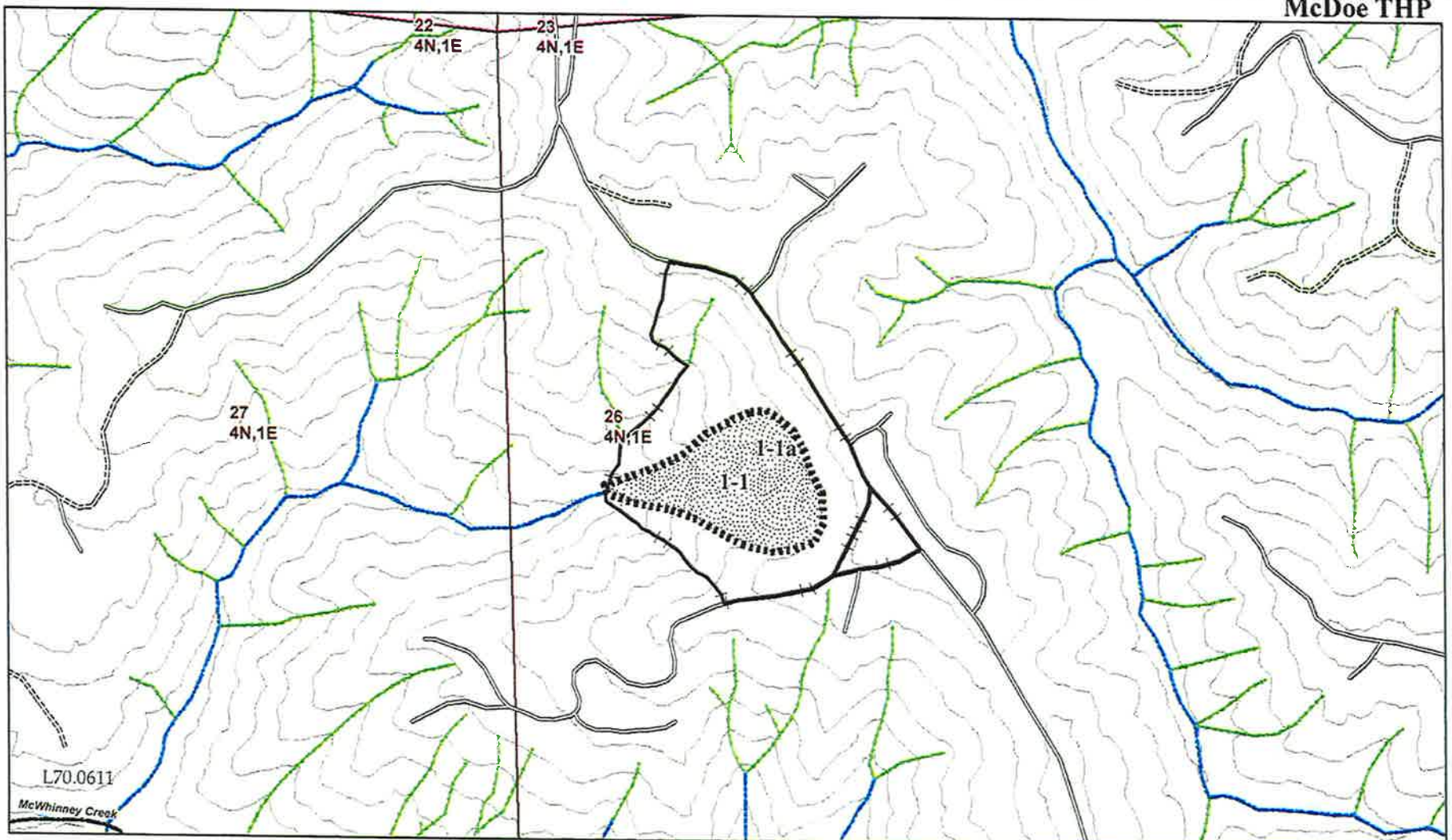


Figure 3: SHALSTAB Map



Watercourses
- Class 1
- Class 2
- Class 3

Roads
- Paved Roads
- Rocked Roads
- Dirt Roads
- Proposed Roads
- Reconstruction

Mass Wasting
- Earthflow (Dormant-Historic or Younger)
- Trans/ Rotationail (Dormant-Historic or Younger)
- Trans/ Rotationail (Dormant-Young or Older)
- Debris Slide Slope (Dormant-Historic or Older)
- Debris Slide (Dormant-Historic or Younger)
- Debris Slide (Dormant-Young or Older)
- Debris Slide Slope (Dormant-Historic or Older)

THP Boundary
- Unit Limits

Refer to Appendix A for Individual Landslide age and Attributes

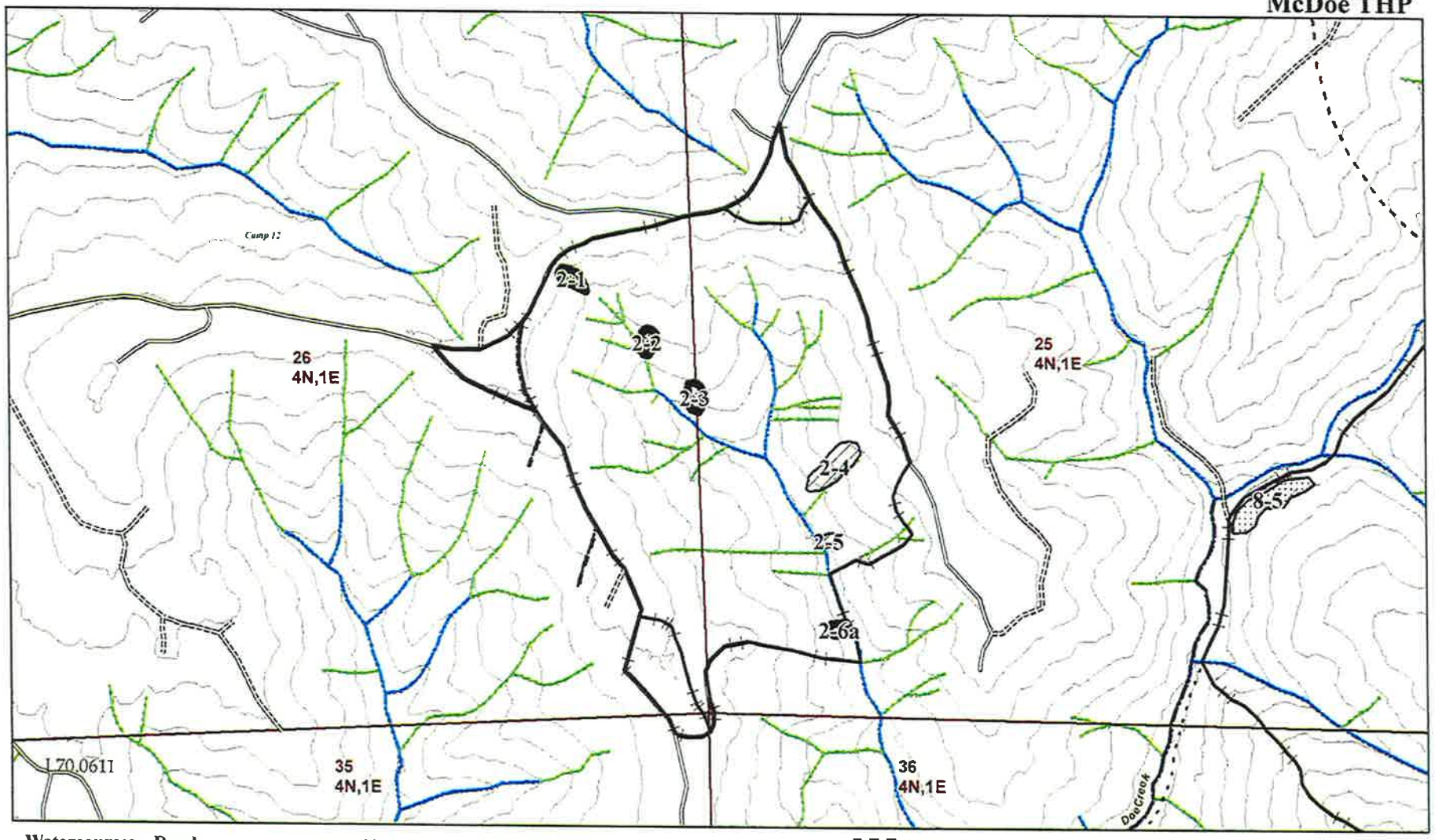
HRC 10 foot LiDAR Contours

HRC Physical Science Dept.	
Drawn by:	**sbeach**
Date:	**3/17/2014**

N

Feet
500 250 0 500

Figure 4
Unit 1: Areas of Concern Map



Refer to Appendix A for Individual Landslide age and Attributes

HRC 10 foot LiDAR Contours

HRC Physical Science Dept.	
Drawn by: sbeach	
Date: 3/17/2014	

N

Feet

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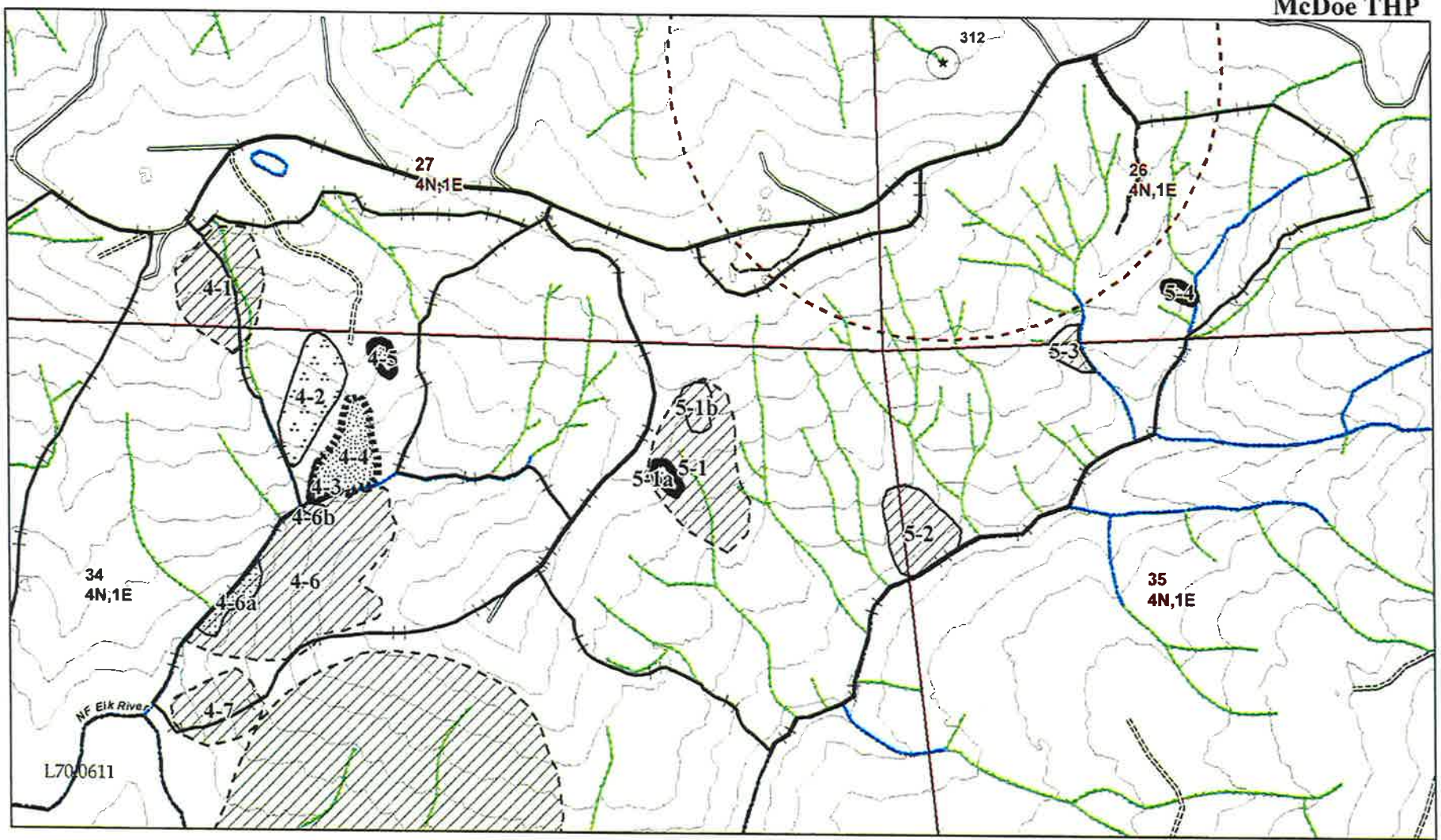
Figure 5
Unit 2: Areas of Concern Map



Refer to Appendix A for Individual Landslide age and Attributes

HRC 10 foot LiDAR Contours

HRC Physical Science Dept.	
Drawn by: sbeach	
Date: 3/17/2014	

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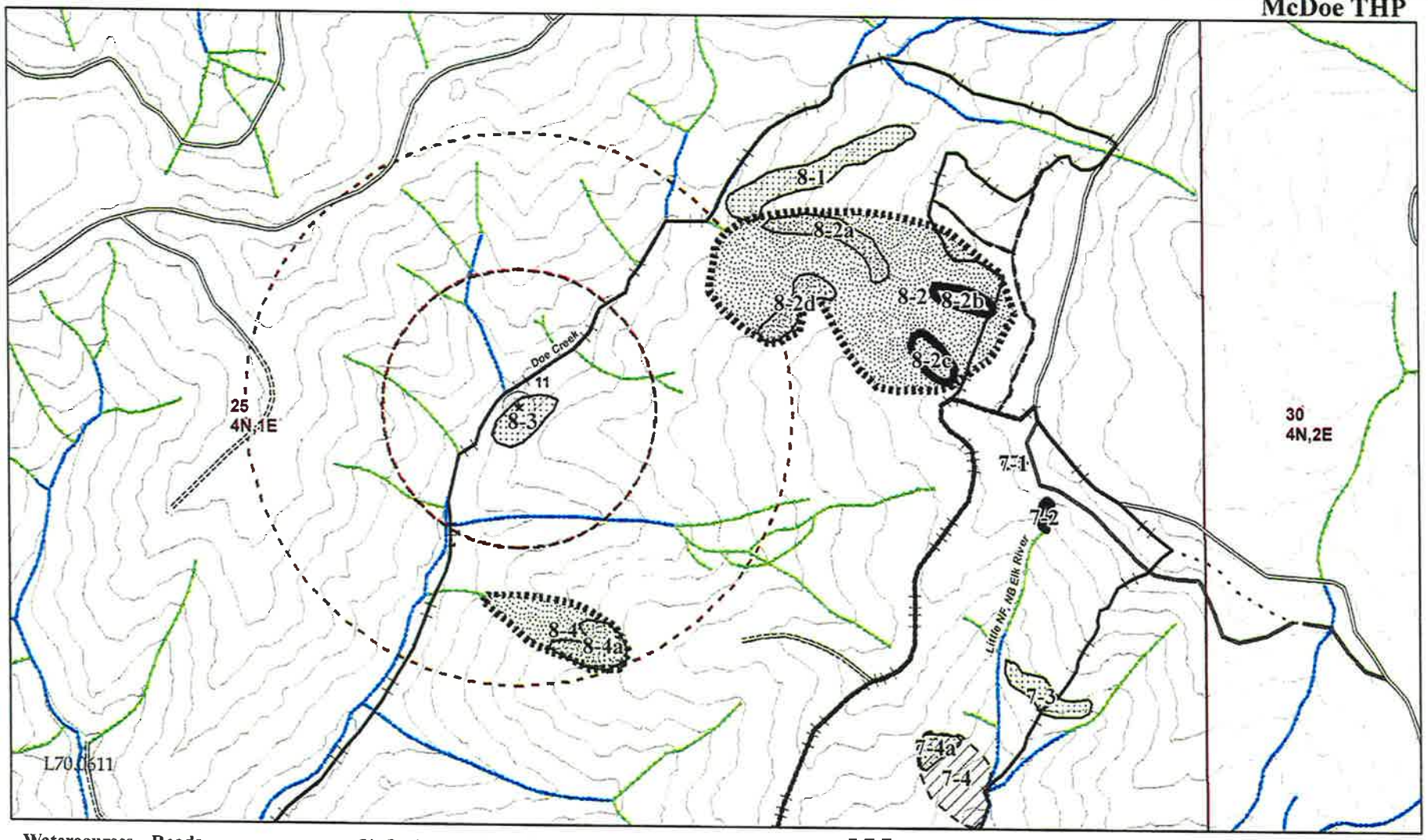
Figure 6
Units 4 and 5: Areas of Concern Map



Watercourses
- Class 1
- Class 2
- Class 3

Roads
- Paved Roads
- Rocked Roads
- Dirt Roads
- Proposed Roads
- Reconstruction

Mass Wasting
- Earthflow (Dormant-Historic or Younger)
- Trans/ Rotationail (Dormant-Historic or Younger)
- Trans/ Rotationail (Dormant-Young or Older)
- Debris Slide Slope (Dormant-Historic or Older)
- Debris Slide (Dormant-Historic or Younger)
- Debris Slide (Dormant-Young or Older)
- Debris Slide Slope (Dormant-Historic or Older)

THP Boundary
- Unit Limits

Refer to Appendix A for Individual Landslide age and Attributes

HRC 10 foot LiDAR Contours

HRC Physical Science Dept.	
Drawn by: sbeach	
Date: 3/17/2014	

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Feet
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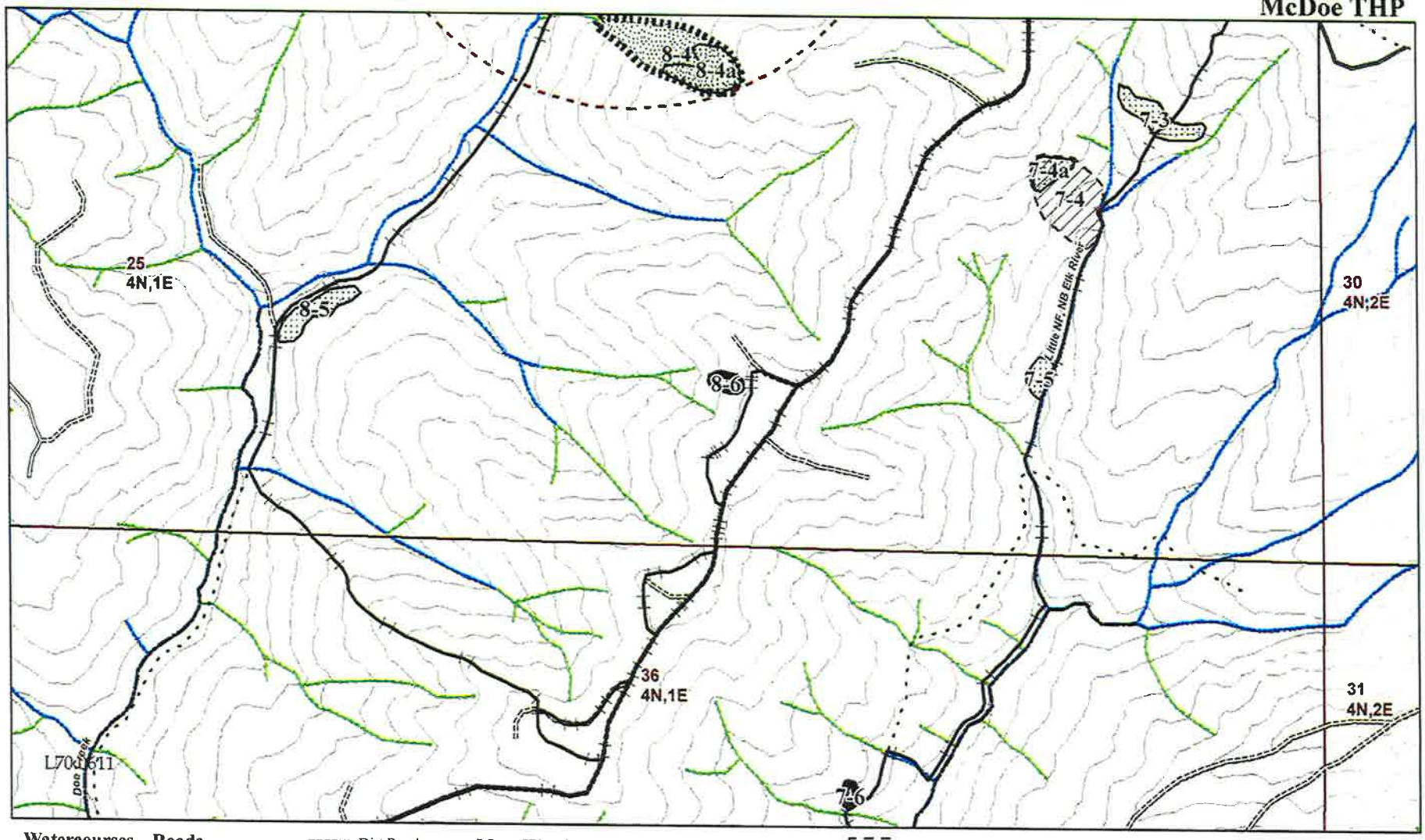
Figure 7
Units 7 and 8: Areas of Concern Map



Refer to Appendix A for Individual Landslide age and Attributes

HRC 10 foot LiDAR Contours

HRC Physical Science Dept.	
Drawn by: sbeach	
Date: 3/17/2014	

N

Feet

500 250 0 500

Figure 8
Units 7 and 8: Areas of Concern Map

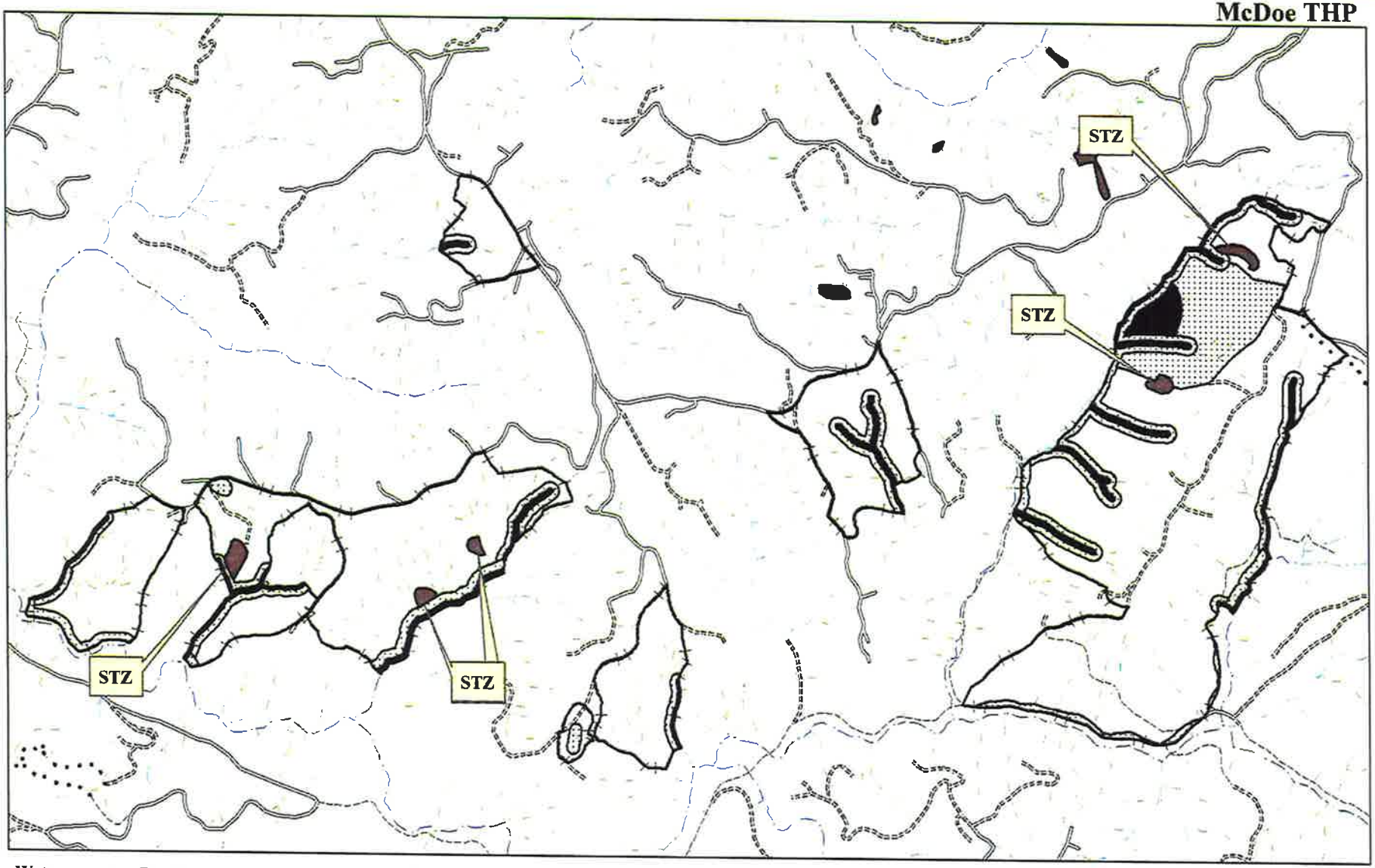


Figure 9: Harvest Restrictions Map

APPENDIX A

LANDSLIDE ATTRIBUTE TABLE

Areas of Concern Characteristics
McDoe THP

ID #	Landslide type	Age	Dimensions (W x L x D) (ft.)	Depletion/ Accumulation Zone Characteristics	Del.	Proposed Silviculture	Comments	Rec.
1-1	debris slide	dormant-mature to dormant-old	390 x 725 x 10	muted LS morphology, straight old growth (OG) stumps and straight 2nd growth (~70 yrs old)	no	group selection	previously mapped for McWhinney 4 THP (02-111), mapped outside McWhinney 4 units and not characterized	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
1-1a	translational/ rotational	dormant-historic	90 x 150 x 5	slump block with 3-5 foot tall head scarp and lateral margins, straight trees and OG stumps, no deformation at toe	no	group selection	previously mapped for McWhinney 4 THP (02-111), foresters mark looks appropriate (>120 sq ft BA retention)	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
1-2	inner gorge	dormant-young to dormant-old	500+ x 75 x 3	densely vegetated slopes leading towards sub-vertical stream banks 5-20 feet tall	no	Class II RMZ no cut	previously mapped for McWhinney 4 THP (02-111), activity status classified as "N/A"	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
2-1	debris slide (embankment failure)	dormant-historic	50 x 100 x 5	densely vegetated with brush, near vertical head scarp, deposit on gently inclined bench	no	group selection	no merchantable trees on slide	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
2-2	debris slide	dormant-historic	50 x 90 x 4	moderately stocked with merchantable timber on body, may have been impacted from down hill steam logging	yes	group selection	numerous "L" trees marked for retention around perimeter and on body	"L" tree retention marked by geologist
2-3	debris slide	dormant-historic	60 x 100 x 4	few merchantable trees on body, perimeter densely stocked, bulk of deposit on slope adjacent Class II watercourse	potentially	expanded Class II RMZ protection	few trees marked in vicinity, mark looks appropriate	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
2-4	translational/rotational	dormant-historic	100 x 245 x 7	rotated OG stumps, straight growing 2nd growth, CIII watercourse has down cut through left lateral margin	yes	group selection	based on age of straight growing timber (~70 yrs old) and CIII down cutting through feature, slide appears unlikely to reactivate	slide marked for harvest by geologist, numerous "L" trees retained, no group opening will occur at this location
2-5	translational/rotational	dormant-historic	40 x 80 x 5	vertical head scarp, majority of deposit appears eroded away	yes	Class II RMZ protection	one small fir tree is growing on body, no trees marked for harvest	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
2-6	translational/rotational	dormant-mature to dormant-old	685 x 475 x 10	not able to identify lateral extents or head scarp	no	group selection	previously mapped by CGS for Elk 218 PHI (02-090)	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
2-6a	debris slide	dormant-historic	40 x 70 x 4	vegetated with brush and slash, few merchantable trees on slide	potentially	Class II RMZ protection	few trees marked in vicinity, mark looks appropriate	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses

Areas of Concern Characteristics
McDoe THP

ID #	Landslide type	Age	Dimensions (W x L x D) (ft.)	Depletion/ Accumulation Zone Characteristics	Del.	Proposed Silviculture	Comments	Rec.
4-1	translational/rotational	dormant-mature to dormant-old	315 x 415 x 10	densely covered in brush and understory, slide morphology highly muted	no	group selection	previously mapped by CGS for Mill C THP (98-038), shelter wood removal harvest in 1988 under THP 96-547	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
4-2	earth flow	active-suspended to dormant-historic	180 x 400 x 5	rotated stumps with swept and leaning second growth, bulk of deposit on slope adjacent watercourse	potentially	Special Treatment Zone	head scarp previously mapped outside unit for Mill C THP (98-038)	no group openings shall be placed on feature and no yarding corridors shall extend through feature, retain 120 sq ft BA per acre post harvest
4-3	debris slide	dormant-historic	100 x 135 x 4	open brushy slope, grass covered head scarp	yes	Class II RMZ protection	stream bank deposits mapped at this location for Mill C THP (98-038)	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
4-4	debris slide	dormant-mature to dormant-old	140 x 325 x 8	subdued landslide morphology, in situ OG stumps and straight growing second growth	no	group selection	slope displays topographic expression of dormant landslide	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
4-5	debris slide (embankment failure)	dormant-historic	60 x 115 x 5	appears to have initiated from landing fill, no trees on slide	no	group selection	very low potential for delivery based on low gradient slopes in deposit zone and distance to watercourse	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
4-6	translational/rotational	dormant-mature to dormant-old	660 x 550 x 10	did not observe landslide morphology throughout majority of mapped feature	no	group selection	previously described as "relatively stable for long periods of time as evidenced by mature conifers ..." (CGS, 1998)	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
4-6a	debris slide slope	dormant-historic	300 x 100 x 5	potentially unstable streamside slopes with evidence of downhill steam yarding disturbance	yes	Class II RMZ protection	previously mapped for the Mill C THP (98-038)	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
4-6b	translational/rotational	dormant-historic	40 x 70 x 6	streamside slump, no merchantable timber on slide	yes	Class II RMZ protection	deposit from LS 4-3 may have deflected flow towards LS 4-6b and triggered failure	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
4-7	debris slide	dormant-mature to dormant-old	225 x 350 x 8	well stocked with merchantable conifer and in situ OG stumps	no	group selection	previously described as "relatively stable for long periods of time as evidenced by mature conifers ..." (CGS, 1998)	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
5-1	translational/rotational	dormant-mature to dormant-old	340 x 520 x 10	rounded lateral margins and head scarp with subtle hummocky morphology on body	no	group selection	in situ OG stumps and straight growing second growth	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses

Areas of Concern Characteristics
McDoe THP

ID #	Landslide type	Age	Dimensions (W x L x D) (ft.)	Depletion/ Accumulation Zone Characteristics	Del.	Proposed Silviculture	Comments	Rec.
5-1a	debris slide (embankment failure)	dormant-historic	60 x 130 x 5	densely covered in brush and grasses, no merchantable timber on slide	potentially	group selection	this portion of LS 5-1 was thinned with helicopter yarding in 1999 under Mill C THP (98-038)	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
5-1b	translational/rotational	dormant-historic	100 x 175 x 7	rotated OG stumps with swept and leaning second growth, deposit back fills large stump and fairy ring	no	group selection	previous landslide mapping in near vicinity from Mill C THP (98-038) is potentially same feature	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
5-2	translational/rotational	dormant-historic	230 x 310 x 10	straight second growth with rotated OG stumps	yes	Special Treatment Zone	distinct head scarp and step-riser morphology, straight 2nd growth ~60 to 70 yrs old	no group openings, retain 120 sq ft BA post harvest
5-3	translational/rotational	dormant-historic	150 x 105 x 8	straight second growth with rotated OG stumps	yes	Special Treatment Zone	similar morphology to LS 5-2 but smaller	no group openings, retain 120 sq ft BA post harvest
5-4	debris slide	dormant-historic	50 x 100 x 5	young 2nd growth timber	yes	Class II RMZ protection	very light mark within and adjacent landslide	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
7-1	translational/rotational (embankment failure)	dormant-historic	40 x 80 x 6	brush covered fill slump, no merchantable on slide	no	group selection	low gradient slopes down slope of slumped fill	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
7-2	debris slide (embankment failure)	dormant-historic	40 x 100 x 5	vegetated with pampas grass and brush, no merchantable, deposit adjacent to Class III watercourse	potentially	group selection	no merchantable trees to be harvest	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
7-3	debris slide slope	dormant-historic	330 x 75 x 5	shallow failures on steep slopes compromised by skid trails	potentially	mostly within Class II RMZ protection	where outside RMZ low delivery potential due to low gradient down slope of failures	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
7-4	translational/rotational	dormant-mature to dormant-old	240 x 350 x 8	subdued landslide characteristics, step-riser morphology indicates topographic expression of dormant landslide	no	group selection	numerous in situ OG stumps on body of slide	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
7-4b	debris slide slope	dormant-historic	110 x 100 x 4	shallow failures initiating from dormant head scarp, significant percentage of tan oak in vicinity	no	group selection	low potential for delivery based on distance to watercourse and slope gradient	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses

Areas of Concern Characteristics
McDoe THP

ID #	Landslide type	Age	Dimensions (W x L x D) (ft.)	Depletion/ Accumulation Zone Characteristics	Del.	Proposed Silviculture	Comments	Rec.
7-5	debris slide slope	dormant-historic	125 x 80 x 5	young second growth timber	yes	Class II RMZ protection	no trees marked for harvest within landform	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
7-6	debris slide	dormant-historic	45 x 75 x 5	initiated in cut slope of old haul road	no	group selection	majority of deposit has been removed or re-graded, road has been decommissioned and slash packed	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
8-1	debris slide slope	active-suspended to dormant-historic	730 x 130 x 4	series of slope failures along consistent trend line could be fault related, McLaughlin (2000) maps thrust fault in near vicinity	potentially	group selection	portion of DSS with highest potential for delivery is within Class II RMZ protection	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
8-2	debris slide	dormant-young	530 x 1000 x 12	numerous insitu OG stumps and straight growing 2nd growth, evidence of slope disturbance from downhill yarding	no	group selection	previously mapped for Little Doe THP (00-370)	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
8-2a	debris slide slope	dormant-historic	530 x 70 x 6	series of swales lead to hummocky bench, swales are void of OG stumps with straight growing 2nd growth	potentially	Special Treatment Zone	slope stability possibly impacted by faulting and/ or downhill yarding	no group openings, retain 120 sq ft BA per acre post harvest
8-2b	debris slide	dormant-historic	60 x 220 x 6	no field notes	no	group selection	previously mapped for Little Doe THP (00-370)	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
8-2c	debris slide	dormant-historic	90 x 200 x 6	steep, brushy source area, deposit zone contains several rotated OG stumps, majority of deposit remains on slope	yes	Special Treatment Zone	position and orientation of rotated OG stumps is not typical, abnormally large amount of saw cut LWD within LS 8-2, could be yarding disturbance from initial entry	no group openings, retain 120 sq ft BA per acre post harvest
8-2d	debris slide slope	dormant-historic	300 x 80 x 5	historically active debris slides initiating from larger, dormant head scarp	potentially	Special Treatment Zone	distinct landslide morphology, sharp, near-vertical scarps	no group openings, retain 120 sq ft BA per acre post harvest
8-3	debris slide slope	dormant-historic	230 x 130 x 4	forested	yes	group selection	65% slopes leading towards Class II, no recent landslides observed	none, proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
8-4	debris slide	dormant-mature to dormant-old	190 x 550 x 10	forested	no	group selection	topographic expression of dormant landslide	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
8-4a	debris slide slope	dormant-historic	140 x 120 x 5	small debris slides initiating from skid trails, brush, slash and conifer from 10- 16" DBH	yes	Special Treatment Zone	Class III watercourse extends into landform	no group openings, retain 120 sq ft BA per acre post harvest

Areas of Concern Characteristics
McDoe THP

ID #	Landslide type	Age	Dimensions (W x L x D) (ft.)	Depletion/ Accumulation Zone Characteristics	Del.	Proposed Silviculture	Comments	Rec.
8-5	debris slide slope	dormant-historic	375 x 70 x 4	vegetated with brush and scattered 2nd growth, numerous skid trails in near vicinity	yes	expanded Class II RMZ protection	few trees marked for harvest on landform	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses
8-6	debris slide	dormant-historic	50 x 100 x 5	cut slope failure initiated from skid trail	no	group selection	slope gradient ~ 45%	none; proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses

Humboldt Redwood™

Professional Certification of Design

I Shane M. Beach , P.G. 7396 , September 10, 2014
Name License # Date

Signature

hereby certify, in accordance with North Coast Regional Water Quality Control Board (NCRWQCB) Order Nos. R1-2006-0039 and R1-2006-0041, that the attached application and the description of THP modifications, and the materials submitted along with:

THP No. 1-14-039HUM (McDoe) Unit # 1 through 8

a. are in accordance with accepted practices, and recognized professional standards;

b. comply with the requirements of the Monitoring and Reporting Program No. R1-2008-0071, approved by the Executive Officer of the North Coast Regional Water Quality Control Board; and

c. provided that the THP is properly implemented, operated, and maintained, are adequate for the THP to meet the applicable Zero Net Delivery performance standards of NCRWQCB Orders R1-2006-0039, R1-2006-0041, and R1-2008-0100, insofar as such performance can reasonably be predicted by accepted engineering geologic practices.

The opinions presented in the subject THP have been developed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable engineering geologists practicing in this or similar localities. No other warranty, expressed or implied, is made as to the professional advice included in this report.

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THP Unit Review for Tier 2 Enrollment

MCDOE
THP 1-14-039 HUM
UNITS 1 THROUGH 8

Tools Used in This Assessment	Figure Number*
Elevation Map with 10 ft Contours (Humboldt Redwood Company [HRC] LiDAR*)	1
SHALSTAB / Slope Class / Hillshade Maps (Montgomery and Dietrich, 1994; Palco, 2006)	2
California Geologic Survey (CGS) Geology and Geomorphic Features (Marshall and Mendes, 2005)	3
Mass Wasting Potential Map (HRC, 1999)	4
Aerial Photo Map (HRC, 2007)	5
Elk River and Salmon Creek WA deep-seated LS inventory Map (HartCrowser, 2000)	6
Road Condition Map	7

*Refer to back of enrollment package for referenced Figures.

SUMMARY OF CHANGES TO THP PRESCRIPTIONS BASED ON TIER 2 ANALYSIS

Units 1 through 8

Geologic Review Units 1 through 8	Forestry Silviculture/Site Prep Plan Units 1 through 11	Operational Design Plan Units 1 through 11
Site Specific ➢ HRC (2014) ➢ CGS (2014) Prior Regional Investigations ➢ Huber (1998) ➢ SGD (2001); (2005a); (2005b) ➢ BGC (2002) ➢ SHN (2000); (2001)	➢ Silviculture practices/ site preparation activities identified in the approved THP have been not modified. ➢ Variable Retention (dispersed), group selection, and single tree selection are the approved silviculture practices.	➢ Yarding methods in the approved THP have not been adjusted or modified. ➢ Ground-based and cable yarding techniques are the approved methods for timber removal.

EXECUTIVE SUMMARY

Units 1 through 8

General

This THP covers approximately 537 acres within the North Fork Elk River (NFER) watershed between McWhinney Creek and the Little North Fork of the North Branch of Elk River (LNFNBER) (Figure 1). Unit 1 is located in the headwaters of McWhinney Creek, while harvest units 3, 4, 5 and 6 occupy unnamed basins along the northern valley wall of the NFER. Units 7 and 8 are positioned along the flanks of the hydrologic divide that separates Doe Creek from the LNFNBER. Unit 2 encompasses slopes at the headwaters of an unnamed tributary to Doe Creek. A number of unnamed, high order Class II streams and associated tributaries (low order Class II and III watercourses) are present within the plan area.

The upland areas of the plan are characterized by broad, well-rounded ridges, with moderate to steep (30% and greater) flanks. Typically, the upland slopes retain convex to semi-planar profiles and in some instances have developed into low gradient (5% to 20%) topographic benches. As upland areas approach the valley floors, they develop steeper orientations and a more planar-like profile. Slopes along Class I and higher order Class II watercourses often have a very steep orientation (55% to near vertical). This inner valley terrain extends between 50 and 150 feet upslope of the adjoining stream bank edge.

Geology

The project area is principally underlain by Tertiary to Quaternary aged Undifferentiated Wildcat Group sediments. No active faults are mapped passing through or within 7 miles of the project area. The very northern tip of Unit 7 does overlap a mapped trace of the Freshwater fault zone. This particular fault zone is not considered active by the State of California, but does place Cretaceous to Jurassic aged Central belt meta-sedimentary rocks into contact with Undifferentiated Wildcat Group sediments.

Evaluation

A geologic evaluation was conducted for the THP using guidelines established under Note 50 (CGS, 1997), Note 45 (CGS, 1999), and Tier 2 enrollment. To evaluate slope stability in the plan area the project geologist used high-resolution, 10-foot LIDAR contour map, SHALSTAB model results, historical aerial photographs, Mass Wasting Potential (MWP) maps, the Geologic and Geomorphic Features Related to Landsliding map of Elk River (Marshall and Mendes, 2005), on-site investigations, and THP Operational maps with unit boundaries, creeks, and roads. A discussion of the findings, conclusions, and recommendations associated with this assessment is contained in a geologic report that is attached to Section 5 of the THP titled *'Engineering Geologic Evaluation of the McDoe THP, Humboldt Co., California'*.

This is a public document and can be found at ftp://thp.fire.ca.gov/THPLibrary/North_Coast_Region/THPs2014.

In general, the stability of slopes within the proposed plan area was not significantly impacted by past land use activities (ground based operations, rail road logging, clear cut, partial cut, and site preparation). Only 30 areas of recent/historic instability were observed within this 537-acre plan. There is no indication that past land use operations significantly altered the mass balance of the managed slopes such that it resulted in the renewal or activation of a large number of mass wasting events. The project area, overall, is characterized by very low levels of mass wasting activity.

A set of 1:6000 scaled maps are attached to the geologic report that show the position of the identified unstable area as they relate to roads, watercourses, and timber harvest boundaries (HRC, 2014; Figures 4 through 8). Ground movement in the plan area is dominated by hillslope processes affiliated with translational and rotational failure mechanisms and is concentrated along the inner valley slopes of the more deeply entrenched Class I and II watercourses. Detailed characterizations of the slide areas and justification for operations on and around them are provided in the geologic report attached to Section 5.

The THP pre-harvest investigation (PHI) was attended by staff from several state agencies. PHI reports found the THP was compliant with the California Forest Practice Rules and HCP prescriptions (HRC, 2005) with respect to disclosure of all known unstable areas. CGS (2014) concluded that areas of concern had been appropriately mitigated through avoidance and reduced levels of harvest. This PHI report, as well as the other state agency reports is available for review at the above listed website.

HILLSLOPE SENSITIVITY

Units 1 through 8

Geomorphic Mapping

Intermixed with and underlying many of the active and dormant-historic slides on Figures 4 through 8 of the geologic report (HRC, 2014) are large to moderate-sized, geomorphic features identified during previous investigations (HartCrowser, 2000; Marshall and Mendes, 2005)as being a potential by-product of landslide activity (Figures 3 and 6). These geomorphic features are intermittently dispersed across the slopes occupied by this THP. Many of these landforms are multi-acre in size and extend from ridge crest to valley floor.

Examination of the slopes encompassed by these previously mapped landforms revealed a general absence of slope morphology directly attributable to historic landslide processes. Although at times steep, a majority of the slopes enveloped by these landforms were void of landslide characteristics that would imply that they have been subject to wide spread or localized landslide activity in the recent past. The stability of slopes within these landslide-related landforms (debris slide slopes, translational/rotational landslides, etc) do not appear to have been adversely impacted by past land use activities. The geologic report noted that there was no evidence of post-harvest adjustment associated with these features and that there was an

absence of morphology relating to recent or historic movement in these areas. Those slopes (landforms) that exhibited evidence of having a negative response to past management activities or are prone to landslide processes are identified on Figures 4 through 8 of the geologic report.

SHALSTAB

Limited areas within the THP were assigned an "Extreme" (1) to "High" (2) landslide potential value by the SHALSTAB model (Figure 2). Pixels with "Extreme" ratings were limited and typically scattered, with a majority being concentrated along waterways. Some "High" pixels are present in the mid-section of several of the larger units, but appear to be associated with cut banks along large legacy skid trails/ haul roads.

Those regions identified by this model as "Extreme/ High" that correspond to areas of recent or historic instability are mapped as unstable landforms on Figures 4 through 8 of the geologic report.

Mass Wasting Potential

The Mass Wasting Potential (MWP) model used to evaluate the plan area calculated a majority of the slopes to have a "Low" to "Moderate" landslide potential (Figure 2). "High" potential polygons are limited and appear to be confined to areas classified on Figure 2 as having slope gradients in excess of 60% and a "High" rating per SHALSTAB.

A majority of the "High" polygon areas overlap slopes devoid of morphology indicative of recent or historic instability; therefore these areas were compared to adjacent lower hazard modeled slopes with similar slope inclination, convergence, and vegetative coverage to determine if unstable conditions existed. Where field observation suggested that the model was incorrect in assessing the potential for mass wasting, especially in response to selective silviculture, the modeled areas were not considered potentially unstable and are not identified on the landslide maps attached to Section 5 of the THP (HRC, 2014). These omitted areas underwent intensive management practices in the past (historic tractor operations, clear cut, and burning) and there is no field or aerial photographic evidence suggesting that these activities had an adverse effect on their overall stability. We anticipate that these slopes will have a similar response to the uneven age land use practice currently proposed on their surfaces; consequently we did not identify them as potential areas of concern.

Those regions identified as having experienced historic ground movement regardless of the underlying slope stability ratings (Low to High) are shown on Figures 4 through 8 of the geologic report.

Below is a brief descriptions of the models used in this evaluation:

SHALSTAB was first described in Dietrich and Montgomery (1994). SHALSTAB is a simple, physically-based model based on the Mohr-Coulomb failure law that can be used to map shallow landslide potential. The model calculates the potential for failure using gridded digital elevation data. The simplicity of the model lies in the formulation of slope stability parameters that allow the model to be run parameter-free using default values suggested by the authors or determined by local measurement. Because the model uses no field measurements of critical characteristics that determine slope stability, the evaluation of potential instability is only an approximation. In applying SHALSTAB for Tier 2 enrollment, HRC has run the model on a 10-m spatial grid using LiDAR elevation data and applied the parameters as suggested by the model authors. HRC's application of the method and parameters is described in HRC (2008).

Mass Wasting Potential (MWP) modeling is a cursory regional assessment that numerically values soil, slope inclination, geology type, and geomorphology with respect to past mass wasting (HRC, 1999). The sums of the values specific to an area are measured against a set ranking system that extends from very low to extreme. The models intent is to highlight areas of high potential for instability at the planning level. The model's use at the site specific level is limited in that pedogenic soil types are used, not textures, the geologic formations utilized provide one value for all of the incorporated facies, and the model is heavily biased if past mass wasting has occurred or has been mapped as occurring in the area.

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Humboldt Redwood Company LLC

Status of 2015 Water Drafting Sites

Week of 14-Sep-2015

						Stream Drafting		Tanks					
Area	Site ID	Site Type	Location	Drainage	Last Discharge Date	Discharge (cfs)	Minimum Q (cfs)	Discharge (GPM)	Minimum Q (GPM)	Water Temp (F)	Likely Close Date	Current Status	Comment
North	60	Water Drafting	End of pavement	Yager	8/21/2015	1.54	1.5			71		Closed	Closed due to low flow
	67	Water Drafting	Side 8	Lawrence	7/31/2015	1.28	1.5			67		Closed	Closed due to low flow
	79	Water Drafting	Bottom of gorge	Lawrence	7/2/2015	1.54	1.5			64		Closed	Closed due to low flow
	112	Tank	Silver bullet	Freshwater	7/24/2015			4.75	4.5	54		Closed	Fire use only
	131	Tank	Road 15 8 marker	Elk river	9/4/2015			20.87	4.5	54		Open	
	150	Tank	Upper Freshwater marker 19	Freshwater	9/4/2015			34.43	4.5	52		Open	
South	14	Water Drafting	Dyerville	Eel River	9/14/2015	12	1.5					Open	
	23	Water Drafting	Bear river below Nelson ck	Bear River	8/21/2015	1.53	1.5			60		Open	Closed due to low flow
	26	Water Drafting	Bear river @ bridge	Bear River	9/4/2015	3.95	1.5			57		Open	
	28	Water Drafting	B Tree	Larabee CK	9/4/2015	4.17	1.5			64		Open	
	30	Water Drafting	Holmes	Eel River	9/14/2015	28	1.5					Open	
	31	Water Drafting	Bear Creek	Eel River	7/17/2015	1.68	1.5			60		Closed	Closed due to low flow
	33	Water Drafting	Elinor	Eel River	9/8/2015	19	1.5					Open	Needs work to get trucks to the river
	36	Water Drafting	Root CK	Van Duzen	9/11/2015	3.47	1.5			67		Open	Needs work to get trucks to the river
	39	Water Drafting	Strongs station	Van Duzen	9/11/2015	4	1.5			66		Open	
	40	Water Drafting	Grizzly			1.26	1.5					Closed	Not enough flow to open
	43	Water Drafting	LP Deck @ Corbett	Van Duzen	9/11/2015	4.95	1.5			68		Open	
	107	Tank	14 1/2 marker Bear river	Bear River								Closed	Fire use only
	108	Tank	Popsicle rock	Bear Creek	6/26/2015			3.57	4.5			Closed	Fire use only
	109	Tank	9 1/4 marker Bear river	Bear River								Closed	Fire use only

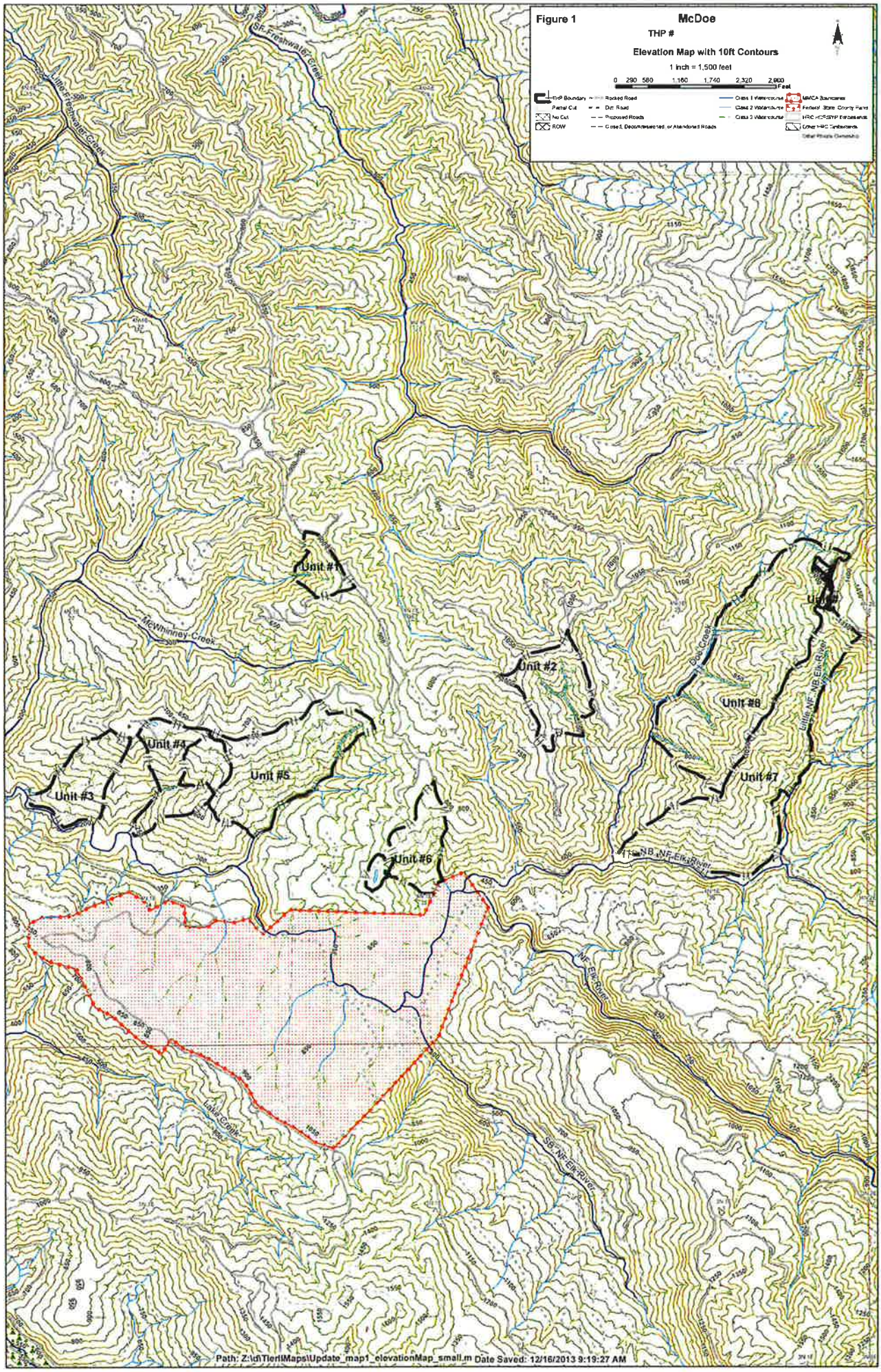
Figure 1
McDoe
THP #
Elevation Map with 10ft Contours
1 inch = 1,500 feet
0 290 580 1,160 1,740 2,320 2,900
Feet
THP Boundary
Partial Cut
No Cut
ROW
Rocked Road
Dirt Road
Proposed Roads
Closed, Decommissioned, or Abandoned Roads
Class 1 Watercourse
Class 2 Watercourse
Class 3 Watercourse
MMCA Boundaries
Federal, State, County Parks
HRC /CFSTIP Ownerships
Other HRC Timberlands
SR Freshwater Creek
Little Freshwater Creek
McWhinney Creek
Unit #1
Unit #2
Unit #3
Unit #4
Unit #5
Unit #6
Unit #7
Unit #8
Dock Creek
Little NF NB Elk River
NB NF Elk River
NF Elk River
SB NF Elk River
Lava Creek
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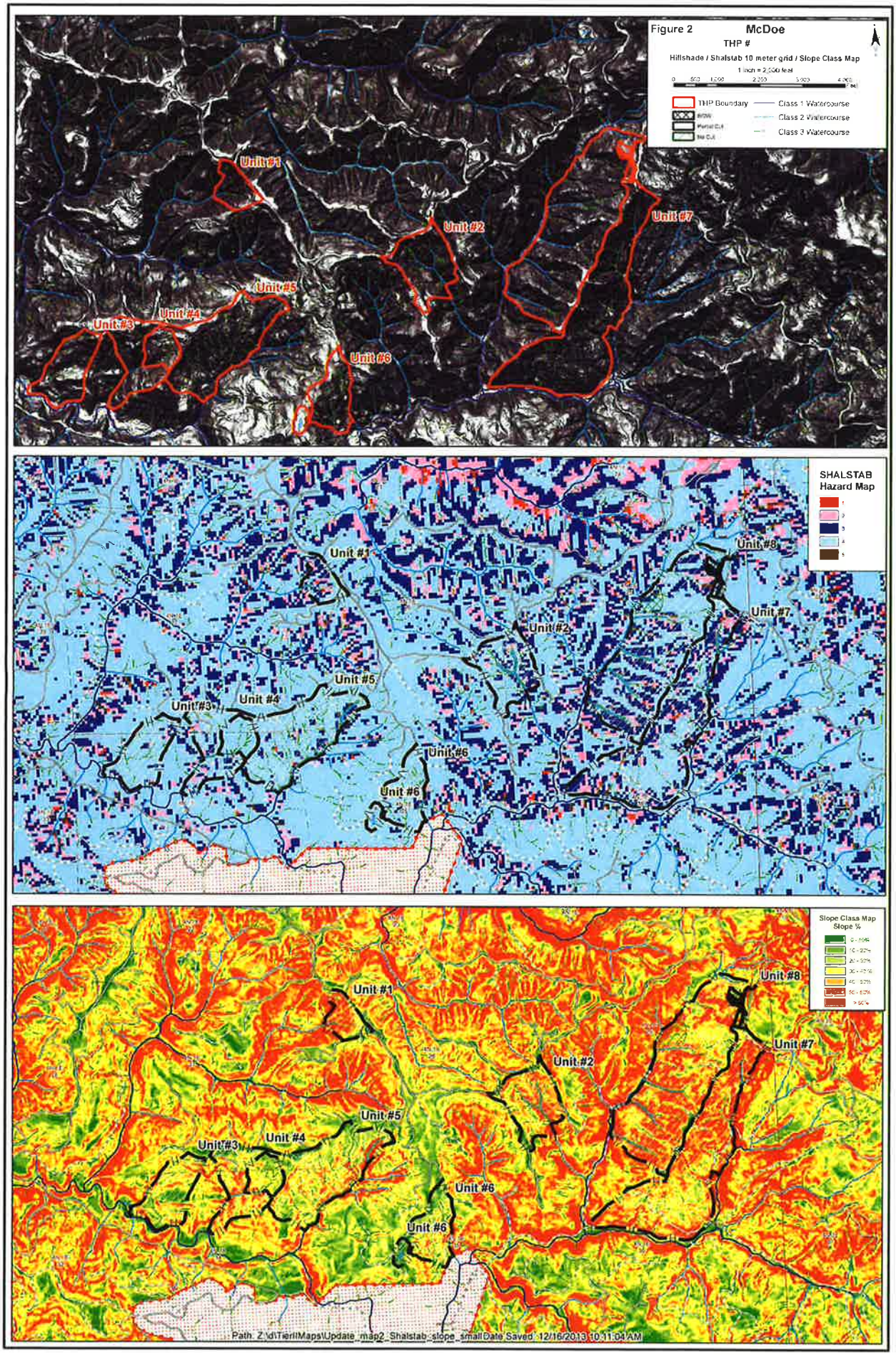
Figure 2
McDoe
THP #
Hillshade / Shalstab 10 meter grid / Slope Class Map
1 Inch = 2,000 feet
THP Boundary
Class 1 Watercourse
Class 2 Watercourse
Class 3 Watercourse
Unit #1
Unit #2
Unit #3
Unit #4
Unit #5
Unit #6
Unit #7
SHALSTAB
Hazard Map
Unit #8
Slope Class Map
Slope %
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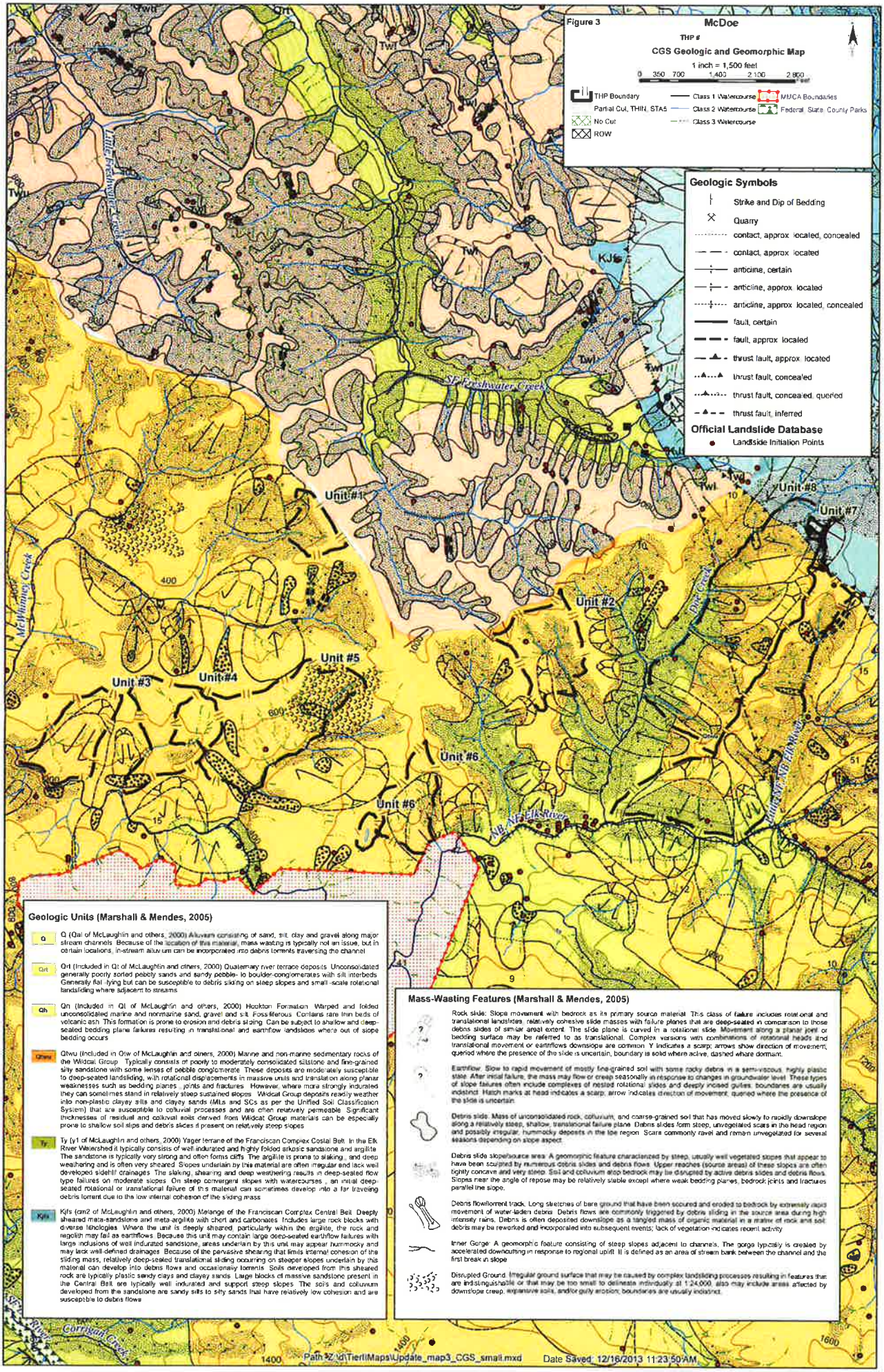
Figure 3
McDoe
THP #
CGS Geologic and Geomorphic Map
1 inch = 1,500 feet
0 350 700 1,400 2,100 2,800
THP Boundary
Partial Cut, THIN, STA5
No Cut
ROW
Class 1 Watercourse
Class 2 Watercourse
Class 3 Watercourse
MMCA Boundaries
Federal, State, County Parks
Geologic Symbols
Strike and Dip of Bedding
Quarry
contact, approx. located, concealed
contact, approx. located
anticline, certain
anticline, approx. located
anticline, approx. located, concealed
fault, certain
fault, approx. located
thrust fault, approx. located
thrust fault, concealed
thrust fault, concealed, queried
thrust fault, inferred
Official Landslide Database
Landslide Initiation Points
Unit #1
Unit #2
Unit #3
Unit #4
Unit #5
Unit #6
Unit #7
Unit #8
Twl
Twlt
Qrt
KJfs
SF Freshwater Creek
McWhinney Creek
Dow Creek
NB of Elk River
Corrigan Creek
Geologic Units (Marshall & Mendes, 2005)
Q (Qal of McLaughlin and others, 2000) Alluvium consisting of sand, silt, clay and gravel along major stream channels. Because of the location of this material, mass wasting is typically not an issue, but in certain locations, in-stream alluvium can be incorporated into debris torrents traversing the channel
Qrt (Included in Qt of McLaughlin and others, 2000) Quaternary river terrace deposits. Unconsolidated generally poorly sorted pebbly sands and sandy pebble- to boulder-conglomerates with silt interbeds. Generally flat-lying but can be susceptible to debris sliding on steep slopes and small-scale rotational landsliding where adjacent to streams
Qh (Included in Qt of McLaughlin and others, 2000) Hookton Formation: Warped and folded unconsolidated marine and nonmarine sand, gravel and silt. Fossiliferous. Contains rare thin beds of volcanic ash. This formation is prone to erosion and debris sliding. Can be subject to shallow and deep-seated bedding plane failures resulting in translational and earthflow landslides where out of slope bedding occurs
Qtwu (Included in Qtw of McLaughlin and others, 2000) Marine and non-marine sedimentary rocks of the Wildcat Group. Typically consists of poorly to moderately consolidated siltstone and fine-grained silty sandstone with some lenses of pebble conglomerate. These deposits are moderately susceptible to deep-seated landsliding, with rotational displacements in massive units and translation along planar weaknesses such as bedding planes, joints and fractures. However, where more strongly indurated they can sometimes stand in relatively steep sustained slopes. Wildcat Group deposits readily weather into non-plastic clayey silts and clayey sands (MLs and SCs as per the Unified Soil Classification System) that are susceptible to colluvial processes and are often relatively permeable. Significant thicknesses of residual and colluvial soils derived from Wildcat Group materials can be especially prone to shallow soil slips and debris slides if present on relatively steep slopes
Ty (y1 of McLaughlin and others, 2000) Yager terrane of the Franciscan Complex Costal Belt. In the Elk River Watershed it typically consists of well-indurated and highly folded arkosic sandstone and argillite. The sandstone is typically very strong and often forms cliffs. The argillite is prone to slaking, and deep weathering and is often very sheared. Slopes underlain by this material are often irregular and lack well developed sidehill drainages. The slaking, shearing and deep weathering results in deep-seated flow type failures on moderate slopes. On steep convergent slopes with watercourses, an initial deep-seated rotational or translational failure of this material can sometimes develop into a far traveling debris torrent due to the low internal cohesion of the sliding mass
Kjfs (am2 of McLaughlin and others, 2000) Melange of the Franciscan Complex Central Belt. Deeply sheared meta-sandstone and meta-argillite with chert and carbonates. Includes large rock blocks with diverse lithologies. Where the unit is deeply sheared, particularly within the argillite, the rock and regolith may fail as earthflows. Because this unit may contain large deep-seated earthflow failures with large inclusions of well indurated sandstone, areas underlain by this unit may appear hummocky and may lack well-defined drainages. Because of the pervasive shearing that limits internal cohesion of the sliding mass, relatively deep-seated translational sliding occurring on steeper slopes underlain by this material can develop into debris flows and occasionaly torrents. Soils developed from this sheared rock are typically plastic sandy clays and clayey sands. Large blocks of massive sandstone present in the Central Belt are typically well indurated and support steep slopes. The soils and colluvium developed from the sandstone are sandy silts to silty sands that have relatively low cohesion and are susceptible to debris flows
Mass-Wasting Features (Marshall & Mendes, 2005)
Rock slide: Slope movement with bedrock as its primary source material. This class of failure includes rotational and translational landslides, relatively cohesive slide masses with failure planes that are deep-seated in comparison to those debris slides of similar areal extent. The slide plane is curved in a rotational slide. Movement along a planar joint or bedding surface may be referred to as translational. Complex versions with combinations of rotational heads and translational movement or earthflows downslope are common. Y indicates a scarp; arrows show direction of movement; queried where the presence of the slide is uncertain, boundary is solid where active, dashed where dormant.
Earthflow: Slow to rapid movement of mostly fine-grained soil with some rocky debris in a semi-viscous, highly plastic state. After initial failure, the mass may flow or creep seasonally in response to changes in groundwater level. These types of slope failures often include complexes of nested rotational slides and deeply incised gullies; boundaries are usually indistinct. Hatch marks at head indicates a scarp; arrow indicates direction of movement; queried where the presence of the slide is uncertain.
Debris slide: Mass of unconsolidated rock, colluvium, and coarse-grained soil that has moved slowly to rapidly downslope along a relatively steep, shallow, translational failure plane. Debris slides form steep, unvegetated scars in the head region and possibly irregular, hummocky deposits in the toe region. Scars commonly ravel and remain unvegetated for several seasons depending on slope aspect.
Debris slide slope/source area: A geomorphic feature characterized by steep, usually well vegetated slopes that appear to have been sculpted by numerous debris slides and debris flows. Upper reaches (source areas) of these slopes are often tightly concave and very steep. Soil and colluvium atop bedrock may be disrupted by active debris slides and debris flows. Slopes near the angle of repose may be relatively stable except where weak bedding planes, bedrock joints and fractures parallel the slope.
Debris flow/torrent track: Long stretches of bare ground that have been scoured and eroded to bedrock by extremely rapid movement of water-laden debris. Debris flows are commonly triggered by debris sliding in the source area during high intensity rains. Debris is often deposited downslope as a tangled mass of organic material in a matrix of rock and soil; debris may be reworked and incorporated into subsequent events; lack of vegetation indicates recent activity.
Inner Gorge: A geomorphic feature consisting of steep slopes adjacent to channels. The gorge typically is created by accelerated downcutting in response to regional uplift. It is defined as an area of stream bank between the channel and the first break in slope.
Disrupted Ground: Irregular ground surface that may be caused by complex landsliding processes resulting in features that are indistinguishable or that may be too small to delineate individually at 1:24,000; also may include areas affected by downslope creep, expansive soils, and/or gully erosion; boundaries are usually indistinct.
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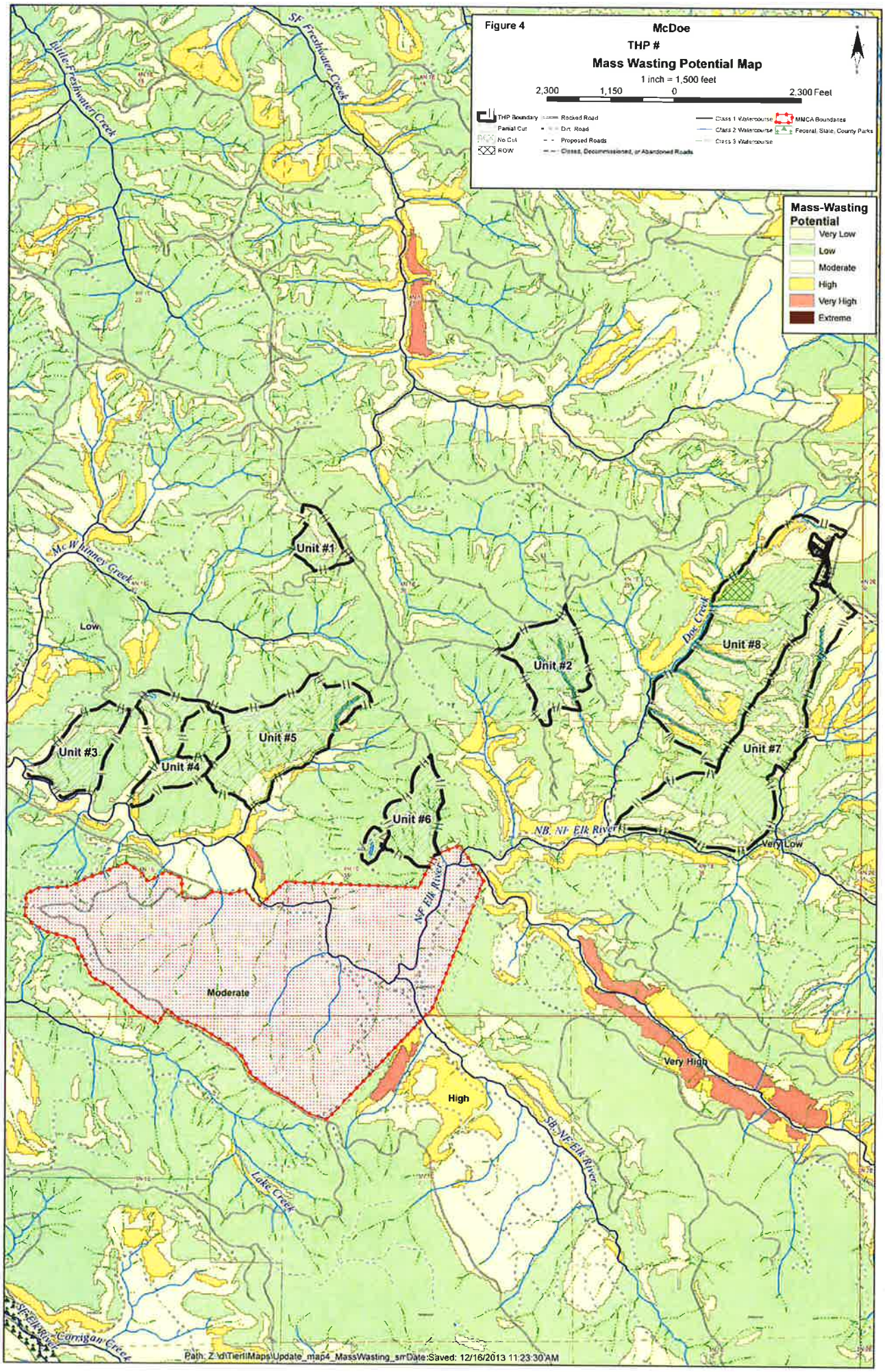
Figure 4
McDoe
THP #
Mass Wasting Potential Map
1 inch = 1,500 feet
2,300
1,150
0
2,300 Feet
THP Boundary
Partial Cut
No Cut
ROW
Rocked Road
Dirt Road
Proposed Roads
Closed, Decommissioned, or Abandoned Roads
Class 1 Watercourse
Class 2 Watercourse
Class 3 Watercourse
MNCA Boundaries
Federal, State, County Parks
Mass-Wasting Potential
Very Low
Low
Moderate
High
Very High
Extreme
Little Freshwater Creek
SF Freshwater Creek
McWhinney Creek
Unit #1
Unit #2
Unit #3
Unit #4
Unit #5
Unit #6
Unit #7
Unit #8
Doe Creek
NB. NF Elk River
NF Elk River
SB. NF Elk River
Lake Creek
Corrigan Creek
Low
Moderate
High
Very High
Very Low
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Figure 5
McDoe
THP #
Aerial Photo Map
1 inch = 1,500 feet
0 500 1,000 2,000 3,000 4,000
Feet
Little Freshwater Creek
SF Freshwater Creek
Unit #1
Unit #2
Unit #3
Unit #4
Unit #5
Unit #6
Unit #7
Unit #8
Dow Creek
NB. NF Elk River
NF Elk River
Late Creek
SF Elk River
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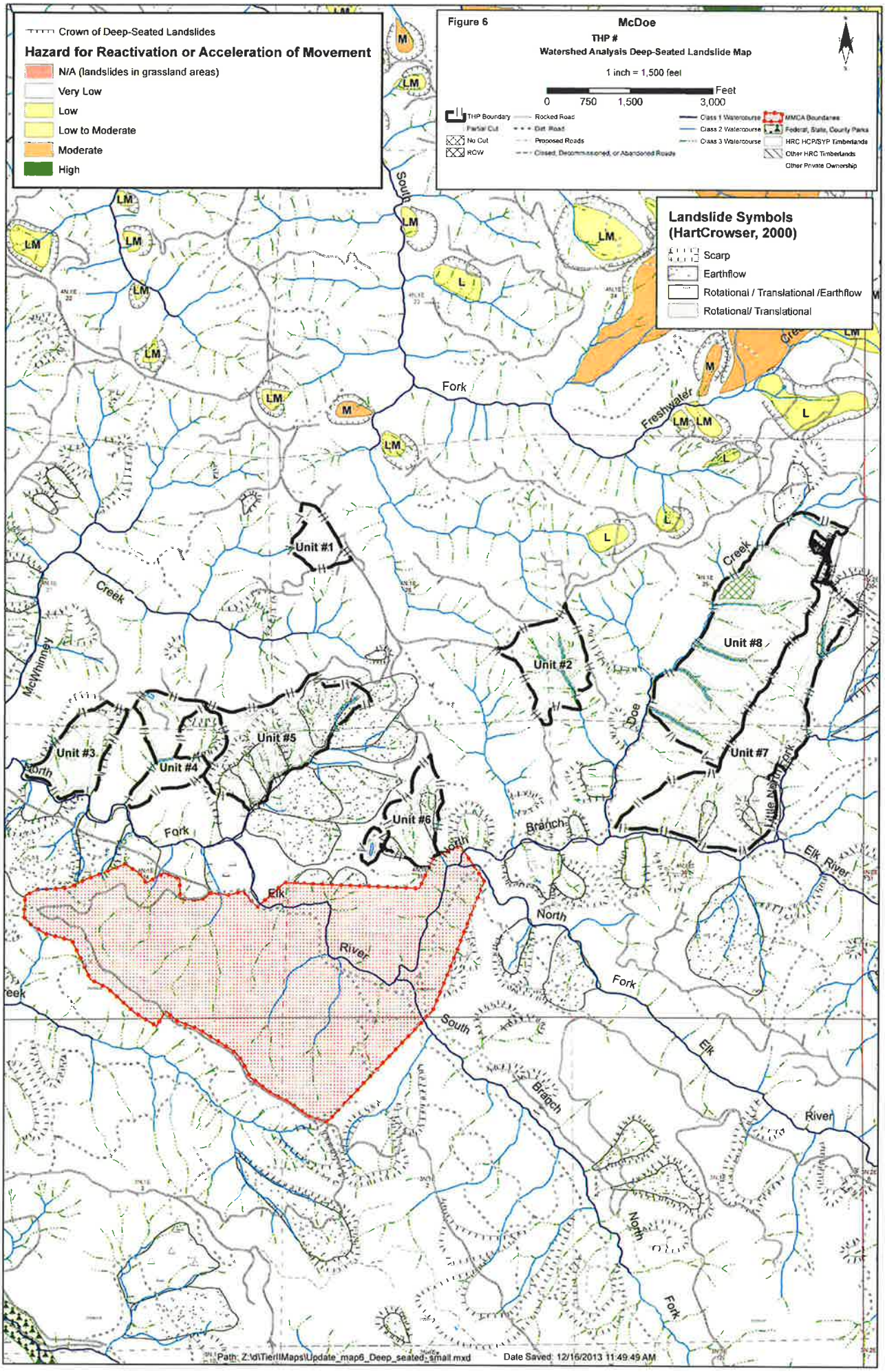
Figure 6
McDoe
THP #
Watershed Analysis Deep-Seated Landslide Map
1 inch = 1,500 feet
Feet
0 750 1,500 3,000
THP Boundary
Partial Cut
No Cut
ROW
Rocked Road
Dirt Road
Proposed Roads
Closed, Decommissioned, or Abandoned Roads
Class 1 Watercourse
Class 2 Watercourse
Class 3 Watercourse
MMCA Boundaries
Federal, State, County Parks
HRC HCP/SYP Timberlands
Other HRC Timberlands
Other Private Ownership
Crown of Deep-Seated Landslides
Hazard for Reactivation or Acceleration of Movement
N/A (landslides in grassland areas)
Very Low
Low
Low to Moderate
Moderate
High
Landslide Symbols (HartCrowser, 2000)
Scarp
Earthflow
Rotational / Translational /Earthflow
Rotational/ Translational
Unit #1
Unit #2
Unit #3
Unit #4
Unit #5
Unit #6
Unit #7
Unit #8
South Fork
Freshwater Creek
McWhinney Creek
North Fork
Elk River
Doe Creek
Little North Fork
South Branch
North Fork
Elk River
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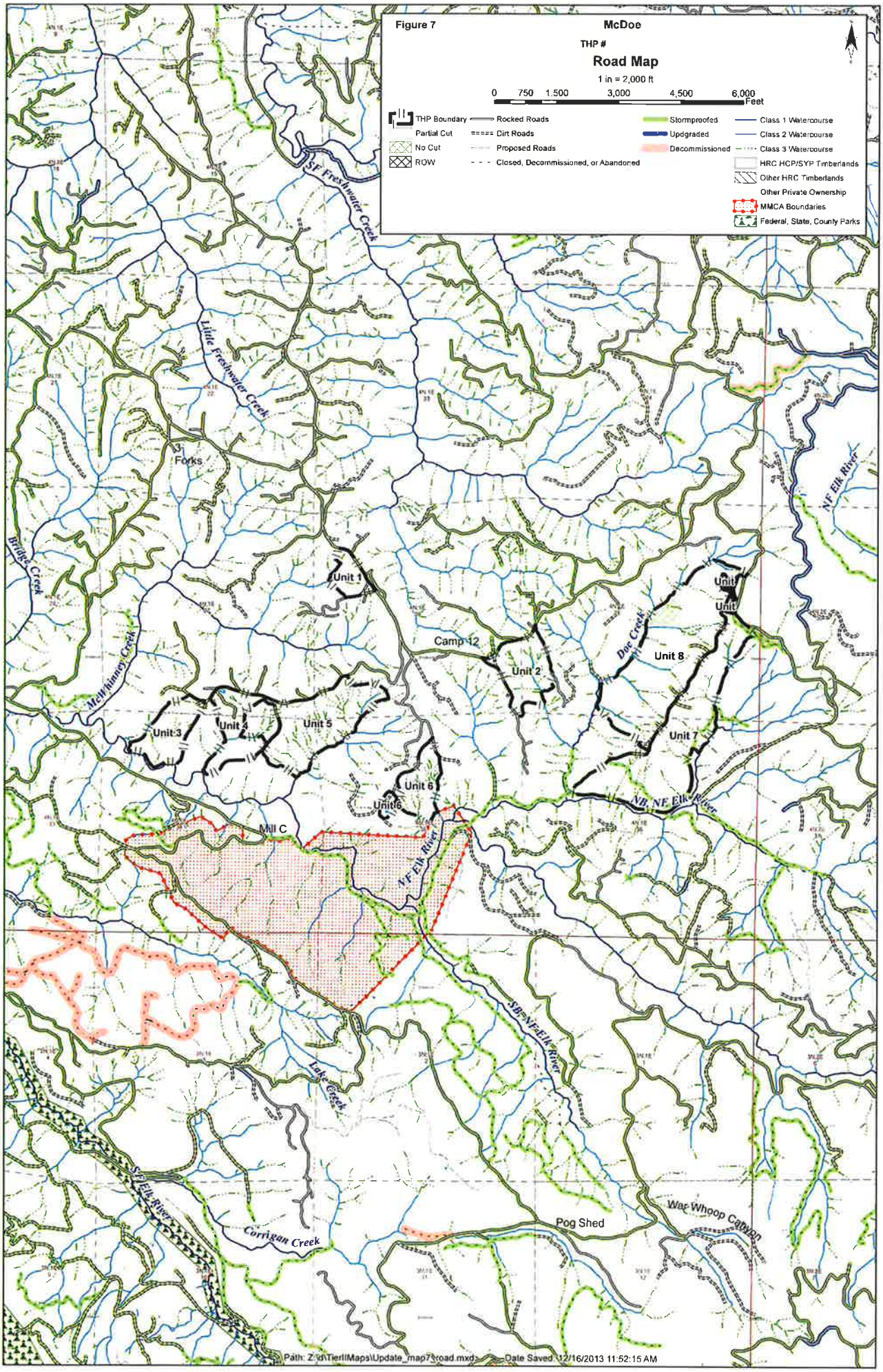
Figure 7
McDoe
THP #
Road Map
1 in = 2,000 ft
0 750 1,500 3,000 4,500 6,000
Feet
THP Boundary
Partial Cut
No Cut
ROW
Rocked Roads
Dirt Roads
Proposed Roads
Closed, Decommissioned, or Abandoned
Stormproofed
Upgraded
Decommissioned
Class 1 Watercourse
Class 2 Watercourse
Class 3 Watercourse
HRC HCP/SYP Timberlands
Other HRC Timberlands
Other Private Ownership
MMCA Boundaries
Federal, State, County Parks
SF Freshwater Creek
Little Freshwater Creek
Forks
Bridge Creek
Mellhinney Creek
NF Elk River
Unit 1
Camp 12
Unit 2
Unit 3
Unit 4
Unit 5
Unit 6
Unit6
Unit
Unit
Doe Creek
Unit 8
Unit 7
NB NF Elk River
Mill C
NF Elk River
SB NF Elk River
Lake Creek
SF Elk River
Corrigan Creek
Pog Shed
War Whoop Canyon
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UNIT, RPF, PLANSUB, ftp/NEW

DEPARTMENT OF CONSERVATION

CALIFORNIA GEOLOGICAL SURVEY

2120 Campton Road • Suite E • EUREKA, CALIFORNIA 95503

PHONE 707/441-5746 • FAX 707/441-5748 • TDD 916 / 324-2555 • WEBSITE conservation.ca.gov

TO: Duane Shintaku, Deputy Director for Resource Management
California Department of Forestry and Fire Protection
135 Ridgway Avenue
Santa Rosa, California 95401

FROM: John Oswald, Certified Engineering Geologist
Department of Conservation
California Geological Survey
2120 Campton Road, Suite E
Eureka, California 95503

RECEIVED
MAY 27 2014
COAST AREA OFFICE
RESOURCE MANAGEMENT

DATE: May 27, 2014

SUBJECT: ENGINEERING GEOLOGIC REVIEW OF TIMBER HARVESTING PLAN 1-14-039-HUM ("McDoe" THP)

Date of Inspection: May 14, 15, and16, 2014

Participants-Affiliation:

Tom Schultz – RPF, Humboldt Redwood Co.
Dave Rogers – RPF, Humboldt Redwood Co.
Shane Beach, PG, Humboldt Redwood Co.
William Forsberg – RPF, CALFIRE Inspector
James Robbins, RPF, CALFIRE (day 1)
Drew Coe, CALFIRE (day 1)
Nick Simpson –Env. Sci., CDFW (day 1)
Adam Hutchins, CDFW (day 1)
Cheri Sanville, CDFW (day 1)
Maggie Robinson, PG, NCRWQCB
John Oswald – CEG, CGS (day 1 and 3)

County: Humboldt

Timber and Timberland Owner: Humboldt Redwood Company LLC (HRC)

Watershed: Elk River

Calwater v 2.2: #1110.000201 Lower North Fork Elk and 1110.000202 Upper North Fork Elk.

Logging Method: Cable and ground-based

Slopes: Gentle to steep (>65%) on streamside slopes.

USGS 7½ Min. Quadrangle: McWhinney Creek

Legal Description: portions of Section 25, 26, 27, 34, 35, and 36 T1N/R4E HB&M

Area: 537 ac.

Silviculture: Group Selection 420 ac., Selection 95 ac.

EHR: Low to Moderate

Geologic Concerns

Geologic concerns for this Timber Harvesting Plan (THP) include road reconstruction activities on

unstable areas with the potential for sediment delivery to Elk River and major tributaries to Elk River.

References:

CGS, 2005, Geologic and Geomorphic Features Related to Landsliding Elk River Watershed, Humboldt County, California, Watershed Mapping Series, Map Set 4, CD 2005-01.

Hart, E.W., compiler, 1999, *Fault number 15, Little Salmon fault zone*, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, http://earthquakes.usgs.gov/hazards/qfaults.

HRC 2014, Geologic Evaluation of the McDoe Timber Harvest Plan, Humboldt County, California, unpublished report for Mr Dave Rogers, RPF, from S. Watkins, PG, and S. Beach, PG dated March 17, 2014.

Jennings, C.W., and Bryant, W.A., 2010, *Fault activity map of California*: California Geological Survey Geologic Data map No. 6, map scale 1:750,000.

Aerial Photographs

1988 WAC Inc., 1988, black and white photographs, flight WAC-88CA, flightline 6, frames 163 and 164, nominal scale 1:31,680, dated April 6 1988.

Google Earth imagery, 1988, 2002, 2003, 2004, 2005, 2006, 2009, 2010, 2011 and 2012, accessed through Google Earth Pro.

Geologic Conditions:

The Timber Harvest Plan (THP) area is adjacent to North Fork Elk River and Doe Creek, a Class I tributary to Elk River. Elk River is listed as a temperature and sediment impaired waterbody under section 303(D) of the Federal Clean Water Act. Elk River has a dendritic to directional trellis stream pattern that extends westward to Humboldt Bay. Elevations in THP area range from about 200 feet above mean sea level (msl) to about 1,360 feet msl.

A geology report is included as pages 290 to 335 of the plan (HRC, 2014). This geology report includes a discussion of the regional and site geology that is consistent with the reviewed published geologic mapping and our understanding of geologic conditions in the area of the plan. Regional geologic mapping by the California Geological Survey (CGS, 2005) shows the Neogene to Quaternary-aged undifferentiated Wildcat Group and the Tertiary to Cretaceous-aged Yager terrane and Coastal terrane of the Coastal Belt of the Franciscan Complex underlying the THP area (see Figure 1, Regional Geologic Map). The undifferentiated Wildcat Group is described as weakly consolidated, light brown to gray, mudstone, shale, sandstone, siltstone, and conglomerate. The Yager terrane is consolidated silt-shale, siltstone, sandstone, mudstone, and conglomerate, locally highly sheared shale and mudstone slake when wetted. The Little Salmon fault is a low angle, north dipping thrust fault located about 7 miles to the west of the plan area. The Little Salmon fault is considered active by the State of California and is reported to have a slip rate of greater than 5.0 mm/yr (Jennings and Bryant, 2010; Hart, 1999).

The plan attached geology report and the reviewed published geologic mapping indicate mass wasting in the plan area is dominated by debris slides on bluffs and steep streamside slopes with large apparently dormant rockslides on slopes undercut by fluvial incision. Shallow landslides also appear to be heavily associated with roads.

Review Team Questions: (to be answered by the geologist).

1) *Has the geology of the plan area been characterized in such a manner so as to provide adequate justification for the planned operations on and adjacent to the known unstable areas?*

Response: Based on our review the geology report and plan area during the PHI, the geology report adequately characterizes unstable areas within the operational portions of the plan and provides justification of the proposed harvest based on site conditions and a review of select literature. During the PHI, we observed one unstable area that was not mapped in the report. See below under CGS-1.

General Observations:

Bedrock materials observed in natural exposures and road cuts in the plan area were consistent with mapping as the undifferentiated Wildcat Group. Brown to light brown, siltstone is exposed in cutslopes and natural cuts throughout the plan area. The soils observed during the Phi consisted of thick, well developed silt to clayey silt residual soils on the ridgetops with relatively thin, well drained organic silt colluvial soils on steep sideslopes.

CGS (2005) mapped numerous recent unstable areas within the proposed harvest units. The geologic report shows most of these unstable areas. The mapping in HRC (2014) is consistent with site conditions observed during the PHI and during review of aerial photography for this plan. Elsewhere the geologic report also maps dormant deep-seated rockslides and earthflows within the plan area. Some of the mapping is different from CGS (2005) and is based on the high resolution topographic base developed for the property holdings of HRC.

Elsewhere in the Plan, the RPF appears to have been aware of the geologic framework of the region and appears to have reasonably used the unstable area definitions put forth in the Forest Practice Rules and CLFA Guidelines. Potential problem sites have been mitigated by avoidance, use of appropriate set-backs, and silviculture as based on watershed analysis derived prescription. Additional mitigations are presented in this and other Agency memoranda. The RPF's mitigation measures appear to be reasonable based on our field reconnaissance conducted as a part of the PHI.

Site-Specific Observations:

CGS-1: CGS-1 is a dormant-historic rockslide located in the northern portion of proposed Unit 6. The body is hummocky with closed depressions and deformed old growth stumps. The timber stand on the steep toe of the failure is younger than the surrounding stand and appears to have raveled for some time while timber on adjacent slopes regenerated. The main scarp is steep with raveling soils and little to no vegetation. The area appears to have been heavily disturbed during the initial harvest entry. The second growth forest on the dormant rockslide is undeformed and contains a mature conifer stand with some hardwoods.

General Recommendations: NONE

Site-Specific Recommendations:

CGS-1: The RPF shall add the unstable area CGS-1 to the plan maps and have a licensed geologist evaluate if additional mitigations are needed for the proposed harvest operations at CGS-1.

Original signed by:

John A. Oswald, CEG 2291
Engineering Geologist

PROFESSIONAL GEOLOGIST
J.A. Oswald
No. 2291
CERTIFIED
ENGINEERING
GEOLOGIST
STATE OF CALIFORNIA

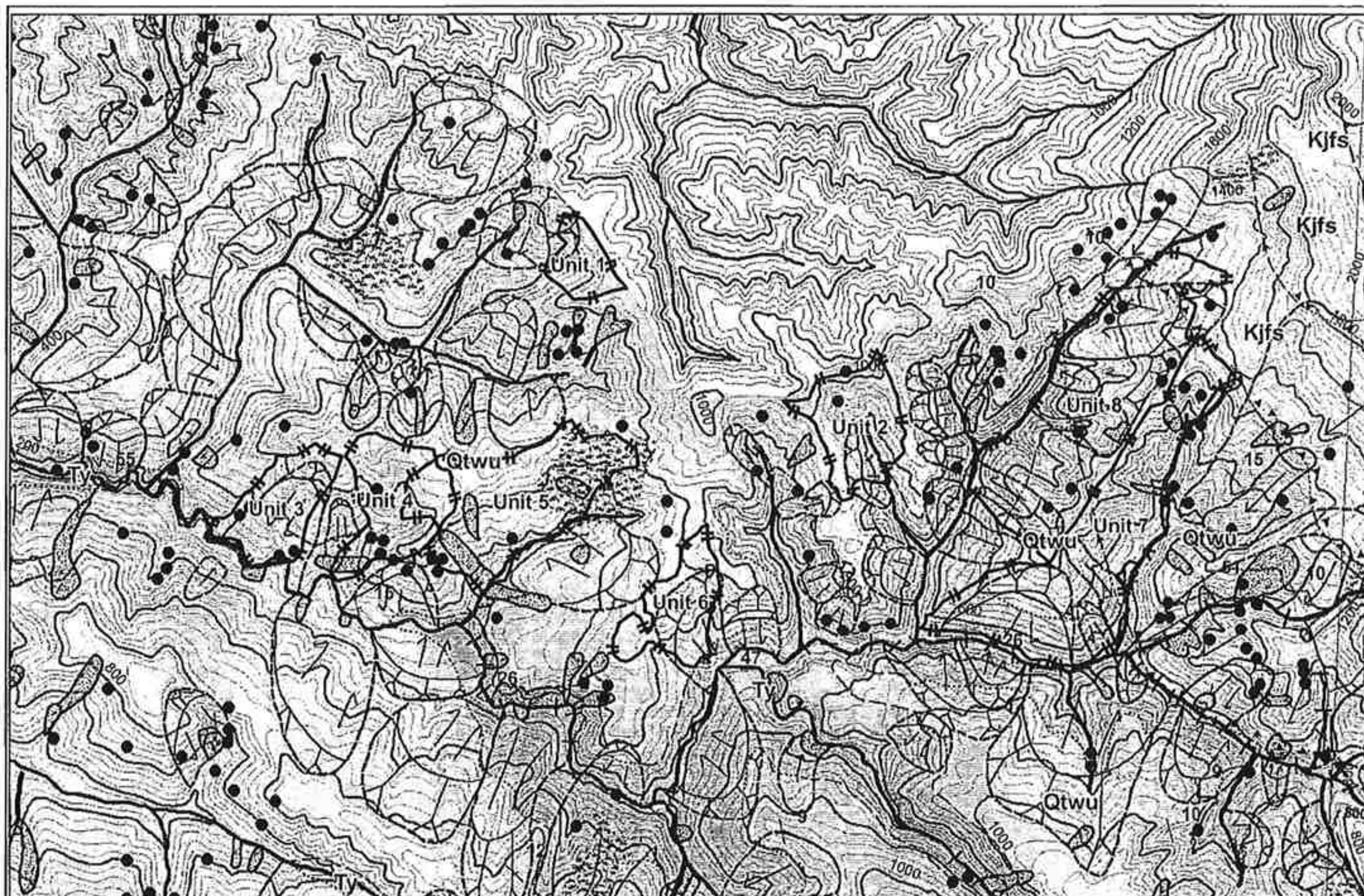
Concur:

Original signed by:

Gerald J. Marshall, CEG 1909
Senior Engineering Geologist

PROFESSIONAL GEOLOGIST
G.J. MARSHALL
No. 1909
CERTIFIED
ENGINEERING
GEOLOGIST
STATE OF CALIFORNIA

Attachments: Figure 1a: Regional Geologic and Geomorphic Map
Figure 1b: Key to Regional Geologic and Geomorphic Map
Figure 2: Site Map, Unit 6



- harvest boundary

modified from CGS, CD 2005-01
see Figure 1b for key

Date: 05/27/14 Scale: 1:24,000 Approved by: jao	**Geologic and Geomorphic Map To Accompany Engineering Geologic Review THP 1-14-039-HUM**	**Figure: 1a**

FEATURE

landslide

FEATURE

Gorge

Scarp

Torrent-track

disrupted ground

INIT_TYPE, ACTIVITY

tt, d

tt, h

debris slide slopes

INIT_TYPE, ACTIVITY

debris slide, dormant

debris slide, historically active

earthflow, dormant

earthflow, historically active

rock slide, dormant

rock slide, historically active

inner gorge

FEATURE, TYPE

Anticlinal-axis, approximately located

Anticlinal-axis, certain

Fault, approximately located

Fault, certain

Gradational-contact,

Lineament,

Slip-fault, approximately located

Slip-fault, certain

Synclinal-axis, approximately located

Synclinal-axis, certain

Thrust-fault, approximately located

Thrust-fault, certain

PTTYPE

dipping strata

horizontal strata

vetrical strata

overturned strata

dipping strata, approximate

dipping fracture

vertical fracture

fault dip

<all other values>

geologic contacts

certain

approximately located

concealed

queried

UNITCODE

Quaternary alluvium

Quaternary fan deposits

Quaternary old river terrace deposits

Quaternary river terrace deposits

Quaternary Hookton Formation

Quaternary Rohnerville Formation

Quaternary Carlotta Formation

Quaternary Tertiary Scotia Bluffs Sandstone

QTrd

Quaternary-Tertiary undifferentiated Wildcat

Tertiary Eel River Formation

Tertiary Pullen Formation

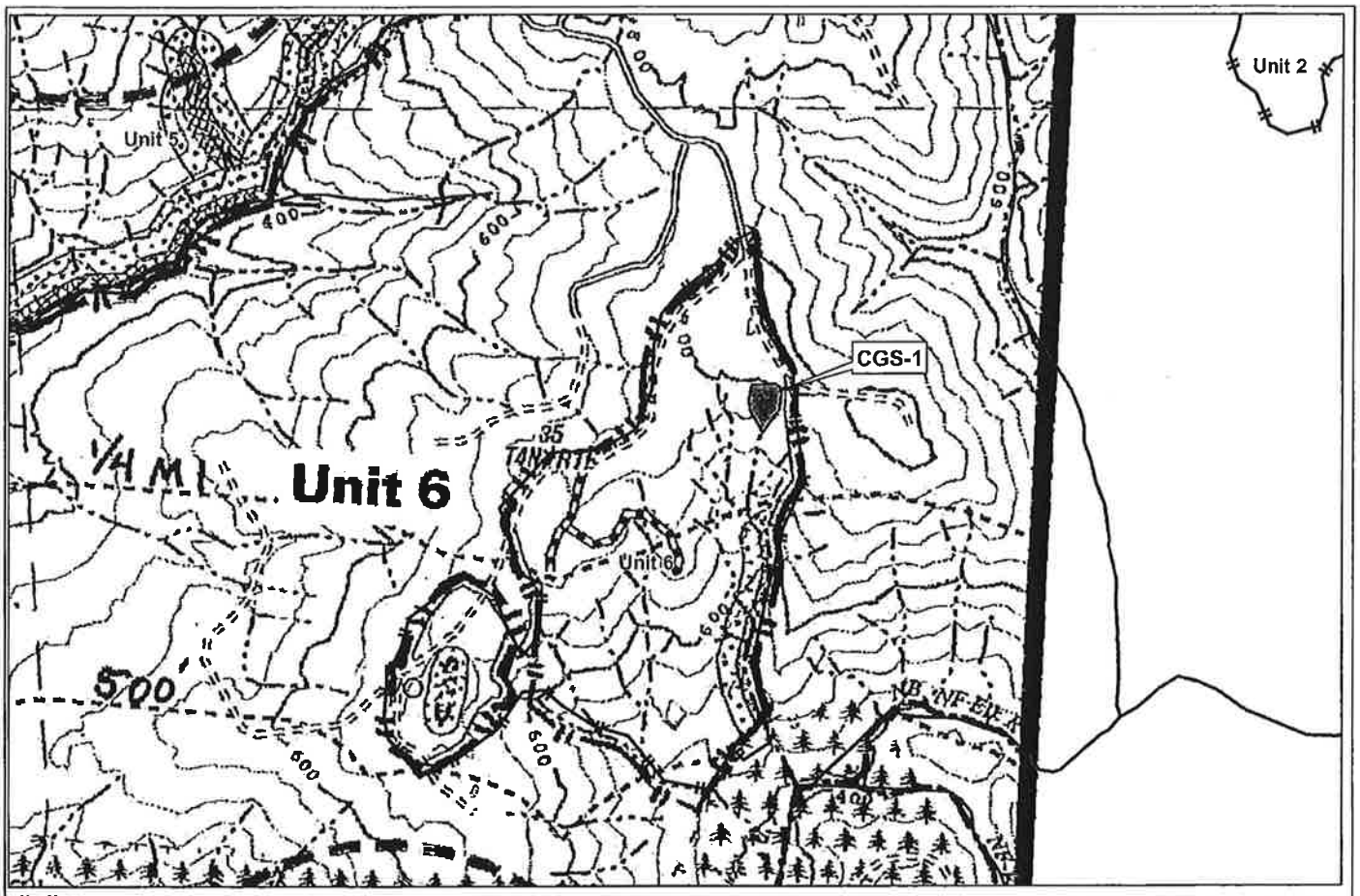
Tertiay-Cretaceous Yager terrane

Tertiary-Cretaceous, Franciscan Coastal Belt

Tertriary-Cretaceous Franciscan Coastal Belt shear zone

Cretaceous-Jurassic, Snow Camp unit, KJfsc

Date: 05/27/14 Scale: Approved by: jao	**Key to Regional Geologic and Geomorphic Map** **To Accompany** **Engineering Geologic Review** **THP 1-14-039-HUM**	**Figure:** **1b**



- harvest boundary

CGS-1, unstable area described in text

modified from THP 1-14-039-HUM

Date: 05/27/14 Scale: 1:24,000 Approved by: jao	**Site Map Unit 6** **To Accompany** **Engineering Geologic Review** **THP 1-14-039-HUM**	**Figure:** **2**

Humboldt Redwood™

September 11, 2014

Mr. Dave Rogers R.P.F.
Humboldt Redwood Company LLC
125 Main St.
Scotia, Ca. 95541

SUBJECT: RESPONSE TO CALIFORNIA GEOLOGICAL SURVEY PRE-HARVEST INSPECTION REPORT FOR TIMBER HARVESTING PLAN # 1-14-039 HUM (McDOE).

INTRODUCTION

This letter contains responses to comments contained within the Pre-Harvest Inspection (PHI) report written by California Geological Survey (CGS) staff for Timber Harvesting Plan (THP) 1-14-039 HUM (McDoe) (CGS, 2014). This letter was prepared by the Humboldt Redwood Company (HRC) Forest Science Department and specifically addresses the area of instability noted by CGS staff at CGS-1. CGS request is presented in *Italics* with our response immediately following in regular text.

CGS-1: The RPF shall add the unstable CGS-1 to the plan maps and have a licensed geologist evaluate if additional mitigations are needed for the proposed harvest operations at CGS-1.

Response:

The area of concern noted at CGS-1 during the May 14, 2014 PHI of THP 1-14-039 has been added to the THP maps. See THP Section 2.

The site was re-assessed subsequent to the May 16 PHI by HRC Forest Science Dept. staff and was noted to have been subjected to significant levels of ground disturbance by past yarding operations. Old skid trails and yarding corridors were observed within and adjacent to the area of concern. None of these structures appear to have been deformed by movement within the body or along the margins of the subject slide.

As described by CGS staff the slope has a rolling/ stepped profile yet supports a healthy stand of roughly straight second growth conifers. There is no indication that the slope has experience any movement since the occupation of the area by the existing second growth

stand. The slide morphology although recognizable is very muted and there is no indication past activities had a significantly destabilizing effect on the slope as a whole.

Timber on the slope, based on the harvest mark and discussions with the project forester, will be managed in accordance with a single tree selection silviculture practice. No groups openings are proposed on or in the immediate vicinity of the subject slope. Based on our observations, general slope conditions, level of harvest, and proposed yarding method (cable) we conclude that operations proposed on and around CGS-1 are acceptable for existing site conditions and should not result in an increase rate of ground movement or sedimentation to down slope waterways.

ID #	Landslide type	Age	Dimensions (W x L x D) (ft.)	Depletion/ Accumulation Zone Characteristics	Del.	Proposed Silviculture	Comments	Rec.
CGS-1	Rock slide	dormant-historic or older	150 x 150 x 8	straight 18 to 24 inch DBH conifers/ hardwoods, and a few tilled old growth stumps	no	group selection	Slope surfaces are significantly disturbed by past ground based operations	none*

* proposed land use activities appear appropriate for site conditions and will not pose a risk to aquatic recourses

HRC Forest Science Department

Shane M. Beach, P G #7396
HRC/MRC Senior Geologist

REFERENCE

California Geologic Survey (CGS), (2012). "*Engineering Geologic Review of Timber Harvesting Plan 1-14-039 HUM (McDoe THP)*" unpublished memorandum to Duane Shintaku, Deputy Director, Resource Management California Department of Forestry and Fire Protection. NR:NR.