Humboldt Redwood
COMPANY, LLC

Main Office
P.O. Box 37
Scotia, CA 95565
(707) 764-4472

Timber Operations
P.O. Box 712
Scotia, CA 95565
(707) 764-4472

March 17, 2011

Ms. Catherine Kuhlman
California Regional Water Quality Control Board
North Coast Region
5550 Skylane Blvd, Suite A
Santa Rosa, CA 95403

Subject: Enrollment of THP 1-11-008 HUM in the Elk River WWDR, "Tier I and II"

Dear: Ms. Kuhlman

HRC is requesting Tier I and II enrollment under Watershed-Wide Waste Discharge Requirement (WWDR) Order No. R1-2006-0039 for THP 1-11-008 HUM. The tier 1 portion of the plan proposed for enrollment is comprised of 112.7 acres of group selection and 0.2 acres of right of way harvest(56.5 clear-cut equivalent acres). The Tier II portion of the plan proposed for enrollment is comprised of 51.6 acres of group selection and 0.7 acres of right of way harvest(26.5 clear-cut equivalent acres). Total acres currently enrolled or proposed for enrollment under Order No. R1-2006-0039 Tier II is shown in the Attached Pre-Harvest Planning Report. The Erosion Control Plan (ECP), Form 200 and an waste discharge enrollment fee are attached. Since the PHI no new ECP sites have been found. The THP is not yet approved. However is has gone through 2nd through with no outstanding issues. Close of Public comment is set for 4/2/2011 and the plan should be approved no later 4/13/11

Tier 2 Review

Landslide risks associated with this plan were evaluated in compliance with the Freshwater Creek and Elk River WWDR Permit Acreage Enrollment and Compliance Monitoring Program Quality Assurance Project Plan (Version 2.0, September 1, 2006) approved by the Executive Officer of the North Coast Regional Water Quality Control Board. This approach uses commonly accepted standards for geologic practices in forest management (Sidle et al. 1985, Soeters and Van Western 1996, and Sidle and Ochiai 2006) to assess factors known to contribute to landslides, such as steepness of slope, slope convergence, hydrology, geologic features, and visibly unstable areas. Overlapping and complementary scientific techniques combining state-of-the-art digital elevation model (DEM) slope stability models, field investigation, and terrain analysis were used in this assessment.

The slopes enrolled for Tier 2 harvest are underlain by underlain by undifferentiated Wildcat Group fine grained silts, sands and clays (please see THP Geology Report). The slopes are generally moderately inclined with numerous low order watercourses within poorly defined channels. Past harvest activities have imparted significant surface alteration due to road building. Utilizing this impact as a measure of slope stability sensitivity, the underlying geology coupled with the generally moderate slope inclinations and multitude of watercourses appears relatively stable (the slope are laid back and well drained). Very few unstable areas were identified during Note 45 geologic assessment. In addition, those practices which produce the high degree of ground disturbance are not proposed in this harvest. Since the highly impactive legacy harvest activities resulted in insignificant mass wasting, we anticipate that our modern partial harvesting with recognition and mitigation of existing unstable areas coupled with less disturbing yarding practices further reduces this potential to insignificant. As such, it is our opinion that the approved THP acres proposed for enrollment meet the Tier II enrollment requirements.

The THP proposes an uneven-age silviculture retaining 120 sq.ft. of basal area, except for group openings. Sub-merchantable trees and those with specific wildlife value characteristics (e.g., cavities, large limbs, broken tops, snags, etc.) will be retained within the harvest area to the extent feasible. Cable and tractor yarding is approved for the entire unit. Post-harvest no site preparation will occur.

Greater detail regarding this landslide hazard assessment is provided in the attached *THP Unit Review for Tier 2 Enrollment*. The licensed geologist involved with the Tier 2 landslide risk evaluation has concluded the proposed harvest operation, if implemented as planned and approved, will result in a negligible increase in potential for post-harvest landsliding; and thereby meets the applicable Zero Delivery of landslide related sediment performance standards of NCRWQCB Orders R1-2006-0039 and R1-2008-0071.

Please do not hesitate to contact me should you have any questions or comments regarding this application for enrollment into WWDR (Order No. R1-2006-0039).

Respectfully,

Jon Woessner,
Area Forester, RPF 2571
Humboldt Redwood Company, LLC

<u>Attachments:</u>
Professional Certification of Design
THP Unit Review for Tier II enrollment
Pre-harvest Planning Report
Maps

Table 1. Proposed 2011 Harvest in South Fork Elk River.

			Silviculture						Hazard[2]	
THP Name	THP Number	Unit Number	CC	ROW	Disp VR	SHR	SEL	CC Equivalent	Low	High
iron Gate	na	tier 1		0.2			112.7	56.5	107.8	5.1
iron gate	na	tier 2		0.7			51.6	26.3	52.3	
								82.8		

Table 3. Summary of THPs by Yarding System and Site Preparation for South Fork Elk River.

			Yarding System			Site Preparation	
THP Name	THP Number	Unit Number	Ground Based	Yarder	Helicopter	Mechanical	Broadcast
iron Gate		tier 1	10	102.9			
iron gate		tier 2	15	37.3			

[2]Hazard Acres are reported here to conform to the requirements of the Pre-Harvest Planning Report. The Staff Landslide Model in South Fork Elk River allows up to 114 Acres irrespective of Hazard Class. Acres reported are true acres

*Does not include 18 acre no-harvest area

Highlight indicates a THP and Specific Unit to be enrolled prior to establishing an enforceable Zero Discharge Monitoring Plan. Weighted Acreage Totals are listed below to demonstrate compliance with the Staff Landslide Model limit of 114 Acres in South Fork Elk River. Other THP Units will be enrolled after approval of the aforementioned Monitoring Plan

No Highlight Indicates a THP and Specific Unit to be enrolled after establishment of an enforcable Zero Discharge Monitoring Plan (Tier II).

Iron Gate

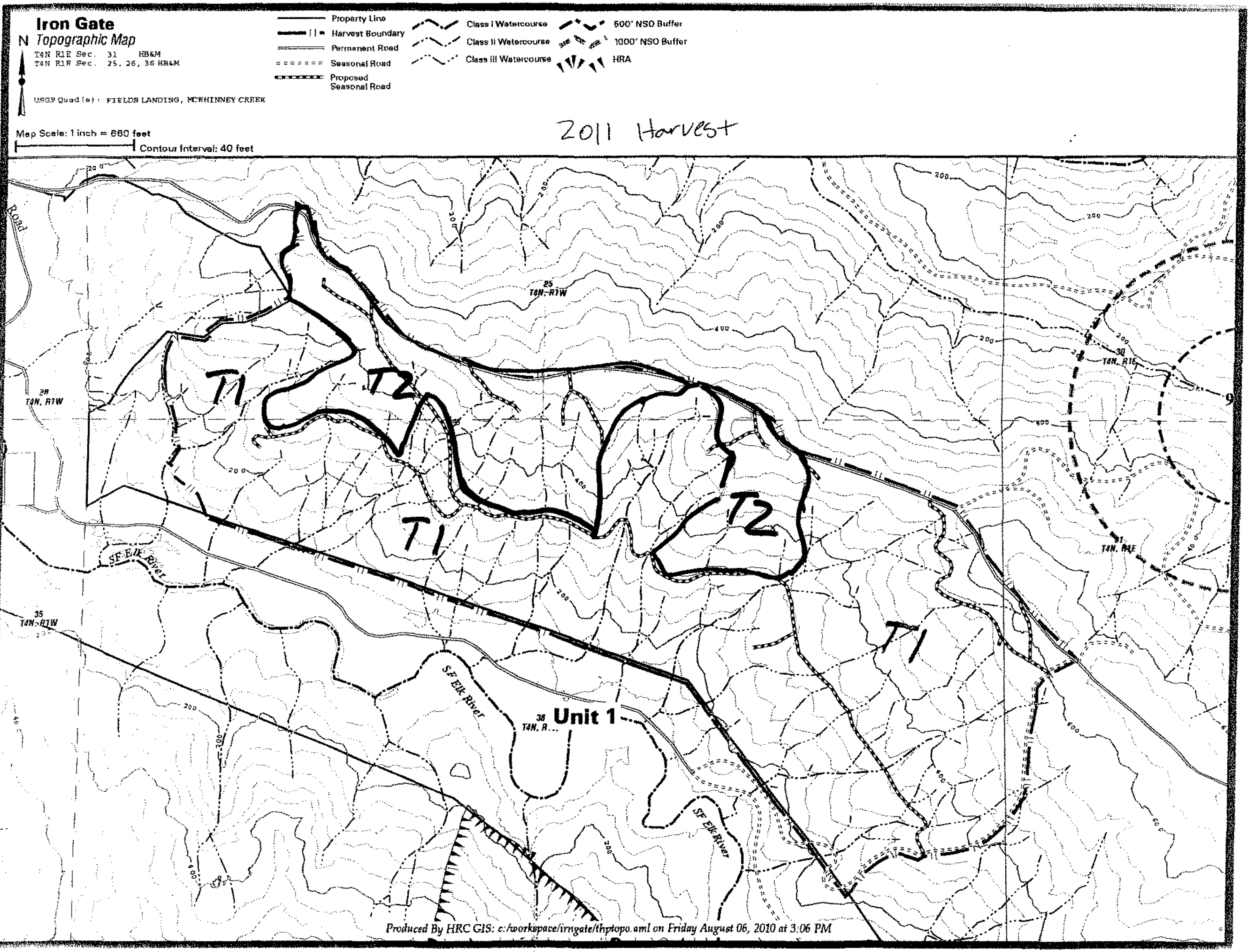
N *Topographic Map*

T4N R1E Sec. 31 HB&M
T4N R1W Sec. 25, 26, 36 HB&M

USGS Quad(s): FIELDS LANDING, MCWHINNEY CREEK

Map Scale: 1 inch = 660 feet

Contour Interval: 40 feet



Produced By HRC GIS: c:/workspace/irngate/thptopo.aml on Friday August 06, 2010 at 3:06 PM

Humboldt Redwood
COMPANY, LLC

THP: Iron Gate THP 11 -008 Unit # 1 March 5, 2011

Tools Used in This Assessment	Figure Number
Elevation Map with 10 ft Contours (HRC LiDAR)	1
SHALSTAB (Montgomery and Dietrich, 1994 and Palco, 2006) / Slope Class / Hillshade Maps	2
CGS Geology and Geomorphic Features (CGS, 2005)	3
Mass Wasting Potential Map (HRC, 1999)	4
Aerial Photo Map (HRC, 2007)	5
HRC Elk River and Salmon Creek WA deep-seated LS inventory (HRC, 2004)	6
Road Condition Map	7

Please see back of enrollment for references

Summary of Changes to THP Prescriptions Based on Tier II Analysis in this Unit:

Geologic Review	Forestry Silviculture/Site Prep Plan	Operational Design Plan
1-1	THP approved silviculture is mostly group selection with small areas of single tree selection in RMZ outer bands. No site preparation will occur due to partial harvesting.	The approved THP proposes ground based yarding on gently inclined slopes near the ridge top. The majority of the unit is approved for cable yarding. No change to approved yarding methods.

Geological Summary (information presented from existing bodies of work):

The THP included a Note 45 Geology report to address potentially unstable areas within the THP. The map series supplied in Tier II review was vetted during THP layout and culminated in the final THP prescriptions with respect to both harvest and road proposals. The report confirmed unstable areas within Unit 1 and provided harvest restrictions sufficient for both retention of slope stability and reviewing agency approval. For a more comprehensive review of the geology associated with this harvest unit, please see the report in Section 5 of the THP. This review is brief summary of the geology report found in the THP. Landslides documented in the geology report are outside the areas proposed for Tier II.

The unit is located on south facing slopes flanking a low relief east-west trending ridge. The unit covers a large area resulting in planar, convergent and divergent slope forms that range from gently to steeply inclined. Numerous watercourses extend into the unit and are typically poorly defined near the ridge top transitioning to well defined in the lower slope positions. The harvest unit is located over 250 feet upslope from the South Fork Elk River, a Class I watercourse.

Figure 3 shows the unit to be underlain by the Undifferentiated Wildcat Group sediments. These sediments are composed of silts, sands, clays, and infrequent gravels that are moderately consolidated. No landslides or landforms are mapped within the Tier II acres on Figure 3.

Figure 6 shows 2 areas of deep-seated mass wasting that extend into the proposed Tier II acres. These areas correspond with low to moderate Mass Wasting Potential shown on Figure 4. No evidence of deep-seated mass wasting was observed in these areas during field review.

Figure 2 (Hillslope shade) reveals shadows indicative of consistent and even weathering of the slopes within the unit. The transition from flanking slopes to the ridge-top is sharp and distinct. Segments of the truck roads and skid trails contrast distinctly with native slopes.

The area has been previously clearcut and ground-based logged with steam donkeys and bulldozers. Ground disturbance is observable throughout the unit in response to past harvest practices. The most recent harvesting occurred under the Forest Practice Rules and consisted of ground based yarding of pre-commercial thinning and salvage silviculture with stream buffers. The landscape mass wasting response to this harvest entry appears to be significantly reduced by these harvest methods and significant areas of concentrated ground disturbance are localized on landings and skid trails.

THP Unit: # 1
Polygon: 1-1

A) General Observations

A small portion of the unit is to be enrolled as Tier II acres. Tier II enrolment acres are concentrated in the upslope, central and western portions of the unit.

No Class I watercourse Riparian Management Zones extend into the unit.

Typical Riparian Management Zones for the Class II watercourses includes a 30-foot no harvest inner band and a selection buffer that extends the RMZ out to between 75 and 100 feet. The outer band may be harvested but must retain a minimum of 60% canopy closure.

The implemented THP mitigation for the Class III watercourses includes the retention of all trees growing within the active channel and all trees 8 inches and less within 15 feet of the channel. Where channel sideslopes are greater than 50%, a 100' RMZ has been established and maintaining 75 sq. ft (or the adjacent retention standard if greater) evenly distributed in the buffer. Where side slopes are less than 50% employ a 50' RMZ that maintains 75 sq. ft (or the adjacent harvest retention standard if greater) evenly distributed in the buffer and no group opening greater than ¼ acre immediately above the terminus of class III with slopes greater than 40% or immediately above a headwall swale. Additionally sub-merchantable trees and those with specific wildlife value characteristics (e.g., cavities, large limbs, broken tops, snags, etc.) will be retained within the harvest area to the extent feasible.

SHALSTAB modeling (Figure 2) highlights one Value 1 area consisting of 2 pixels within the proposed Tier II acres. The area is located adjacent a Class II, Class III watercourse confluence and truck road crossing. The Class II harvest exclusion zone has been expanded to 75 and 100 feet and encroaches on one of the pixels. The pixels are within a landslide mapped for watershed analysis deep-seated landslide inventory. No other landslides have been mapped in the vicinity. Figure 4 models low mass wasting potential in this area. Value 2 pixels are slightly more prevalent. We counted 5 Value 2 pixels that roughly correlate with the right lateral margin of a landslide mapped for watershed analysis. We observed no correlation between SHALSTAB Value 1 and 2 pixels and landslides mapped for the Note 45 Geologic Evaluation provided for this harvest plan.

Figure 4 shows Mass Wasting Potential (MWP) modeling for the unit varies from low to high. Low MWP is modeled in the majority of the unit. Moderate MWP is also prevalent in the lower slope positions of the unit. One area of high MWP extends into the operational portion of the unit. The high MWP is located in the southern, down slope portion of the unit and is not proposed for Tier II acres.

A) General Observations
Eight landslides and landforms were identified in the unit by the project geologist. The unstable areas identified are all associated with skid trails, roads, or streamside slopes and often a combination of skid trails in or adjacent watercourses. One landslide (**LS-6**) is not within Class II RMZ protection. None of the landslides and landforms identified by the project geologist are within areas proposed for Tier II acres.

B) Harvest Related Impacts and Hillslope Sensitivity
Extensive ground disturbance appears to be the most significant component to develop a landslide atop the soils within the unit (see geology report). Those activities are not proposed in this plan. The current planned cable yarding of the more steeply inclined slopes will result in less surface disturbance and significantly reduce the potential for mass wasting. Coupled with a partial harvest, the mass wasting potential is reduced even more. Significant surface disturbance has occurred within the unit in response to past logging activities. The disturbance is the culmination of road and layout construction. Following that impact, the area appears to have adjusted through minor slumping and settling and has reforested. The extensive RMZs were designed to provide sediment filtration bands adjacent the watercourses should extensive sediment be generated from the clearcut harvesting. The current level of harvest will retain both canopy closure and slash from the harvested trees potentially increasing the effectiveness of the sediment filtration band to the whole unit. Overall hillslope sensitivity with respect to the proposed selection harvest appears minimal with respect to mass wasting. Please see the THP geology report for a more comprehensive assessment of the role that timber harvesting has on slope stability.

C) Forestry / Silviculture Plan
We have not changed the silviculture in response to this evaluation.

D) Operational Design Plan
THP approved yarding method is cable where moderate to steeply inclined and ground based on gently inclined slopes, generally near the ridge top. As delineated, the proposed yarding methods appear appropriate.

References:

CGS, 2005, Geologic and Geomorphic Features Related to Landsliding, Elk River Watershed, Humboldt County, California. Department of Conservation, now California Geological Survey (CGS) Watershed Mapping Series, Mapset 4, Plate 1. Available via the web at ftp://ftp.consrv.ca.gov/pub/dmg/thp/maps/elk/elk_color.pdf

Montgomery, D.R. and W.E. Dietrich, 1994. A physically based model for the topographic control on shallow landsliding. Wat. Resour. Res. 30: 1153-1171. For specific details regarding the model used in this evaluation, please see Palco, 2006. Additional information from the model authors is available at the following website: http://socrates.berkeley.edu/~geomorph/shalstab

HRC, 2007, Ortho-photo rectified aerial photographs flown by 3Di West, Eugene Oregon,

HRC, 2008. Freshwater Creek and Elk River WDR Permit Acreage Enrollment and Compliant Monitoring Program, NCRWQCB R1-2006—0039 and R1-2006-0041, Quality Assurance Project Plan, Version 3.0. Policy document submitted to NCRWQCB dated June 7, 2006.

HRC, 2004, Elk River / Salmon Creek Watershed Analysis, Scotia, California, prepared for Pacific Lumber Company (PALCO) dated 2004?, and acquired by Humboldt Redwood Company, LLC in 2008.

HRC, 2005, (Policy Acquired from The Pacific Lumber Company (PALCO)) Prescriptions Based on Watershed Analysis for Freshwater Creek, California, August 15, 2002.

HRC, 1999, The Pacific Lumber Company's Habitat Conservation Plan, Vol. 2 Part D, Landscape Assessment of Geomorphic Sensitivity, Public Review Draft.

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.

Professional Certification of Design

I, Tagg Nordstrom, P.G. 7950, 4/17/11,
Name — license # — Date

PROFESSIONAL GEOLOGIST
TAGG S. NORDSTROM
No. 7950
STATE OF CALIFORNIA

Signature

Place licensed seal here

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. 1-11-008 HUM (Iron Gate) Unit # 1

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 R1-2006-0103, 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.

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

State of California
Regional Water Quality Control Board
APPLICATION/REPORT OF WASTE DISCHARGE
GENERAL INFORMATION FORM FOR
WASTE DISCHARGE REQUIREMENTS OR NPDES PERMIT

I. FACILITY INFORMATION

A. Facility:

Name: THP 1-11-008 Iron Gate			
Address:			
City:	County:	State:	Zip Code:
Contact Person: Jon Woessner		Telephone Number: 707-764-4376	

B. Facility Owner: (timber owner)

Name: Humboldt Redwood Company LLC			Owner Type (Check One): 1. ☐ Individual 2. ☒ Corporation 3. ☐ Governmental Agency 4. ☐ Partnership 5. ☐ Other
Address: P.O. Box 712			
City: Scotia	State: CA	Zip: 95565	
Contact Person: Jon Woessner		Telephone Number: 707-764-4376	Federal Tax ID:

C. Facility Operator (The agency or business, not the person): (plan submitter)

Name: Humboldt Redwood Company LLC			Owner Type (Check One): 1. ☐ Individual 2. ☒ Corporation 3. ☐ Governmental Agency 4. ☐ Partnership 5. ☐ Other
Address: P.O. Box 712			
City: Scotia	State: CA	Zip: 95565	
Contact Person: Jon Woessner		Telephone Number: 707-764-4376	Federal Tax ID:

D. Owner of the Land:

Name: Humboldt Redwood Company LLC			Owner Type (Check One): 1. ☐ Individual 2. ☒ Corporation 3. ☐ Governmental Agency 4. ☐ Partnership
Address: P.O. Box 712			
City: Scotia	State: CA	City: Scotia	State: CA
Contact Person: Jon Woessner		Telephone Number: 707-764-4376	Federal tax ID:

E. Address Where Legal Notice May Be Served:

Address: 125 Main Street		
City: Scotia	State: CA	Zip: 95565
Contact Person: Mike Jani		Telephone Number: 707-764-4403

F. Billing Address:

Address: P.O. Box 712		
City: Scotia	State: CA	Zip: 95565
Contact Person: Jon Woessner		Telephone Number: 707-764-4376

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

State of California
Regional Water Quality Control Board
APPLICATION/REPORT OF WASTE DISCHARGE
GENERAL INFORMATION FORM FOR
WASTE DISCHARGE REQUIREMENTS OR NPDES PERMIT

II. TYPE OF DISCHARGE

Check Type of Discharge(s) Described in this Application (A or B):

☒ **A. WASTE DISCHARGE TO LAND** ☐ **B. WASTE DISCHARGE TO SURFACE WATER**

Check all that apply:

☐ Domestic/Municipal Wastewater Treatment and Disposal	☐ Animal Waste Solids	☐ Animal or Aquacultural Wastewater
☐ Cooling Water	☐ Land Treatment Unit	☐ Biosolids/Residual
☐ Mining	☐ Dredge Material Disposal	☐ Hazardous Waste (see instructions)
☐ Waste Pile	☐ Surface Impoundment	☐ Landfill (see instructions)
☐ Wastewater Reclamation	☐ Industrial Process Wastewater	☐ Storm Water

☒ Other, please describe: Timber harvest activities

III. LOCATION OF THE FACILITY

Describe the physical location of the facility.

1. Assessor's Parcel Number(s)	2. Latitude	3. Longitude
Facility:	Facility:	Facility:
Discharge Point:	Discharge Point:	Discharge Point:

IV. REASON FOR FILING

☒ New Discharge or Facility	☐ Changes in Ownership/Operator (see instructions)
☐ Change in Design or Operation	☐ Waste Discharge Requirements Update or NPDES Permit Reissuance
☐ Change in Quantity/Type of Discharge	☐ Other:

V. CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA)

Name of Lead Agency: California Department of Forestry and Fire Protection

Has a public agency determined that the proposed project is exempt from CEQA? ☐ Yes ☒ No

If Yes, state the basis for the exemption and the name of the agency supplying the exemption on the line below.

Basis for Exemption/Agency:

Has a "Notice of Determination" been filed under CEQA? ☐ Yes ☒ No

If Yes, enclose a copy of the CEQA document, Environmental Impact Report, or Negative Declaration. If no, identify the expected type of CEQA document and expected date of completion.

Expected CEQA Documents:

☐ **EIR** ☐ **Negative Declaration** **Expected CEQA Completion Date:**

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

State of California
Regional Water Quality Control Board
APPLICATION/REPORT OF WASTE DISCHARGE
GENERAL INFORMATION FORM FOR
WASTE DISCHARGE REQUIREMENTS OR NPDES PERMIT

VI. OTHER REQUIRED INFORMATION

Please provide a COMPLETE characterization of your discharge. A complete characterization includes, but is not limited to, design and actual flows, a list of constituents and the discharge concentration of each constituent, a list of other appropriate waste discharge characteristics, a description and schematic drawing of all treatment processes, a description of any Best Management Practices (BMPs) used, and a description of disposal methods.

Also include a site map showing the location of the facility and, if you are submitting this application for an NPDES permit, identify the surface water to which you propose to discharge. Please try to limit your maps to a scale of 1:24,000 (7.5' USGS Quadrangle) or a street map, if more appropriate.

VII. OTHER

Attach additional sheets to explain any responses which need clarification. List attachments with titles and dates below:

____

____

____

You will be notified by a representative of the RWQCB within 30 days of receipt of your application. The notice will state if your application is complete or if there is additional information you must submit to complete your Application/Report of Waste Discharge, pursuant to Division 7, Section 13260 of the California Water Code.

VIII. CERTIFICATION

"I certify under penalty of law that this document, including all attachments and supplemental information, were prepared under my direction and supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment."

Print Name: Jon Woessner	Title: Northern Area Manager
Signature: JWoessner	Date: ~~12/6/10~~ 3/17/11

FOR OFFICE USE ONLY

Date Form 200 Received:	Letter to Discharger:	Fee Amount Received:	Check #:

Humboldt Redwood Company LLC

Erosion Control Plan (ECP) for the "Iron Gate" THP

This plan is being included in the THP to partially meet the requirements
of the North Coast Regional Water Quality Control Board
Watershed-wide Discharge Requirements. (**WWDRs**)

All operational portions of this ECP
that are to be enforced through the Forest Practice Rules
have been included in Section II of the THP.

Version **20080819**

Humboldt Redwood Company LLC Erosion Control Plan (ECP)

This document addresses the requirements of the California Regional Water Quality Control Board, North Coast Region Order No. R1-2006-0039 (Elk River) for an Erosion Control Plan (ECP) related to timber harvest activities on Non-Federal lands in the North Coast Region (Sec. III D2 and D3). The responsible party for this ECP is Humboldt Redwood Company LLC, P.O. Box 712 Scotia, CA 95565 (707) 764-2330.

This ECP is submitted for: Iron Gate: **Iron Gate**
Contact Person: **Jon Woessner [North Area Manager]** Phone: **(707) 764-4376**

The landowner is committed to a wide variety of measures to prevent and minimize the discharge or threatened discharge of sediment from controllable sediment discharge sources as part of this project into the waters of the state in violation of applicable water quality requirements. Prevention and Minimization of Controllable Sediment Discharge Sources associated with this project are identified in the *Controllable Sediment Sources* table. The specific conditions of sediment discharge sources and a summary of prevention and minimization measures (Section I) are identified in the table. General prevention and minimization measures for the project (Section II) are incorporated in the ECP by reference.

The RPF and/or the RPF Designee have conducted an inventory of potential "controllable sediment discharge sources" within the project area. As defined in California Regional Water Quality Control Board Order No. R1-2006-0039 (Elk River).

"Controllable sediment discharge source" means sites or locations, both existing and those created by proposed timber harvest activities, within the Project area that meet all the following conditions:

1. is discharging or has the potential to discharge sediment to waters of the state in violation of applicable water quality requirements or other provisions of these WWDRs,
2. was caused or affected by human activity, and
3. may feasibly and reasonably respond to prevention."

Upon guidance of the North Coast Regional Water Quality Control Board (NCRWQCB) staff, discharge from the source must be likely to occur during the life of the Timber Harvesting Plan (THP) and WWDR. (Holly Lundborg, personal communication)

The inventory method consisted of an appurtenant road survey, aerial photos and ground assessments of the harvest units, and a complete ground assessment of all watercourses and associated stream protection zones.

The schedule for implementing the prevention and minimization management measures for the controllable sediment sources will be consistent with the duration of the THP. These measures will be implemented in accordance with the priority level assigned to each site. High priority sites will be addressed first with low priority sites to follow. Work at all sites will be accomplished prior to THP expiration. The general prevention and minimization measures will be implemented concurrent with operations.

I. Inventory and Treatment of Controllable Sediment Sources

All controllable sediment sources are listed in the attached "Erosion Control Plan" table. These sources have been assigned a treatment priority of low, medium or high based on: 1) potential for significant sediment delivery to a Class I, II or III channel; 2) treatment immediacy (a subjective combination of event probability and sediment delivery); and 3) treatment cost-effectiveness.

The Prioritization for implementing prevention and minimization measures for road-related and non road-related controllable sediment sources is based upon guidance provided in Order No. **R1-2006-0039 (Elk River)**. Highest priority is assigned to the largest sediment discharge sources that discharge to waters that support domestic water supplies or fish. The landowner's prioritization method considers this guidance, and combines it with consideration for accessibility and level of imminent risk of significant sediment discharge. Sources that receive a high priority rating will be treated by a date certain as noted in the Controllable Sediment Sources table. Sources that receive a low or medium rating are determined to have a low to moderate risk of imminent discharge and will be treated prior to completion of the THP, or as otherwise indicated.

Non-road related controllable sediment sources can include skid road crossings, yarding furrow, skid road in watercourse, perched skid road fill, skid road rutting, landslide, layouts, railroad grade, incline, etc.

Information specific to Controllable Sediment Discharge Sources is listed in the Controllable Sediment Sources Table, below. An explanation of information provided in that table is provided below.

II. General Prevention and Minimization Measures for Controllable Sediment Discharge

In addition to the site specific measures detailed above, the general measures proposed in this project, either as required by another State or Federal regulating agency, or as a matter of Humboldt Redwood Company policy, will prevent or minimize future sediment delivery. These measures include, but are not limited to measures incorporated in the THP Section Items as follows:

THP Section II:

- Item 14 – Describes silvicultural prescriptions
  - (i) Site Preparation – Disclosure of selected site preparation treatments and mitigation measures
- Item 16 – Harvesting Practices – Describes yarding systems, equipment utilized, equipment limitations, and drainage facility installation timing
  - Inclusive through (m) – equipment use limitations and mitigation
- Item 18 – Soil Stabilization – waterbreak requirements, mitigation to minimize soil disturbance and sediment transport
- Item 20 – Ground Based Equipment Use Location
- Item 21 – Ground Based Equipment Use in Sensitive Areas – locations, descriptions of operations, limitations and mitigation measures
- Item 22 – Alternative Practices to Harvesting and Erosion Control
- Item 23 – Winter Operations – Provides descriptions of limitations and mitigation measures required during winter period operations and Winter Operating Plan
- Item 24 – Roads and Landings – Describes road and landing construction and re-construction operations, limitations, drainage relief structure installation, mitigation measures, road maintenance, inspections and wet weather road use restrictions
- Item 25 – Site Specific Measures to Reduce Adverse Impacts and Special Instructions to the LTO
- Item 26 – Watercourse and Lake Protection (WLPZ)
- Item 27 – "In Lieu" WLPZ Practice(s)
- Item 28 – Downstream Water Users Notification and Domestic Water Supply Protection Description of protection measures
- Item 29 – Sensitive Watershed – Identifies whether the plan is located in a designated sensitive watershed and mitigation measures
- Item 29 – 1 Hillslope Management (HCP 6.3.3.7) – Describes HCP hillslope management measures required as per watershed analysis

THP Section V:

- Sediment Reduction from Roads and THP Sediment Production--Including Table 1 – "Sediment Delivery for Units and Roads for this THP," references, letter regarding Road related sediment assessment for this THP with the calculations of deliverable net cubic yards of sediment, calculations and PWA information related to the THP project area when available.

III Inspection Plan and Reporting Requirements

A. Inspection Plan
The Inspection Plan is designed to ensure that all required management measures are installed and functioning prior to rainfall events; that the management measures are effective in controlling sediment discharge sources throughout the winter period; and that no new controllable sediment discharge sources developed.

B. Qualified and trained professionals will conduct all specified inspections of the project site to identify areas causing or contributing to a violation of the applicable water quality requirements or other provisions of these WWDRs. The responsible party for inspection and reporting is **Jon Woessner (707) 764-4376**

C. No inspections are required in Project Areas where Timber Harvest Activities have not yet commenced.

D. Project Areas where Timber Harvest Activities have commenced and no winter period Timber Harvest Activities have occurred inspections will be conducted each year and throughout the duration of the Project while Timber Harvest Activities occur.

a. The Project is covered under WWDRs and the following inspection requirements will begin at the startup of timber harvest activities within the Project area:
   i. By November 15 to assure Project Areas are secure for the winter period;

ii. Once following ten (10) inches of cumulative rainfall commencing on November 15 and prior to March 1, as worker safety and access allows; and
iii. After April 1 and before June 15 to assess the effectiveness of management measures designed to address controllable sediment discharges and to determine if any new controllable sediment discharges sources have developed.

b. Project Areas with Winter Period Timber Harvest Activities will conduct inspections of such Project Areas while Timber Harvesting Activities occur and the Project is covered under the WWDRs as follows:
   i. Immediately following cessation of winter period Timber Harvest Activities to assure areas with winter Timber Harvest Activities are secure for the winter;
   ii. Once following ten (10) inches of cumulative rainfall commencing on November 15 and prior to March 1, as worker safety and access allows; and
   iii. After April 1 and before June 15 to assess the effectiveness of management measures designed to address controllable sediment discharges and to determine if any new controllable sediment discharges sources have developed.

c. Inspection reports will identify where management measures have been ineffective and when repairs and design changes will be implemented to correct management measure failures.

d. After completing the required inspections, and when it has been determined new controllable sediment discharges sources have developed, the ECP, implementation schedule, and inspection plan will be updated, if required, consistent with the WWDRs and submit the updated documents to the Regional Water Board to maintain coverage under the WWDRs. If the approved amendment is found to be out of compliance with the WWDRs, the Project will be amended to be consistent with the provisions of the WWDR within 30 days, or coverage under the WWDRs will be terminated. The Project will then be required to seek Project coverage under an individual WDR.

e. Equipment, materials, and workers will be available for rapid response to failures and emergencies, implement, as feasible, emergency management measures depending upon field conditions and worker safety for access.

D. If during the inspection or during the course of conducting timber harvest activities, a violation of an applicable water quality requirement or conditions of WWDRs is discovered, the following procedures will be followed:

a. When it has been determined that discharges are causing or contributing to a violation or an exceedence of an applicable water quality requirement or a violation of a WWDR prohibition:
   i. Corrective measures will be implemented immediately following the discovery that applicable water quality requirements were exceeded or a prohibition violated, followed by notification to the Regional Board by telephone as soon as possible but no later than 48 hours after the discharge has been discovered. The notification will be followed by a report within 14 days to the Regional Board, unless otherwise directed by the Executive Officer, that includes:
      1. the date the violation was discovered;
      2. the name and title of the person(s) discovering the violation;
      3. a map showing the location of the violation site;
      4. a description of recent weather conditions prior to discovering the violation;
      5. the nature and cause of the water quality requirement violation or exceedence or WWDR prohibition violation;
      6. photos of the site characterizing the violation;
      7. the management measure(s) currently being implemented;
      8. any maintenance or repair of management measures;
      9. any additional management measures which will be implemented to prevent or reduce discharges that are causing or contributing to the violation or exceedence of applicable water quality requirements or WWDR prohibition violation; and,
      10. the signature and title of the person preparing the report.
      11. the report will include an implementation schedule for corrective actions and describe the actions taken to reduce the discharges causing or contributing to violation or exceedence of applicable water quality requirements or WWDR prohibition violation.

E. For other inspections conducted where violations are not discovered, a summary report will be submitted to Executive Officer by June 30th for each year of coverage under the WWDRs or upon termination of coverage. The summary report, at a minimum will include the date of inspections, the inspector's name, the location of each inspection, and the title and name of the person submitting the summary report.

If helicopter operations are proposed for this project, please find attached a Columbia Helicopters, Inc. (CHI) Fuel Spill Prevention and Cleanup Plan For Columbia Helicopters Field Operations. **No helicopter operations are proposed for this plan.**

Explanation of Information Included in the Controllable Sediment Sources Table	
Column Heading	Explanation
Site No.	Site identification unique to project area
Site Type	A description of the existing site. Example: Humboldt Crossing; Culvert Crossing; Unstable Fill; Unstable Cut Slope; Diversion Potential.
Estimate of Potential Erosion	A quantitative estimate of the volume, in cubic yards, of the total amount of potential erosion/displacement of soil that will occur should the site entirely fail. The landowner often uses a methodology developed by Pacific Watershed Associates to estimate erosion, which assumes 100% delivery of calculated volume—use of this method for individual sites is noted in Site Description.
Potential Sediment Delivery Percent	An estimate of the relative potential for sediment delivery expressed as a percent of the total amount of Potential Erosion that will be discharged to waters of the State should the site fail.
Sediment Prevention Volume	The volume, in cubic yards, of sediment discharge estimated to be prevented by implementation of the prescribed treatment. Volume represents the Estimate of Potential Erosion multiplied by the Potential Sediment Delivery Percent.
Priority for Treatment	Treatment priority reflects the immediacy of sediment discharge and the relative risk to the receptor, should the site fail. Low priority sites are ones that will not likely deliver significant amounts of sediment during the life of the WWDR permit, and will be treated prior to filing of THP work completion report, which does not exceed 5-years following THP approval date. Medium or high priority sites indicate potentially imminent discharge, and the timing of treatment is indicted in Implementation Schedule column.
Implementation Schedule	Indicates the timing of implementing the prevention and minimization measures listed in the Treatment column.
Site Description	Provides sufficient information that describes the existing condition of the site and factors that inform the chosen treatment methods and implementation schedule. This information will include a description of how the existing condition of the site (ie. stable or unstable) will be affected by different storm events, and whether sediment discharge is imminent. For example, an unstable site could easily discharge significant amounts of sediment in a small storm, thus the treatment priority should be higher. Conversely, a stable site that may take one or more very large storms to trigger discharge could be lower treatment priority. If PWA method is used to calculate erosion/delivery volumes, it will noted here.
Treatment	Sediment discharge prevention and minimization measures that will be implemented at the site, including treatment specifications if necessary.

Attachments:

- **ECP Table**
- **Appurtenant Road Map**
- **Road Construction Locations / ECP Site Locations Map**

Erosion Control Plan

Site	Site Type	Est. Potential Erosion (Cu.Yards)	Est. Potential Delivery (Cu.Yards & %)		Priority for Treatment	Implementation Schedule	Site Description	Treatment
Project iron gate								
RD: Off Road STATION: 0 SITE: bfc509 WOID: 1241314470 SEDID: 8989 REPAIRED: NO	Tractor Crossing	22	22	100%	Med	Prior to THP Final Completion.	Tractor crossing with intact surface, but full subsurface flow. A sediment trail is below crossing.	Tractor crossing with intact surface, but full subsurface flow. Excavate crossing, which may become integrated with sites bfc510 above and bfc512 below. A geologist shall evaluate how much of the channel shall be excavated above this site, in particular the sediment wedge between sites 509 and 510.
RD: Off Road STATION: 0 SITE: bfc510 WOID: -1329322705 SEDID: 8990 REPAIRED: NO	Tractor Crossing	83	83	100%	Med	Prior to THP Final Completion.	Large tractor crossing with active head cutting on the lower end. This site will merge down to site bfc509.	Large tractor crossing with active head cutting on the lower end. This site will merge down to site bfc509. Excavate crossing from the head cutting to the upper stumps. Excavation of the lower channel may not be feasible, as doing so will create steep, unstable side walls. A geologist shall evaluate whether or not to remove the sediment wedge between sites 509 and 510.
RD: Off Road STATION: 0 SITE: bfc541 WOID: -324877500 SEDID: 9021 REPAIRED: NO	Tractor Crossing	48	48	100%	Low	Prior to THP Final Completion.	Tractor crossing just above Site bfc542 (5380 on the U08.12).	Small tractor crossing just above Site bfc542 (5380 on the U08.12). Excavate the crossing to grade concurrent with completing work on Site 5380.
RD: Off Road STATION: 0 SITE: X 1 WOID: 1359702773 SEDID: 11248 REPAIRED: NO	Failing Crossing	6	6	100%	Low	Prior to THP Final Completion.	Small CIII tractor crossing, partially washed out.	Small CIII tractor crossing, partially washed out. Excavate remaining crossing. Access is at the end of the U08.14.
RD: Off Road STATION: 0 SITE: X 2 WOID: 895085330 SEDID: 11247 REPAIRED: NO	Tractor Crossing	30	30	100%	Low	Prior to THP Final Completion.	Small CIII tractor crossing, partially washed out	Small CIII tractor crossing, partially washed out. Excavate remaining crossing. Access is at the end of the U08.14.
RD: U08.08 STATION: 411 SITE: C 1 WOID: 1986031852 SEDID: 11245 REPAIRED: NO	Humboldt	75	75	100%	Low	Prior to Oct 15; FIRST year of operations.	Upper end CIII, subsurface flow above and below.	Upper end CIII, subsurface flow above and below. Use crossing in its current state. Following operations excavate crossing down to channel, exposing inlet and outlet holes at TOP and BOT. After excavation armor as may be necessary the top and bottom subsurface channel openings to prevent collapse. This site shall be completed by October 15 of the first year this road is used.

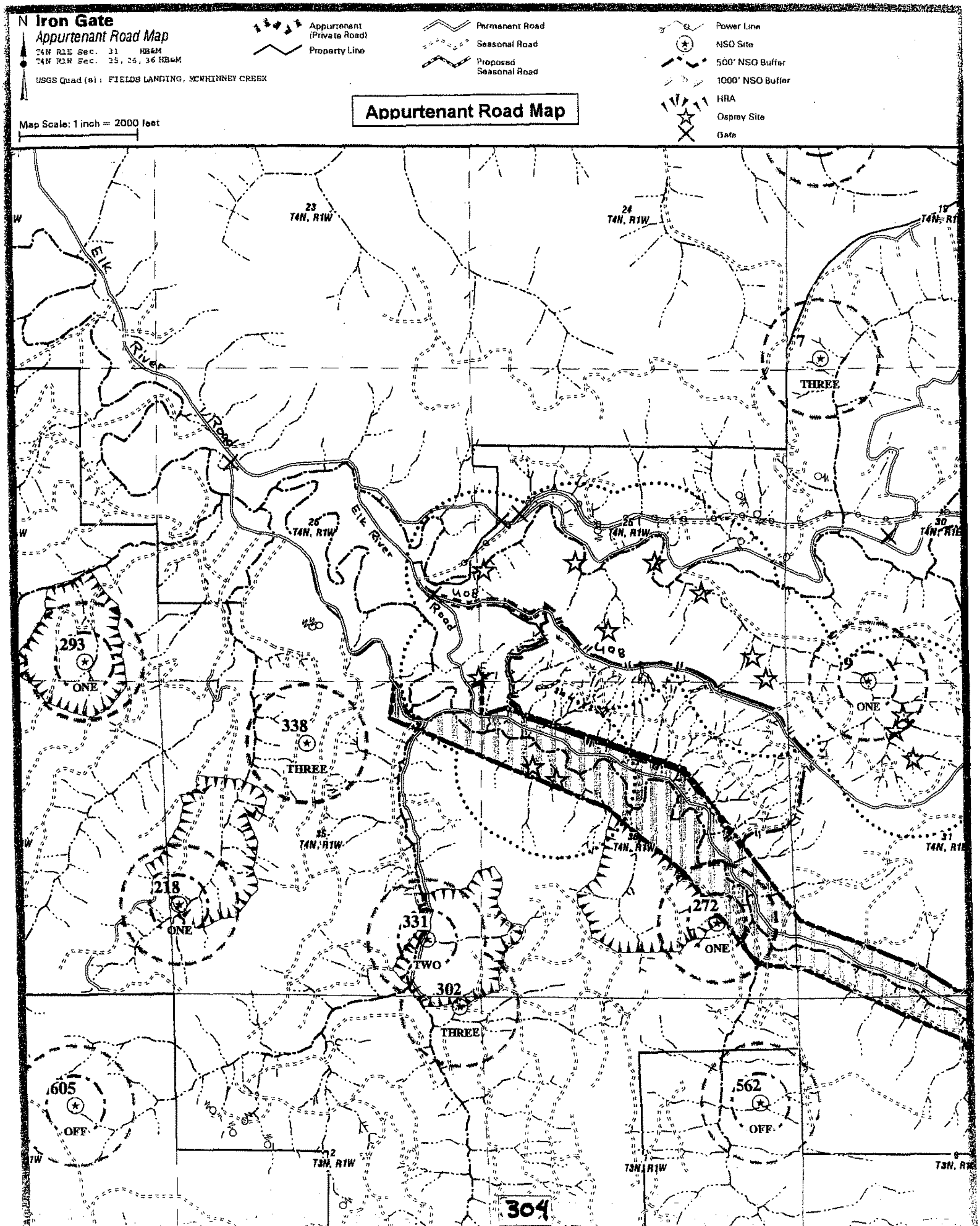
Site	Site Type	Est. Potential Erosion (Cu.Yards)	Est. Potential Delivery (Cu.Yards & %)	Priority for Treatment	Implementation Schedule	Site Description	Treatment
RD: U08.08 STATION: 807 SITE: C 2 WOID: 325575037 SEDID: 11246 REPAIRED: NO	Watercourse Diversion	147	147 100%	Low	Prior to Oct 15; FIRST year of operations.	CIII channel runs subsurface beneath the road for 105 feet before exiting to original channel. The road was constructed over the CIII, both of which run on a downhill sideslope path.	CIII channel runs subsurface beneath the road for 105 feet before exiting to original channel. The road was constructed over the CIII, both of which run on a downhill sideslope path. This site will be used in its current condition for one season, and abandoned by October 15. Usage of the road will consist of filling in the upper sinkhole (at least 6 feet deep) and grading the road surface. Operations on the road will only take place during the dry period of summer (June or later) when this part of the watercourse will be completely water free. Abandonment Procedures: Excavate the entire channel from 807 to 912.. Recontour the outfall slope to form an open channel that merges with the original channel. Armor the outfall if the final gradient appears steep. Place a large dip/berm across the road at 767 (uphill of 807) to disconnect the road surface. Slash or mulch the road surface between 767 and 807. This site shall be completed by October 15 of the first year this road is used.
RD: U08.0802 STATION: 233 SITE: C 1 WOID: 431411682 SEDID: 11243 REPAIRED: NO	Failing Crossing	76	76 100%	Med	Prior to THP Final Completion.	CIII crosing is slumping.	CIII crosing surface is slumping, possibly a failing Humbloldt. 'Excavate to TOP and BOT flags and install culvert.
RD: U08.0802 STATION: 915 SITE: C 2 WOID: -1833381535 SEDID: 11244 REPAIRED: NO	Humboldt	50	50 100%	Low	Prior to THP Final Completion.	CIII crossing with subsurface flow.	CIII crossing with subsurface flow. Excavate the crossing from TOP to BOT flags, and install culvert.
RD: U08.12 STATION: 580 SITE: C 1 WOID: -1144638250 SEDID: 11232 REPAIRED: NO	Failing Crossing	187	187 100%	Med	Prior to THP Final Completion.	Upper CIII with several sinkholes between TOP and BOT.	Upper CIII with several sinkholes between TOP and BOT. Excavate TOP to BOT and install culvert.

Site	Site Type	Est. Potential Erosion (Cu.Yards)	Est. Potential Delivery (Cu.Yards & %)		Priority for Treatment	Implementation Schedule	Site Description	Treatment
RD: U08.12 STATION: 695 SITE: C 2 WOID: -1664119393 SEDID: 11233 REPAIRED: NO	Rock Ford	37	37	100%	Low	Prior to THP Final Completion.	Tractor use has fillied in the Class III channel, allowing flow to divert down the road.	Tractor use has fillied in the upper Class III channel, allowing flow to divert onto the road surface. Reconstruct the channel from TOP flag to the road edge, where the rocked ford will be installed. Rock armor the right side of the channel where it turns sharply to enter the ford. Install a rocked ford, making sure that the lower rim of the dip is high enough to prevent overflow down the road surface. There is no defined channel at the outboard edge. Choose the best option of directing flow between the two large stumps just below the road edge. Rock armor the outflow at least to the stumps. LWD may be used beyond that.
RD: U08.12 STATION: 910 SITE: C 3 WOID: -406271771 SEDID: 11234 REPAIRED: NO	Crossing	23	23	100%	Low	Prior to THP Final Completion.	Class III with over road surface flow.	Class III with over road flow. Excavate crossing from TOP to BOT flags and Install culvert. Remove the overlaying chunks at the TOP, leaving the embedded chunks. Culvert outfall will be narrow and steep, channeling between two large stumps. Use downspout or well placed dissipation materials to prevent scour. Extend lower fill face to stabilize left/right banks.
RD: U08.12 STATION: 965 SITE: C 4 WOID: -1559687614 SEDID: 11235 REPAIRED: NO	Failing Crossing	21	21	100%	Low	Prior to THP Final Completion.	Upper end Class III flows under the road surface.	Upper end Class III flows under the road surface. Excavate from TOP to BOT flags and install culvert. Armor the inlet basin walls to prevent collapse of soil and buried LWD. Construct inlet basin large enough to capture side flow on the right.
RD: U08.12 STATION: 1422 SITE: C 6 WOID: 165574977 SEDID: 11238 REPAIRED: NO	Failing Crossing	26	26	100%	Med	Prior to THP Final Completion.	Class III flows under the road with visible sinkholes in crossing.	Class III flows under the road with visible sinkholes in crossing. Excavate from TOP to BOT and install culvert. Excavate an inlet basin to accept flow from adjacent CIII at 1446.
RD: U08.12 STATION: 1446 SITE: C 7 WOID: 1749792366 SEDID: 11240 REPAIRED: NO	Watercourse Diversion	4	4	100%	Low	Prior to THP Final Completion.	This Class III has been diverted from its original channel at site 1422, and now flows onto the road surface.	This Class III has been diverted from its original channel at site 1422, and now flows onto the road surface. Reconstruct the channel (flagged) to direct flow into the inlet of 1422. Dig deep enough to capture soil pipe below. Rock line the channel's lower side to prevent scour.
RD: U08.12 STATION: 1850 SITE: bfc508 WOID: 2126871116 SEDID: 8988 REPAIRED: NO	Failing Crossing	50	50	100%	Med	Prior to THP Final Completion.	Subsurface CIII with collapsing road surface.	Subsurface CIII with collapsing road surface. Excavate from TOP to BOT and Install an 18 inch culvet with a rock lined inlet basin. Geologist shall be on site during removal of the fill and logs.

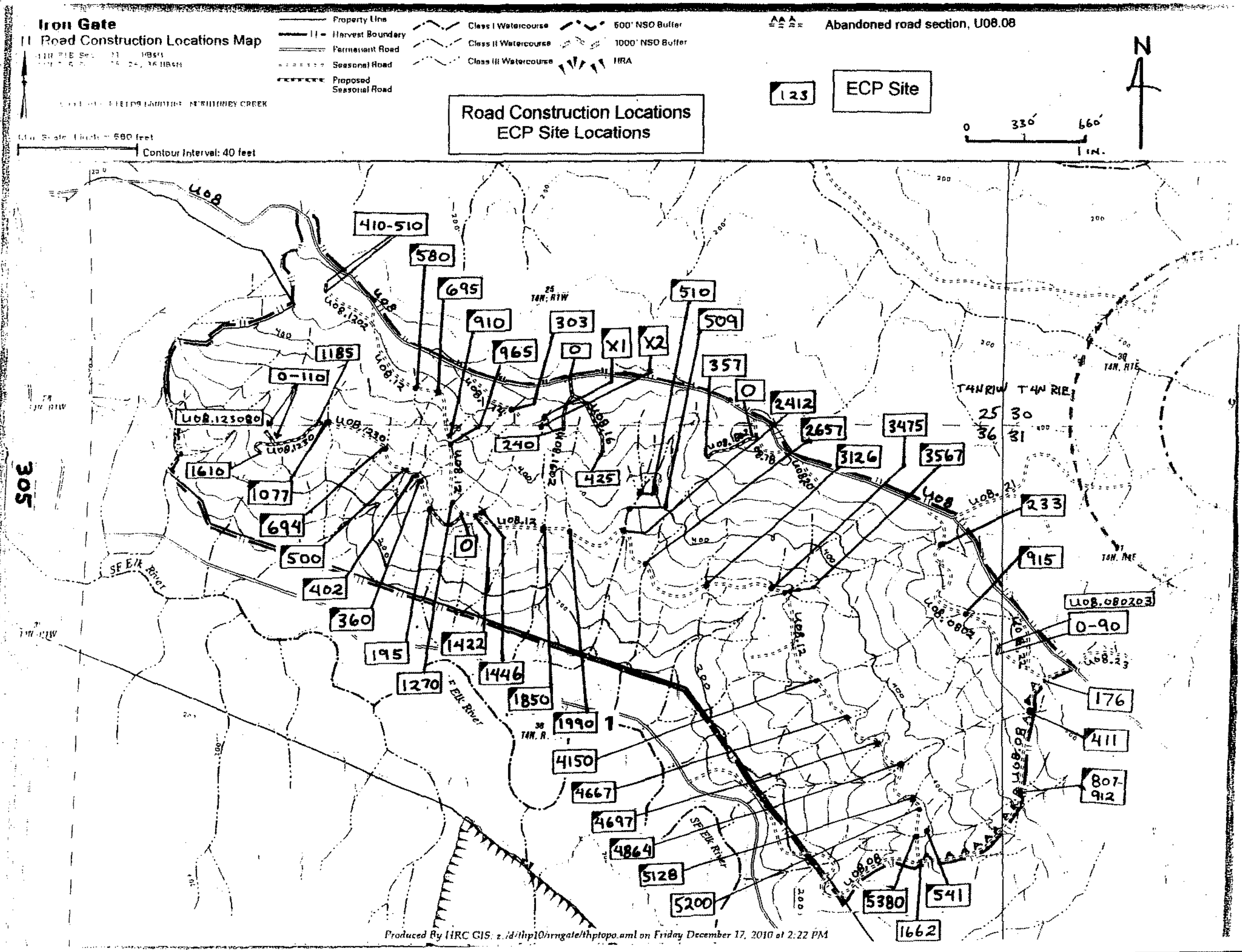
Site	Site Type	Est. Potential Erosion (Cu.Yards)	Est. Potential Delivery (Cu.Yards & %)		Priority for Treatment	Implementation Schedule	Site Description	Treatment
RD: U08.12 STATION: 1990 SITE: C 8 WOID: -879311011 SEDID: 11241 REPAIRED: NO	Rock Ford	132	132	100%	Low	Prior to THP Final Completion.	A Class III flows across the surface of a large landing, diverting left of the original channel. The landing has extensive LWD along its perimeter.	A Class III flows across the surface of a large landing, diverting left of the original channel. The landing has extensive LWD along its perimeter. Excavate the landing to reveal the original channel. Use the onsite LWD for bank armoring. Leave the existing road surface intact, and install a rocked ford. Use armoring to cover the newly exposed outfall channel below the ford.
RD: U08.12 STATION: 2412 SITE: bfc512 WOID: 115251546 SEDID: 8992 REPAIRED: NO	Failing Crossing	116	116	100%	Med	Prior to THP Final Completion.	CII failing Humboldt with large sediment basin above the inlet.	CII failing Humboldt with large sediment basin above the inlet. Excavate TOP to BOT to original channel. Install 24 inch culvert. This site will become integrated with two upper off-road sites, bfc509 and bfc510. A geologist shall provide oversite as to the extent of sediment removal above the crossing.
RD: U08.12 STATION: 2657 SITE: bfc513 WOID: 1197986003 SEDID: 8993 REPAIRED: NO	Failing Crossing	103	103	100%	Med	Prior to THP Final Completion.	Failing Humboldt with several sinkholes in the road. A small skid road crossing is located at the TOP.	Failing Humboldt with several sinkholes in the road. A small skid road crossing is located just below the TOP flag (not listed as a sediment site). Excavate the skid road crossing in conjunction with the truck road crossing. Install a buttress wall as needed at the TOP for support of upstream debris. Excavate the main truck road crossing down to BOT, where the watercourse continues under ground for at least 150 feet. Armor the lower entrance hole as needed to prevent collapse. Install culvert.
RD: U08.12 STATION: 3126 SITE: C 9 WOID: 1291130131 SEDID: 11242 REPAIRED: NO	Humboldt	29	29	100%	Med	Prior to THP Final Completion.	CIII crossing with failing Humboldt.	CIII crossing with failing Humboldt. Excavate from TOP to BOT and install culvert. Install dissipater at the outlet.
RD: U08.12 STATION: 3567 SITE: bfc518 WOID: -1113789063 SEDID: 8998 REPAIRED: NO	Failing Crossing	118	118	100%	Med	Prior to THP Final Completion.	Failing Humboldt, just above the Class III / II split.	Failing Humboldt, just above the Class III / II split. Install 24 inch culvert. Both top and bottom channells are impacted with LWD, and flow subsurface. Excavate between top and bottom stumps to locate the original channel. Remove the LWD mass on the lower left slope. Excavate an inlet basin with headwall armoring at the top. Extend lower fill to large stump for stabilization of side slopes.
RD: U08.12 STATION: 4667 SITE: bfc527 WOID: 1798097892 SEDID: 9007 REPAIRED: NO	Failing Crossing	60	60	100%	Med	Prior to THP Final Completion.	CII crossing is partially washed out. All flow is subsurface. The lower side is impacted with LWD.	CIII crossing has sunk about two feet, with six foot deep sinkhole at inboard edge of road. The upper channel is completely subsurface. Excavate channel TOP to BOT and install culvert.
RD: U08.12 STATION: 4697 SITE: bfc526 WOID: -1693536491 SEDID: 9006 REPAIRED: NO	Failing Crossing	111	111	100%	Med	Prior to THP Final Completion.	CIII road surface has sunk. Flow is subsurface above and below the crossing, with heavy LWD deposits above TOP.	CIII road surface has sunk. Flow is subsurface above and below the crossing, with heavy LWD deposits above TOP. Excavate channel from TOP to BOT, exposing channel inlet and outlet openings. Install culvert. Armor both openings as needed to prevent collapse. This crossing is basically an out of hole, back into hole, with a culvert in between.

Site	Site Type	Est. Potential Erosion (Cu.Yards)	Est. Potential Delivery (Cu.Yards & %)	Priority for Treatment	Implementation Schedule	Site Description	Treatment
RD: U08.12 STATION: 4864 SITE: bfc535 WOID: -1893620558 SEDID: 9015 REPAIRED: NO	Humboldt	133	133 100%	Med	Prior to THP Final Completion.	CII crossing is partially washed out. All flow is subsurface.	CII crossing is partially washed out. All flow is subsurface. The lower side is impacted with LWD. Excavate the crossing down to grade, from TOP to BOT and install culvert. The bottom flag is short, stopping at a mass of LWD which is stabilizing the lower channel. Excavate the lower left shoulder (stumps and trees), and stabilize the bank. Extend fill as needed to stabilize left/right side banks. The TOP flag is located close to the inlet to prevent the creation of instability upstream. Excavate to expose the channel, and stabilize the inlet area with rock or LWD.
RD: U08.12 STATION: 5128 SITE: bfc544 WOID: -1788747957 SEDID: 9024 REPAIRED: NO	Rock Ford	53	53 100%	Low	Prior to THP Final Completion.	CIII upper end of channel, with no apparent Humboldt.	CIII upper end of channel, with no apparent Humboldt. Install rocked ford, with a rocked outfall of at least 25 feet. As an alternative an 18 inch culvert with dissipater or downspout may be used.
RD: U08.12 STATION: 5380 SITE: bfc542 WOID: 1766892145 SEDID: 9022 REPAIRED: NO	Failing Crossing	62	62 100%	Med	Prior to THP Final Completion.	CII crossing with failing Humblodt.. Upper and lower channels are impacted and subsurface, with steep side slopes.	CII crossing with failing Humblodt. Upper and lower channels are impacted and subsurface, with steep side slopes. Excavate between TOP and BOT to expose channel, and install culvert. Stabilize the lower channel to prevent collapse of the entrance hole. TOP flag is close to the inlet due to two large stumps in the channel. Excavate around the lower stump, removing as much edge wood as possible, and create a small inlet basin between stumps. Site bfc541 lies just above this crossing, and should be completed concurrently. This site is the sediment savings site for the THP.
RD: U08.1230 STATION: 360 SITE: C 2 WOID: 1833774538 SEDID: 11237 REPAIRED: NO	Permanent Crossing	84	84 100%	Med	Prior to THP Final Completion.	CIII with subsurface flow.	CIII with subsurface flow. Excavate TOP to BOT and install culvert. A geologist shall delineate the upper cut limit, due to the presence of scarp lines, and recommend mitigation work. This site will blend into site 402, just up the road.
RD: U08.1230 STATION: 402 SITE: bfc507 WOID: -1909159805 SEDID: 8987 REPAIRED: NO	Failing Crossing	18	18 100%	Med	Prior to THP Final Completion.	Mostly washed out CII crossing.	Mostly washed out CII. Excavate TOP to BOT and install culvert. This site will blend into site 360
RD: U08.1230 STATION: 500 SITE: bfc506 WOID: 60928264 SEDID: 8986 REPAIRED: NO	Failing Crossing	35	35 100%	Med	Prior to THP Final Completion.	Mostly washed out CIII crossing.	Mostly washed out CIII crossing. Excavate small inlet basin and rock line. Install culvert

Site	Site Type	Est. Potential Erosion (Cu.Yards)	Est. Potential Delivery (Cu.Yards & %)	Priority for Treatment	Implementation Schedule	Site Description	Treatment
RD: U08.1230 STATION: 694 SITE: C 3 WOID: 41504361 SEDID: 11249 REPAIRED: NO	Rock Ford	2	2 100%	Low	Prior to THP Final Completion.	CIII crossing with a shallow, layed back channel.	CIII crossing with a shallow, layed back channel. Install rocked ford.
RD: U08.1230 STATION: 1077 SITE: C 4 WOID: -1190846858 SEDID: 11236 REPAIRED: NO	Temporary Crossing	27	27 100%	Low	Prior to THP Final Completion.	Mostly dipped out CIII crossing.	CIII crossing, mostly dipped out. Use crossing as is, stabilizing as necessary for usage. At the end of operations pull crossing to grade. . . . .
Total Estimated Yards		1968	1968				



Produced By HRC GIS: z:/d/thp10/irngate/apprdplot.aml on Friday December 17, 2010 at 2:27 PM


Iron Gate
Road Construction Locations Map
Property Line
Harvest Boundary
Permanent Road
Seasonal Road
Proposed Seasonal Road
Class I Watercourse
Class II Watercourse
Class III Watercourse
500' NSO Buffer
1000' NSO Buffer
HRA
Abandoned road section, U08.08
ECP Site
Road Construction Locations
ECP Site Locations
Contour Interval: 40 feet
0 330' 660'
1 IN.
N
U08
U08.12
U08.1202
U08.123080
U08.1230
U08.21
U08.080203
U08.0802
U08.23
SF Elk River
T4N R1W T4N R1E
25 30
36 31
410-510
580
695
910
965
303
0
X1
X2
510
509
357
2412
2657
3475
3126
3567
1185
0-110
1610
1077
694
500
402
360
195
1422
1270
1446
1850
1990
240
425
233
915
0-90
176
411
807-912
4150
4667
4697
4864
5128
5200
5380
541
1662
305
Produced By HRC GIS: z:/d/thp10/irngate/thptopo.aml on Friday December 17, 2010 at 2:22 PM

John A Oswald
certified engineering geologist
CA lic. PG 7219, CEG 2291
po box 126
Loleta, CA 95551
707 407 5102
johno@oswaldgeologic.com

natural resource
based solutions

August 6, 2010

ENGINEERING GEOLOGIC EVALUATION OF THE IRON GATE THP, HUMBOLDT CO., CALIFORNIA

Prepared for: Mr. Jon Woessner, RPF.
Humboldt Redwood Co.
PO Box 712
Scotia, CA 95565

INTRODUCTION

This evaluation is prepared for the Humboldt Redwood Company (HRC), Iron Gate Timber Harvest Plan (THP) under the direction of Mr. Jon Woessner, Registered Professional Forester (RPF) HRC, and the project RPF, Mr. Dave Rogers. The purpose of this investigation is to evaluate the proposed harvest with respect to potential risks to public health, safety, structures and land, as well as sediment delivery to watercourses as a result of landsliding resulting from THP activities. The recommendations from this investigation were incorporated into the THP prior to submittal and are part of the plan.

Location and Regulatory Framework

The Iron Gate THP is located in the Elk River watershed (Figure 1). The harvest unit is adjacent the South Fork Elk River a Class I watercourse. The proposed harvest unit occupies the south, southwest facing flanks of a west-northwest trending ridgeline that varies in elevation from about 120 to 850 feet above mean sea level. Pertinent location information is presented below in Table 1.

Table 1: Pertinent Location Information	
Legal Description	Section 25, Township 4N, Range 1W; Section 36, Township 3N, Range 1W; and Section 31, Township 4N, Range 1E HB&M.
USGS Quadrangle	Fields Landing and McWhinney Creek USGS 7.5-minute quadrangle.
Cal Watershed	Lower South Fork Elk 1110.000302

Elk River is listed as sediment and temperature impaired under Section 303(d) of the Federal Clean Water Act. This plan is prepared under the California Forest Practice Rules (FPR) and the HRC Habitat Conservation Plan (HCP). There are no reported domestic water supplies within 1000 feet of the THP area or potential public safety hazards posed by the proposed operations.

Scope

The RPF asked Oswald Geologic to address unstable areas as defined in California Forest Practice Rules and HRC HCP prescriptions for the Elk River and Salmon Creek watersheds, dated August 12, 2005 (HRC, 2005). The Forester has implemented the "Hillslope Management Checklist for Elk River and Salmon Creek Watershed Analysis Unit". The Forester did not identify potentially unstable areas within the operational portions of the plan area but based on its proximity to public access and parklands opted for review by a geologist. Portions of these unstable areas are proposed for harvest. Special Riparian and Hillslope Prescription areas consisting of areas with slope gradients greater than 50% leading to streams and other areas and identified as having "very high hazard" have been identified in this THP. The "Hillslope Management Checklist" is based on the guidelines developed co-operatively between the California Geological Survey (CGS, formerly CDMG) and the California Division of Forestry and Fire Protection (CDF), contained in CLFA (1999), to be used by a forester for determining the need for input from a California licensed geologist (CLG) during THP preparation.

The appropriate scope of the THP evaluation was determined based on the location of the THP units, published geological information, conditions found during geologic evaluations for neighboring THPs, conditions observed by the Forester, results of the site investigation, and review of aerial photography. This report considered potential impacts of specific operations within the proposed plan insofar as they may affect any recommendations provided.

Methods

This study was conducted in accordance with generally accepted engineering geological standards and practices, with the objective of providing a geological evaluation in accordance with the guidelines set forth by the Department of Conservation, California Geological Survey in Note 45 (CGS, 1999a) and guidelines provided by the California Board for Geologists and Geophysicists (BGG, 1998). This study evaluates the slope stability conditions of the plan area using previously-developed geological information, historical aerial photography, and on-the-ground observations, consistent with established engineering geological practices, to characterize slope stability conditions within THP units, evaluate the potential impacts of THP activities on slope stability and sediment delivery, and guide mitigations. This approach uses site specific geologic and geomorphic mapping, combined with observation of slope performance under historic and modern land management operations to predict landscape response to proposed operations.

HCP Prescriptions

The Iron Gate THP is proposed under prescriptions based on watershed analysis for the Elk River and Salmon Creek watersheds (HRC, 2005). Section 6.3.2 describes slope stability measures to reduce management related sediment delivery to aquatic systems. Unstable areas are identified in and adjacent the operational portions of the plan.

Class I watercourses have 150- to 200-foot wide RMZ divided into an inner and outer zone. The inner, no harvest zone is 100 feet wide. The outer zone extends to a minimum of 150 to 200 feet wide depending on streambank slope gradient class. The outer zone retains 50% post-harvest canopy closure unless streamside slope inclination is greater than 50%, where the outer zone is covered under the Special Hillslope Prescription (SHP). Under SHP, the outer zone of the RMZ extends to 200 feet and retains a minimum of 150 sq. ft./acre basal area or 50% of pre-harvest basal area whichever results in greater retention.

Class II watercourses have 75- and 100-foot wide RMZ, respectively. The inner, no harvest zone is 50 feet wide. The outer zone extends to a minimum of 125 feet wide and, depending on streambank slope gradient class, can contain an additional zone out to 200 feet wide. The outer zone retains 60% post-harvest canopy closure unless streamside slope inclination is greater than 50%, where the outer 125 to 200 feet of the RMZ is covered under the Special Hillslope Prescription (SHP). Under SHP, the outer zone of the RMZ extends to 200 feet and retains a minimum of 150 sq. ft./acre basal area or 50% of pre-harvest basal area whichever results in greater retention.

Class III watercourses have 50- to 100-foot wide equipment exclusion zones based on slope gradient considerations that contain habitat, tree in contact with bank, and less than 8" diameter retention requirements. The minimum Class III watercourse prescription retention standards are exceeded by the proposed selection harvest as marked and proposed by the RPF. Please see Section 2 of the timber harvest plan prepared by the RPF for a complete description of environmental mitigations.

Proposed Operations
The RPF proposes a cable and ground-based yarded selection harvest with progressively greater timber retention in watercourse protection zones as described above. This report provides recommendations for timber harvesting on unstable areas consistent with HRC HCP requirements and CA Forest Practice Rules. Please find detailed descriptions of management activities and acreages associated with this timber-harvesting plan in the environmental disclosure of which this report has been made a part.

The planning area has undergone substantial road mitigation and remediation work since adoption of the HCP in 1999. The mainline, rocked haul roads in the plan area are in good condition and need minor upgrades and maintenance. The secondary haul roads both rocked and native surfaced are also in relatively good condition and require some upgrading and maintenance. Several secondary haul roads and skid roads are being opened for this plan and the RPF proposes to upgrade crossing areas and other erosion sites as descried in the roadwork order. These roads are being used for the proposed harvest and to access road mitigation sites to comply with HCP and State agency regulations.

GEOLOGIC AND GEOMORPHIC SETTING

Regional Setting
The Iron Gate THP is located within the Northern Coast Ranges Province of California. North-northwest oriented ranges that reflect the dominant regional structural trend characterize the province. In the northern part of the province, the structural trend is dominated by northwest striking, northeast dipping thrust faults and northwest trending fold axes that accommodate northeast directed shortening. Shortening is in response to convergence of the North America and Gorda Plates across the Cascadia subduction zone. In the southern part of the province, the local structural grain is dominated by north-northwest trending strike-slip faults associated with the San Andreas transform margin between the North American and Pacific Plates. Between the northern and southern portions of the province, the northwest trending structure is overprinted with west-northwesterly trending folds and thrust faults. The superimposed west-northwest trending structures are generally accepted to be a result of the northward migration of the Mendocino Triple Junction (Kelsey and Carver, 1988; Aalto et al., 1995). The Mendocino Triple Junction (MTJ) marks the location where the Cascadia subduction zone to the north transitions to a transform margin to the south.

Seismotectonic Setting
The THP is located within a seismically active area. Because of the seismotectonic setting of Humboldt County there are numerous sources of potentially large earthquakes. Large earthquakes have occurred and will occur in the vicinity of the THP. Slope stability may be reduced by strong ground accelerations. Site response during strong ground motion will depend on a complex interaction between site-specific conditions of earth materials, topography, lithology, hydrology, earthquake wave travel path and distance to source. Research by Keefer (1984) and published observations of the 1992 Cape Mendocino earthquake (Prentice et al., 1992) show that earthquakes are important in the initiation or reactivation of both deep-seated and shallow landslides than. Prentice et al. (1992) describes three large earthflows just south of the Eel River Delta that were reactivated in both the 1992. Cape Mendocino earthquake and the 1906 San Francisco earthquake. Hundreds of shallow landslides were also described along the Eel River and coastal bluffs.

Additionally, the association of landslides and major geologic structures is well documented (Guzzetti, et al., 1996; McCalpin and Irvin, 1995; Savage and Varnes, 1987, Savage and Swolfs, 1986).

A variety of seismic sources have potential to generate large earthquakes in Humboldt County. In general, the seismic sources are a manifestation of the interaction between the North American, Gorda, and Pacific Plates. The sources are a combination of different inter-plate and intra-plate fault systems.

The nearest active state-mapped fault is the Little Salmon fault (LSF) (Jennings, 1994; Peterson et al., 1996). The LSF is a northeast-dipping thrust fault with its trace approximately 2.5 miles west-southwest of the THP area (McLaughlin et al., 2000; Jennings, 1994). The LSF is considered to be the structure that has the potential, along with Cascadia Subduction Zone, to generate the greatest ground shaking at the site.

The LSF is thought to have about 4-5 miles of total displacement across it and a slip-rate of about 6-10 mm/yr (Clarke and Carver, 1992). Clarke and Carver (1992) documented about 16-23 feet of single event offset in fault trenches. Using relationships of fault offset to earthquake magnitude, Clarke and Carver (1992) suggest the LSF is capable of M_w=7.6-7.8. More recent estimates by Geomatrix Consultants (1994) put the maximum magnitude earthquake expected at M_w=7.3.

Geologic Setting

CGS (1999b) mapped the plan as underlain by the Quaternary- to Tertiary-aged undifferentiated Wildcat Group and the eastern portion of the plan area as underlain by the Quaternary Hookton Formation (Figure 2a). Ogle (1953) describes the Hookton Formation as Quaternary aged, predominantly non-marine, poorly consolidated, gravel, sand, and clay. Exposures of the Hookton Formation are described as loose brown sand, brownish gray clay, and silt (Ogle, 1953). The undifferentiated Wildcat Group is described as Quaternary to Tertiary aged, marine siltstone and sandstone regionally cropping out predominantly north of the Yager and Little Salmon faults. The Hookton Formation is exposed in the eastern portion of the plan area along the ridgetop that separates the South and North Forks of the Elk River. This mapping is taken from Ogle (1953) who initially mapped the plan area. The undifferentiated Wildcat Group is described as light brown to gray mudstone and sandstone (Ogle, 1953). Light brown to gray, massive, weakly consolidated, fine sandy siltstone and silty fine sandstone was observed exposed in natural exposures and road cuts throughout the plan area, consistent with descriptions of the Undifferentiated Wildcat Group (Ogle, 1953).

The west-northwest trending, Humboldt Anticline is mapped just north of the northern harvest boundary (Ogle, 1953). The anticlinal fold is probably active and likely provides structural control of the orientation of the ridgeline the THP is laid out on. Bedding is reported within the harvest unit as dipping about 7 to 25 degrees to the northeast and northwest. Bedding likely becomes steeper the further north or south of the axis of the Humboldt Anticline. Geologic units observed within the plan area were massive siltstone and silty fine sandstone and do not contain features showing primary structure. Bedding of the undifferentiated Wildcat Group was not confirmed within the harvest unit.

Geomorphic Setting

Within the Elk River drainage, the drainage network regionally forms an asymmetric trellis drainage pattern characteristic of incision into gently folded sediments with minor secondary structural control (Bloom, 1978). This is consistent with uplift and erosion of the regionally gently folded strata of the Hookton Formation and Wildcat Group within the fold and thrust belt of the Cascadia Subduction zone. The main stream network forms a relatively wide valley with an under fit, meandering main channel. Tributaries to the main channel are generally short seasonal feeder streams extending upslope at a generally 45° angel to the main stream. Asymmetry of the drainage network suggests a secondary structural control, likely on the North Spit fault and anticline that trends west-northwest just west of the plan area (Woodward-Clyde, 1980; Stallman, 2003). This fault system appears to control the location of the change from the Elk River being an incised canyon to a meandering alluvial river.

A review of published geomorphic mapping shows shallow landslide hazards as potentially present and mapped debris slide amphitheater slopes in the lower slope portions of the proposed harvest unit (CGS; 1999b)(Figure 2a) and more recent mapping shows a relatively large earthflow just outside of the western harvest boundary (CGS, 2005). Recent mapping does not show debris slide amphitheater slopes. Mapping by CGS (1999b and 2005) is somewhat consistent with mapping from this investigation and is modified in the project site maps introduced and described below.

The hillslope morphology exhibited throughout the THP suggests a correlation between landscape morphology, bedrock structure, and mass wasting processes. Hillslopes in the plan area are moderately to steeply inclined with broadly divergent to convergent slopes that transition downslope to steep streamside slopes. The upper hillslope is characterized by relatively low gradient slopes with a broad essentially flat ridgeline. The upper slopes transition downslope to moderately to steeply inclined slopes that are well incised by tributaries to the main watercourse. The moderately to steeply inclined midslopes generally become steeper along tributaries and main stream network. Elk River is a meandering channel within a broad floodplain.

Watercourses in the plan area vary from poorly to well-incised channels and in general do not have an armoring of gravels and cobbles except in the main Class I streams that flow from areas of the watershed with a source of hard rock. Typically, the higher order watercourses become more entrenched in the lower slope positions. Where landsliding is chronic and recently expressed, watercourses have aggraded beds with large amounts of fines and woody debris. The morphology of the stream channels in the plan area is closely associated with the activity status of landslides. Headwall swales were observed in select locations throughout the watershed and were generally small and very steep convergent depressions at the upper extent of Class III watercourses. These locations are shown on Figures 3a-d and discussed below in the HCP Prescription Discussion.

Evidence of unregulated, legacy timber operations from the initial harvest are evident in streams as excessive saw-cut timber clogging the channels and Humboldt crossings formed by pushing sidecast and woody debris in to the channels to create road crossings. Many of these Humboldt crossings are sources of erosion and episodic turbid input into the surrounding streams. The main Class I and Class II stream channels are typically heavily impacted by legacy timber operations and have evidence of railroad trestle pilings, large volume cut and fills, and flat graded floodplains. During the initial harvest entry, the unsuspended yarding of large timber across the slopes by steam donkeys created many yarding furrows. The furrows are up to several feet deep and 10 feet wide and generally converge downslope through swales towards the main channel. Site disturbance is almost ubiquitous across the plan area and complicates geomorphic interpretation. As discussed below, ground disturbance is considered one of the primary factors contributing to management related landsliding in the plan area.

During the site investigation, sand, silt, and clay (SM to CL) soils were observed exposed in cutbanks and natural exposures throughout the plan area. Observed soils appear to be about 3-5 feet in depth, weakly developed, and generally contain a relatively gradational contact with bedrock at depth. Finer soils were preferentially observed in lower gradient slopes than coarse soils. The observation of finer grained soils located in low gradient earthflow terrain suggests a strong association of both landform and soil type to underlying parent material.

LAND USE HISTORY/AERIAL PHOTOGRAPHIC REVIEW

The initial harvest history maps show the plan area as initially harvested circa 1860-1869. Timber harvesting methods at this time used railroad access along Class I Elk River, steam donkey timber yarding, and gas and diesel powered tractors in the later initial harvest entries. The yarding of timber typically utilized topographic swales as yarding corridors and roads. Harvested logs were brought downslope to a railroad located adjacent to and within Elk River. Railroad construction techniques generally consisted of 50/50 cut and fill with unengineered sidecasted fills and raised trestles with pilings driven into the creek bed. Harvested timber was dragged across the ground with little to no suspension of the log and resulted in concentrated areas of significant disturbance focused on watercourse swales. A second harvest entry after the 1965 aerial photography used ground-based, track mounted, bulldozers and cable yarding techniques to harvest timber. This harvest entry likely occurred pre-Forest Practice Rules and used largely unregulated construction techniques to construct roads in creeks and on steep slopes. Fills on steep slopes were often 'cribbed' or reinforced with logs. Over time, the log cribbing rots and results in an apparent increase in landsliding. The proposed harvesting is probably the third entry for the plan area and occurs under the HCP and implements road management rules and large stream buffers. The landscape mass wasting response to the most recent harvest entries appears to be significantly reduced by these harvest methods and significant areas of concentrated ground disturbance are not visible.

Slopes in the plan area support moderately to very dense, multi-tier stands of 30- to 60-year-old redwood, fir, and hardwood forest. Intermixed with the second growth conifers are scattered residual old growth trees remaining from the initial entries. They are mostly located in modern stream protection zones and under the proposed operations no old growth timber is to be harvested. Underlying the overstory and sub-canopy is a variably thick shrub layer composed of huckleberry and other common ground cover species.

No landslides from adjacent and underlying THP are mapped within the plan area. This report also refers to landslides mapped as part of this investigation. Please refer to the site map provided in this report for the location of landslides discussed in the aerial photograph section (Figure 3).

Land Use and Mass Wasting Observations

1948 aerial photographs: The 1948 aerial photographs show an uneven canopy with the western portion of the plan area having a relatively less dense stand of conifer and more hardwood. No obvious landslides were observed and recent cable and ground-based harvesting is visible to the north of the proposed harvest unit. Lineaments within the forest canopy suggest the midslope skid trails are already constructed and the ridgetop road looks recently graded. Several linear canopy openings along stream channels suggest some debris slides or flows likely initiating from midslope road.

1954 aerial photographs: The 1954 aerial photographs have poor coverage and no stereo pairs of the plan area were available. No obvious landslides or canopy breaks are visible and recent harvesting is still visible north of the proposed harvest unit.

1965 aerial photographs: The 1965 aerial photographs show no active harvest operations in the proposed harvest unit and the recent operations to the north or the plan area are revegetating with brush and timber. A recent landslide is visible initiating from a landing in the recent operations north of the proposed unit. No mass wasting is observed in the plan area and the plan area is covered with mature timber.

1984 aerial photographs: The proposed harvest unit appears selectively harvested using ground-based equipment and several midslope skid trails access the proposed harvest unit. No recent landslides are visible in the proposed harvest unit. A large debris flow is visible just north of the plan area that initiated from the outboard edge of the ridgetop road. The failure appears to have delivered to the North Fork Elk River.

1997 aerial photographs: The proposed harvest unit appears harvested using ground-based equipment. Based on regrowth and the size of timber it appears the plan area was harvested in the 1970's or early 1980's. A dense network of skid trails is visible within the harvest unit and appears to be bare and eroding in places. No recent landslides are readily visible in the aerial photography but several small areas of high albedo in streamside slopes suggest some streamside slumps are present. The large debris flow just north of the plan area appears reactivated from just downslope of the ridgetop road and appears to deliver to the North Fork Elk River.

2007 aerial photographs: No recent harvesting was observed in the proposed plan area. No recent landslides are visible and the plan area is covered with mature conifer and hardwoods.

Aerial Photography Summary
Observation and analysis of the land use data and aerial photography reveal the plan area has performed adequately under the initial two harvest entries with very limited mass wasting response. The few landslides observed appear to have been locally, negatively impacted by legacy harvest and road construction activities on steep convergent slopes conducted in the 1940's through 1970's. It should be noted that large portions of the plan area have performed adequately after two entries of clearcut and selection silviculture. These observations combined with detailed site mapping and knowledge of the regional geologic structure provides good indicators of potential unstable areas within the plan area.

SITE CHARACTERIZATION

The plan area is a single contiguous harvest area that is broken into areas based on silviculture prescription and yarding method. Please see the maps provided with the plan for detailed locations of silviculture, yarding, and site preparation.

(see Site Map Figures 3a)

LS-1 is a dormant-historic debris slide that initiated from the fillslope of the U08.0810 Road at Road Point 1686. The failure is about 100 feet long, 75 feet wide and 3-5 feet deep. The failure delivered to a Class III watercourse and contains two undeformed 10-inch and 18-inch diameter redwood. The forester proposes to pull perched fill at the site and disconnect road surface drainage to the site. This proposal is appropriate and should prevent additional failures at the site. Few trees if any will be harvested from the landslide because of the selection silviculture and the existing stand density. Selection of timber from the surrounding slopes is considered appropriate because the failure is related to road construction techniques and harvesting adjacent the landslide should not negatively affect the landslide.

LS 2, **LS 3**, and **LS 4** are dormant-historic debris slides that initiated from steep streamside slopes. All failures are associated with skid trails and delivered to the watercourse downslope. The three failures are also within the no harvest band for the Class II watercourse and should not be negatively affected by the proposed harvest operations.

LS 5 and **LS 6** are dormant-historic debris slides that initiate from steep streamside slopes in the southern portion of the plan. The failures are associated with skid trails or disturbed ground related to ground-based yarding. **LS 5** is within the no harvest band for the Class II watercourse. **LS 6** is a failed skid trail crossing and should perform adequately under the cable-yarded selection because the failure is largely stabilized. **LS 6** contains small unmerchantable timber up to 8 inches in diameter. The landslides should perform adequately to the proposed silviculture based on the low levels of tree removal and cable-yarding harvest.

LS 7 is an area of debris slide slopes in the central portion of the proposed harvest unit. The debris slide slopes are restricted to steep streamside slopes in a narrow v-shaped Class II draw. The channel appears impacted from sediment likely derived from the adjacent raveling streamside slopes. **LS 7** is also within the no harvest band for the Class II watercourse and poses a very low hazard of delivering sediment to the watercourse under the proposed selection silviculture.

LS 8 is a dormant-historic debris slide that initiates from a skid trail just upslope of steep streamside slopes. **LS 8** delivered to a Class II watercourse. The failure is within the Class II RMZ and few trees if any will be harvested because of the existing stand density.

LS 9 is a dormant-historic earthflow that initiates from low gradient slopes near the upper extents of the ridge. The earthflow extends downslope to a steeper and narrower section of the watercourse draw. **LS 9** is outside of the harvest boundary and will not be affected by the proposed operations. **LS 9** appears to be the upper extents of a large earthflow mapped by CGS (2005; Figure 2a).

HCP PRESCRIPTION DISCUSSION

During the layout of the plan it was realized that ground disturbance was associated with landsliding shortly after timber harvesting was conducted in the plan area in the initial and subsequent, pre-HCP and Forest Practice Rules harvest entries. Many of the landslides that have delivered sediment to a watercourse are located on steep streamside slopes and associated with skid trail crossings. During the review of aerial photography and the site investigation, it was evident that selection silviculture combined with wide stream buffers of the HCP that contain progressively denser retention towards the watercourses is an effective means to mitigating harvest related landsliding and delivery of sediment to watercourses. While Class III watercourses do not contain no-harvest zones, the retention of all timber less than 8 inches, retention of channel trees, and retention of 75 sq. ft./acre basal area is considered adequate to provide canopy and root strength retention within these zones.

Many of the source areas for shallow landslides are unvegetated or have a sparse distribution of merchantable timber species and the use of a distributed selection silviculture effectively make these areas of no harvest.

This investigation used the program SHALSTAB in a GIS to evaluate stability based primarily on the driving inputs to the program: slope convergence, slope gradient, and modeled concentration of groundwater (Figure 4). The model output provides values of 1-5 representing potentially unstable to potentially stable slopes. The values for the two highest values of instability were overlain on the map with multiple data layers that included:

1) 10-foot contour maps,
2) Landslide mapping,
3) Watercourse mapping

The areas containing clusters of modeled potentially unstable slopes were compared with landslide mapping, evaluated for delivery potential, and potentially unstable slope morphology. No significant clusters of modeled potentially unstable slopes were shown on the model output. One section of debris slide slopes was mapped from field reconnaissance but not recognized in the SHALSTAB model. The lack of modeled unstable ground is supportive of the field investigation that found few open slope landslides and the few landslides mapped were associated with the skid trail network.

It should be recognized that landsliding is a natural process in this portion of the Elk River watershed and the plan area is considered to have a moderate landslide hazard because of the relatively weak bedrock, steep incision controlled slopes, and weakly developed soils. The natural landslide potential in the Elk River watershed can easily be exacerbated by land management activities, especially ground-disturbance. This hazard is recognized and is mitigated by the distributed selection timber harvesting and yarding that has a low to non-existent potential for ground disturbance. Ground based equipment is restricted to low gradient areas on and adjacent the ridgetop.

CONCLUSIONS

Observation of the aerial photography and geologic investigation indicate that few unstable areas of any activity status underlie the plan area. Review of the plan area shows some landsliding following the initial harvest and subsequent pre-HCP harvest entries. The proposed harvest retains essentially all the canopy along the Class I and II watercourses and retains about ½ to 1/3 of the stand across the remainder of Class III watercourses. The retained timber is intended to provide canopy closure and root strength distributed across the plan area. Other landslides in the plan area while affected by the initial harvest are largely attributed to road construction and excessive ground disturbance. It is my opinion that the proposed harvest does not pose a significant risk of exacerbating the existing conditions presented by landslides and unstable areas present in the portions of the plan I reviewed. I have worked with the forester to provide recommendations that allow for the harvesting of trees in such a manner that the existing hazards will not be significantly increased. It is also my opinion that the plan does not pose a threat to public health and safety from mass wasting as a result of the proposed harvest operations. This is because of the selection silviculture, the wide and low gradient buffer between the area of proposed operations and public access along Elk River. The performance of the plan area under two previous entries also shows that this plan poses a low to negligible risk to public safety as a result of proposed operations.

To the best of my knowledge, this plan conforms to Forest Practice Rules and the hillslope management strategy that applies to Humboldt Redwood Company ownership under prescriptions of the Habitat Conservation Plan.

I agree with the proposed harvest methods and it is my opinion that the methods and recommendations provided in this report and to the forester during the plan layout are geologically compatible with the site. The recommendations provided in this report, required under the current HCP and Forest Practice Rules, and recommendations provided to the forester during the layout of the plan will decrease the potential for sediment delivery to watercourses as a result of harvesting. I recognize that the plan area is in a dynamically active site and conditions can and will change. I have used my best professional judgment to assess the present and future risks and assist the forester in proposing a harvest plan that does not increase the risk to the resources present in the plan area.

This report, recommendations, and conclusions are solely intended for the site discussed above. The information contained in this report is only intended for use at the stated site using the stated proposed operations. This report should not be used as justification for harvest of any other site or different operations, and only be used for information purposes if referenced and reviewed for other projects.

The opinions presented herein 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.

RECOMMENDATIONS

There are no recommendations above the mitigations already proposed by the Registered Professional Forester.

I hope this report is sufficient for your immediate purposes. Please contact me if you have any questions.

REGISTERED GEOLOGIST
JOHN A. OSWALD
No. 2291
CERTIFIED
ENGINEERING
GEOLOGIST
STATE OF CALIFORNIA

John A. Oswald, PG 7219, CEG 2291
Certified Engineering Geologist

ATTACHED FIGURES AND APPENDICES:

Appendix A: Potential Impacts of THP Activities on Slope Stability

REFERENCES

Aalto, K.R.; McLaughlin, R.J.; Carver, G.A.; Barron, J.A.; Sliter, W.V.; McDougall, K.; 1995, Uplifted Neogene margin, southernmost Cascadia-Mendocino triple junction region, California; Tectonics, vol. 14, no. 5, p. 1104-1116.

Bawcom, J.A., 2003; Clearcutting and Slope Stability: Preliminary Findings on Jackson Demonstration State Forest, Mendocino County, California, *in:* Proceedings of the 24[th] Annual Forest Vegetation Management Conference, Moving Forward by Looking Back, S.L. Cooper (ed.), January 14-16, 2003, Redding California, University of California Cooperative Extension, pp55-64.

CGS, 1999a, Note 45, Guidelines for Engineering Geologic Reports for Timber Harvest Plans.

CGS, 1999b, North Coast Watersheds Mapping, DMG CD-ROM 99-002.

CGS, 2005, Maps and GIS Data For The Elk River Watershed, Humboldt County, California, Watershed Mapping Series, Map Set 4, CGS CD 2005-01, March 2005.

[Online URL]: http://www.elfa.org/geologyguide. accessed June 10, 2002

Clarke, S.H. and Carver, G.A., 1992, Late Holocene Tectonics and Paleoseismicity, Southern Cascadia Subduction Zone, Science, v. 255, p. 188-192.

Geomatrix Consultants, 1994, Seismic Ground Motion Study for Humboldt Bay Bridges on Route 255, unpublished consultants report for the California Department of Transportation.

Guzzetti, F., Cardinali, M., Reichenbach, P., 1996, The Influence of Structural Setting and Lithology on Landslide Type and Pattern, Environmental and Engineering Geosciences, Vol. II, no. 4, p. 531-555

HRC, 2004. The Humboldt Redwood Co. LLC (HRC) Prescriptions Based on Watershed Analysis for Elk River and Salmon Creek Watershed Unit, California, dated March 25, 2005

Iverson, R. M., and Major, J. J., 1987, Rainfall, ground water flow and seasonal movement at Minor Creek landslide, northwestern California: Physical interpretation of empirical relations, GSA Bull. Vol. 99, p. 579-594, 1987.

Jennings, C.W., 1994, Fault activity map of California and adjacent areas, California Department of Conservation, Division of Mines and Geology, Geologic Data Map Series, Map no. 6.

Jones, J. A., 2000, Hydrologic processes and peak discharge response to forest removal, regrowth, and roads in 10 small experimental basins, western Cascades, Oregon, Water Resources Research Vol. 36, p. 2621-2642, 2000.

Keaton, J.R. and DeGraff J.V., 1996, Surface Observation and Geologic Mapping, *in* Turner, A.K., and Schuster, R.L., (editors), Landslides Investigation and Mitigation: National Research Council Transportation Research Board Special Report 247, p. 178-230.

Keefer, D.K., 1984, Landslides Caused by Earthquakes, Geological Society of America, v.95, p. 406-421.

Kelsey, H.M. and Carver, G.A.; 1988, Late Neogene and Quaternary Tectonics Associated with Northward Growth of the San Andreas Transform Fault, Northern California, Journal of Geophysical Research, vol. 93, p. 4797-4819.

Keppeler, E.T., Ziemer, R. R., and Cafferata, P. H., 1994, Changes in soil moisture after harvesting a forested forested hillslope in northern California, *in* American Water Resources Association, Effects of Human-induced Changes in Hydrologic Systems, June 1994, p. 205-214.

McCalpin, .P. and Irvin, J.R., 1995, Sackungen at Aspen Highlands Ski Area, Pitkin County, Colorado: Environmental and Engineering Geosciences, Vol. I, no. 3, p. 277-290.

McLaughlin, R.J.; Ellen, S.D.; Blake, M.C.; Jayko, A.S.; Irwin, W.P.; Aalto, K.R.; Carver, G.A.; and Clark, S.H.; 2000, Geology of the Cape Mendocino, Eureka, Garberville and Southwestern part of the Hayfork – 30x60 minute Quadrangles and Adjacent Offshore Area, Northern California, U.S. Geological Survey, Miscellaneous Field Study 2335, 1:100,000.

Montgomery, D. R., Schmidt, K. M., Greenberg, H. M., and Dietrich, W. E., 2000, Forest clearing and regional landsliding, Geology vol. 28 no. 4, p. 311-314.

Ogle, B.A., 1953, Geology of the Eel River Valley area, Humboldt County, California: California Division of Mines Bulletin 164, 128 p.

Petersen, M.D.; Bryant, W.A.; Cramer, C.H.; Cao, T. and Reichle, M.S., 1996, Probabilistic Seismic Hazard Assessment for the State of California, California Department of Conservation, Division of Mines and

Geology Open-File Report 96-08.

Prentice, C.S., Keefer, D.K., and Sims, J.D., 1992, Surface Effects of the Earthquakes, in Earthquakes and Volcanoes, v.23 no. 3, p. 127-134.

Reid, L. M., 1998, Review of the Sustained Yield Plan/Habitat Conservation Plan for the Properties of The Pacific Lumber Company, Scotia Pacific Holding Company, and Salmon Creek Corporation, unpublished report, USDA Forest Service, PSW Research Station, 1700 Bayview Drive, Arcata, CA, 95521, 62 pp.

Savage, W.Z. and Varnes, D.J., 1987, Mechanics of Gravitational Spreading of Steep-sided Ridges, "Sackung": Bulletin International Association of Engineering Geologists, Vol. 35, p. 31-36.

Savage, W.Z. and Swolfs, 1986, Tectonic and Gravitational Stress in Long Symmetric Ridges and Valleys, Journal Geophysical Research, Vol. 91, p. 3677-3685.

Schmidt, K. M., Roering, J. J., Stock, J. D., Dietrich, W. E., Montgomery, D. R., and Schaub, T., 2001, The variability of root cohesion as an influence on shallow landslide susceptibility in the Oregon Coast Range, Canadian Geotechnical Journal vol. 38 no. 5, 2001, p. 995-1024.

SHN, 2000, Geologic Reconnaissance in Connection With the Scout Camp 5 Timber Harvest Plan, Humboldt County, California, unpublished consultant report from Gary Simpson and Shane Beach, SHN Geologists and Engineers to Mr. Bob Kelly, Natural Resource Management Company, dated July 12, 2000.

University of California Committee on the Scientific Basis for the Analysis and Prediction of Cumulative Watershed Effects, 1999 (T. Dunne, Ed.), Review of An Analysis of Flooding in Elk River and Freshwater Creek Watersheds, Humboldt County, California, unpublished report dated July 1, 1999, prepared for California Department of Forestry and Fire Protection, 13 p.

Wieczorek, G. F., 1984, Preparing a Detailed Landslide-Inventory Map for Hazard Evaluation and Reduction, Bulletin of the Association of Engineering Geologists, vol. 21 no. 3, pp.345-354

Ziemer, R. R., 1981, The role of vegetation in the stability of forested slopes. *in* International Union of Forest Research Organizations, XVII IUFRO World Congress Proceedings, Division 1, 1981, p. 297-308.

AERIAL PHOTOGRAPH REFERENCES

U.S. Forest Service, 1948 black and white photographs, flight CDF2-16, frame 79 and 78, dated July8, 1948, nominal scale 1:26,400.

California Department of Natural Resources, Division of Forestry, 1954 black and white photos, flight CVL 13N frame 75, dated August 3, 1954, nominal scale 1: 20,000.

Richard B. Davis Company, 1984, photographs, flight HUM84, flightline 206, frames 3 and 4, dated August 7, 1984, nominal scale 1:12,000.

Photogrammetric Data Services of Oregon, Inc., 1997, color photographs, flight HUM 97, flightline 15, frames 69 and 7, dated July 26, 1997, nominal scale 1:12,000.

WAC Inc., 2000, color photographs, flight PALCO-00, flightline 8B, frames 18 and 19; August 15, 2000, nominal scale 1:12,000.

Bergman Photographic, 2007, color photographs, flight 07-222, flightline 10, frames 44 through 46; and flightline 9, frames 46 through 48, dated August 14, 2007 nominal scale 1:12,000.

APPENDIX A: POTENTIAL IMPACTS OF THP ACTIVITIES ON SLOPE STABILITY

This section was co-authored with a large input from Gilbert Craven, CEG, PG and is provided to give a general overview of slope stability issues and the literature associated with my understanding of forest slope stability.

Timber harvest related impacts on slope stability fall into two general categories: 1) impacts of tree removal and 2) impacts of ground disturbance (yarding scars and road building). Impacts of tree removal consist of loss of root strength, loss of evapotranspiration, and loss of canopy effects. Impacts of ground disturbance consist of surface and groundwater diversion, changes in slope mass balance (cutting and filling) and potential instability of fill due to poor compaction (excess porosity) or incorporated organic debris.

Keppeler et al. (1994) documented increased groundwater levels after clearcut logging and cable yarding in coastal northern California and offered a range of possible causes including decreased evapotranspiration and decreased canopy interception due to tree removal, and decreased soil infiltration capacity due to yarding-related compaction. Montgomery et al. (2000) monitored rates of shallow landsliding after clearcut logging in coastal southern Oregon. Montgomery et al. (2000) concluded that, while landslide rates increased dramatically, the increased landsliding occurred mainly in areas that were already slide-prone, as demonstrated by previous landslide occurrence and as derived from a model of landslide occurrence based on soil strength parameters, slope steepness, and slope hydrology. Montgomery et al. (2000) modeled variation in soil cohesion as a function of root strength to explain increased landslide occurrence in harvested areas and noted piezometric variations in response to rainfall microbursts. Their analysis was weighted towards root strength as a primary influence; however, piezometric variation in response to microbursts was also considered a possible influence. Iverson and Major (1987) documented the dynamics of pore pressure waves and groundwater levels in soil resulting from storm and seasonal rainfall, and concluded that pore pressure waves from storms attenuate rapidly in the upper soil. The piezometric variation noted by Montgomery et al. (2000) appears to be analogous to the pore pressure waves noted by Iverson and Major (1987). Cafferata and Spittler (1998) found a preponderance of management-related landslides in the Caspar Creek Watershed between 1967 and 1997 to be caused by earthworks (roads, landings, and skid trails). In particular, earthworks constructed prior to the implementation of the Forest Practices Act were found to be significant sources of landsliding decades after their original construction, in contrast with those constructed according to Forest Practice Rules. Bawcom (2003) studied the effects of clearcut harvesting conducted during the 1980s and 1990s on landsliding in the Jackson Demonstration State Forest. Among the 32 shallow landslides associated with clearcut units, all but four were associated with roads, landings, and skid trails. None of the dormant deep-seated landslides associated with clearcut units showed evidence of re-activation. Bawcom (2003) concluded that there was little evidence to suggest that vegetation removal associated with clearcut harvesting of Coastal Redwoods was a significant contributor to slope instability. The findings of Bawcom (2003) and Cafferata and Spittler (1998) indicate that the effects of ground disturbance and roads are the most significant impacts to slope stability.

Root reinforcement is a significant factor allowing soils to remain stable on steep slopes (CGS, 2004; Krogstad, 1995; Schmidt et al., 2001; Ziemer, 1981). According to Krogstad et al. (1999) and Schmidt et al. (2001) the effect of root reinforcement on soil stability is limited by the depth to which roots penetrate the soil, and increased effective cohesion of the soil due to lateral root reinforcement may outweigh vertical anchoring as a factor increasing soil stability. CGS (2004) provides a literature-based discussion of effective soil cohesion as a function of vital root biomass and indicates that root reinforcement may increase effective soil cohesion by as much as a factor of two. Root strength loss could increase the potential for movement of shallow landslides.

Krogstad (1995) uses pipe-model theory and physiological considerations to model root biomass as being proportional to sapwood basal area and foliage density. The analysis by Krogstad (1995) provides a basis for estimating the potential loss of root strength after harvest as proportional to the decrease in foliage. Krogstad (1995) also describes the distribution of vital root biomass as a function of proximity to the tree bole and the age of the tree. Root biomass is generally concentrated near the tree bole; however, it is relatively more distributed for younger trees, particularly in stands not experiencing crown competition.

Krogstad (1995) and Roering et al. (2003) have some important implications for root reinforcement relative to tree age, species, and stand structure, with potential for guidance of silvicultural practices for maintaining slope stability. The root reinforcement contributed by larger trees relative to smaller trees is less than proportional to relative tree size, since a relatively large portion of the basal area of large trees is composed of heartwood, which does not support vital root mass. The root reinforcement associated with larger trees is more concentrated near the tree bole, especially when the greater spacing between larger trees is considered. All other factors equal, the greatest potential for slope failure within a stand occurs where the root reinforcement is the lowest (Roering et al., 2003). Occurrence of landslides in forested areas in the Oregon Coast Range is empirically associated with areas beyond the radii of dominant overstory conifers, particularly in areas vegetated with hardwoods and herbaceous vegetation (Roering et al., 2003). These considerations suggest that critical root reinforcement may be contributed by understory conifers in the gaps between the overstory trees in a mixed-age stand. Canopy closure may be used as a proxy for estimating root reinforcement with some qualification. Crown competition decreases the distribution of root reinforcement. Canopy closure is only one metric for the robustness of tree crowns, which is more directly proportional to root reinforcement than canopy closure. The theoretically optimal stand from a root reinforcement standpoint would consist of vigorously growing long-crowned conifers evenly spaced on the slope and not experiencing crown competition.

The amount of root strength loss after harvest is proportional to the mortality and decay of root systems after harvest. Root mortality varies according to harvested species, harvest practices, and site preparation after harvest (Schmidt et al., 2001; Ziemer, 1981). Decay of Douglas-fir root systems results in a maximum loss of strength within about 10 years after harvest, however, variations of decay rates between climates and species result in uncertainty regarding the timing of the strength loss (Schmidt et al., 2001; Ziemer, 1981). Decay rates are slow for Coastal Redwoods and the mortality of their root systems is significantly less than 100% after harvest, so a significant portion of the root strength is retained. CGS (2004) discusses relative die-off rates of old growth and second growth redwood root systems after harvest. Root mass vitality is typically maintained after harvest of second growth redwoods due to rapid stump sprouting. Root mass vitality is depressed after harvest of old growth redwoods because of decreased probability of stump sprouting and less canopy biomass to support the root mass. One implication of the argument presented by CGS (2004) is that the potential root mass die-off of old growth redwoods is proportional to the vitality of the existing crown, consistent with the findings of Krogstad (1995).

The greatest short-term loss of root strength is associated with clear-cut harvest; however, recovery of root reinforcement is variable after harvest depending on site treatment and reforestation (Schmidt et al., 2001; Ziemer, 1981). Understory root systems may ameliorate the loss of root strength between harvest and mature reforestation (Schmidt et al., 2001). According to Ziemer (1981), 50% root reinforcement recovery occurs typically between 15 and 25 years after harvest. Ziemer (1981) also cites possible 100% recovery after about 25 years after harvest, however, Schmidt et al. (2001) estimates that hardwood invasion after harvest may delay full recovery by 100 years or more. Silvicultural systems that result in reduced crown competition, such as overstory selection and thinning, stimulate the growth of understory trees, with potential for a net gain in root reinforcement if the vigorous growth of understory roots exceeds the decay rate of the harvested roots (Ziemer, 1981). The replacement of the more concentrated root systems of larger trees with the more distributed root systems of the released understory also would result in more distributed root reinforcement according to the model of Krogstad (1995). Depending on the pre-harvest stand conditions, a similar long-term result is possible with vigorous reforestation after clearcut or rehabilitation harvest, although the time interval to achieve it would obviously be longer.

The significance of canopy interception and evapotranspiration to storm hydrology and slope stability remains controversial. Evapotranspiration is generally accepted as a significant component of annual water budgets for forested lands (cf. Keppeler et al., 1994; Jones, 2000; Ziemer, 1981). Under arid summer conditions in the Sierra Nevada, evapotranspiration depletes as much as 30 cm of soil moisture from forested areas relative to non-forested areas (Ziemer, 1981). The difference would be less for a coastal forest that experiences lower evapotranspiration potential and has fog interception as a significant portion of its dry season water budget (Jones, 2000). The findings of Jones (2000) and Ziemer (1981) indicate that evapotranspiration can be expected to have a signature on dry-season water table levels and decrease the antecedent groundwater levels to storms following a seasonal dry period. During high rainfall periods and winter conditions, evapotranspiration potential is lower and the water budget becomes dominated by large storms. Given these considerations, a series of large storms that raises groundwater levels toward a threshold of instability would overwhelm the antecedent influences of annual evapotranspiration and become the dominant antecedent influence, as indicated by the findings of Jones (2000). While it is theoretically possible for a very large storm to occur during the period when the difference in soil moisture between forested and un-forested areas may be critical to slope stability, landslide-triggering storms generally occur during the period when the antecedent influences of other large storms dominate the water budget. In the opinion of Ziemer (1981), "the critical period during which forested slopes are drier than cut slopes may be insignificantly short."

Average canopy evaporation rates during *small* (<1.2") winter storms in a coastal climate in New Zealand, similar to that of Humboldt County, have been estimated in a range from 0.26"– 0.33" per day (Pearce, 1980 and oral communications, cited by the "UC Team", 1999). A 3"/24 hour rainfall event is considered potentially significant to slope stability and triggers landslide monitoring under the PALCO Habitat Conservation Plan. The evaporation rates cited by the UC Team (1999) indicate a *maximum* evaporative loss of approximately 11% of the rainfall in a 3"/24 hour event. Since evaporation is controlled by relative humidity, the evaporation rate would be higher for rainfall during warmer periods when relative humidity is lower, and lower for large winter storms when relative humidity is highest.

Reid (1998) presented data from *small* (0.13"-1.3") winter storms in the Freshwater Creek watershed showing a 17% to 36% difference in rainfall reaching the ground between open areas and areas under forest canopy. The time intervals of the storms were not specified, so it is not possible to evaluate the consistency of the data presented in Reid (1998) with the evaporation rates presented by the UC team (1999).

According to an abstract by Reid and Lewis (2004), evaporative losses in a 100-year-old Douglas-fir/redwood forest canopy are approximately 22% of the total annual rainfall, asymptotically approaching 21% for storms with rainfall totals greater than 70 mm (2.8"). The assumption of the Reid and Lewis (2004) study is that the difference between the rainfall detected on collectors beneath forest canopy and in an adjacent clearing (six total) is due entirely to evaporation and stem flow losses. That assumption is not valid. The differences between the locations where rainwater falls into and out of the canopy are significant, particularly under windy conditions. Under an alternative hypothesis, not considered by Reid and Lewis (2004) but discussed in the presentation of that paper, the results indicate substantial re-direction of rainfall by the canopy, rather than large evaporative loss, during large storms. Additionally, the evaporation rates postulated under the Reid and Lewis (2004) model are at a minimum twice the evaporation rates cited by the UC Team (1999).

Reid and Lewis (2004) hypothesize that large evaporation rates from mature conifer forest canopy occur because of the large surface area of foliage. That hypothesis incorrectly assumes that the surface area of foliage is the surface area available for evaporation of water. Redwood and Douglas fir fronds are very efficient devices for gathering surface water into large, spheroidal drops. That is an evolutionary water-conserving feature that allows conifers to extend their photosynthetic period under drought conditions, utilizing condensation and fog. The evaporative surface of water stored in spheroidal drops is much lower than the evaporative surface that would occur if water were evenly distributed over the fronds, as the Reid and Lewis (2004) model assumes. It is also unclear how the rainfall re-direction issue was addressed in the studies that provided the canopy evaporation data cited by the UC Team (1999). Taking those results at face value, it is theoretically possible for a storm to occur where a canopy evaporation rate of less than 0.3"/day makes a critical difference to slope stability. There is, however a greater probability of storms occurring that exceed a 0.3"/day critical evaporation window, and an even greater probability if the critical evaporation rate is smaller.

To summarize, canopy interception during large storms may be mainly significant as a microburst buffer that would attenuate pore pressure waves in near-surface soils, analogous to infiltration through on-ground organic debris. The loss of microburst buffering is an impact limited to the area where the canopy has been removed. Loss of on-ground organic debris, through either yarding-related ground disturbance or site preparation, may be of equal or greater significance to canopy loss as an impact on microburst buffering.

Given the dynamic and evolving nature of the literature surrounding tree removal and shallow landsliding, this investigation incorporates this background information into an analysis of potential harvest impacts based on past and current slope stability conditions and the effects of past disturbances on slope stability conditions, as revealed by thorough observation of historical and field evidence. Potential slope stability conditions are considered in the context of the past and current slope stability conditions, potential impacts from root strength loss, evapotranspiration changes, canopy interception, ground disturbance, and drainage disturbance. Our operating assumptions are the following, based on empirical observation and literature review in accordance with standards and practices for engineering geology:

1) Slide-prone terrain can be identified by evaluating where landsliding has occurred in the past and identifying the conditions that led to landsliding. Younger landslides are more likely than older landslides to be near a threshold of instability that could be impacted by management practices. The activity classification system of Keaton and DeGraff (1996) provides a tool for evaluating the potential sensitivity of landslides to management-related disturbances.

Transient loss of root strength can be expected, however, much root strength will be retained after logging of Coastal Redwood because of the ability of cut redwood to re-sprout stumps and maintain vital root systems after harvest. Alternative silvicultural prescriptions can mitigate this hazard.

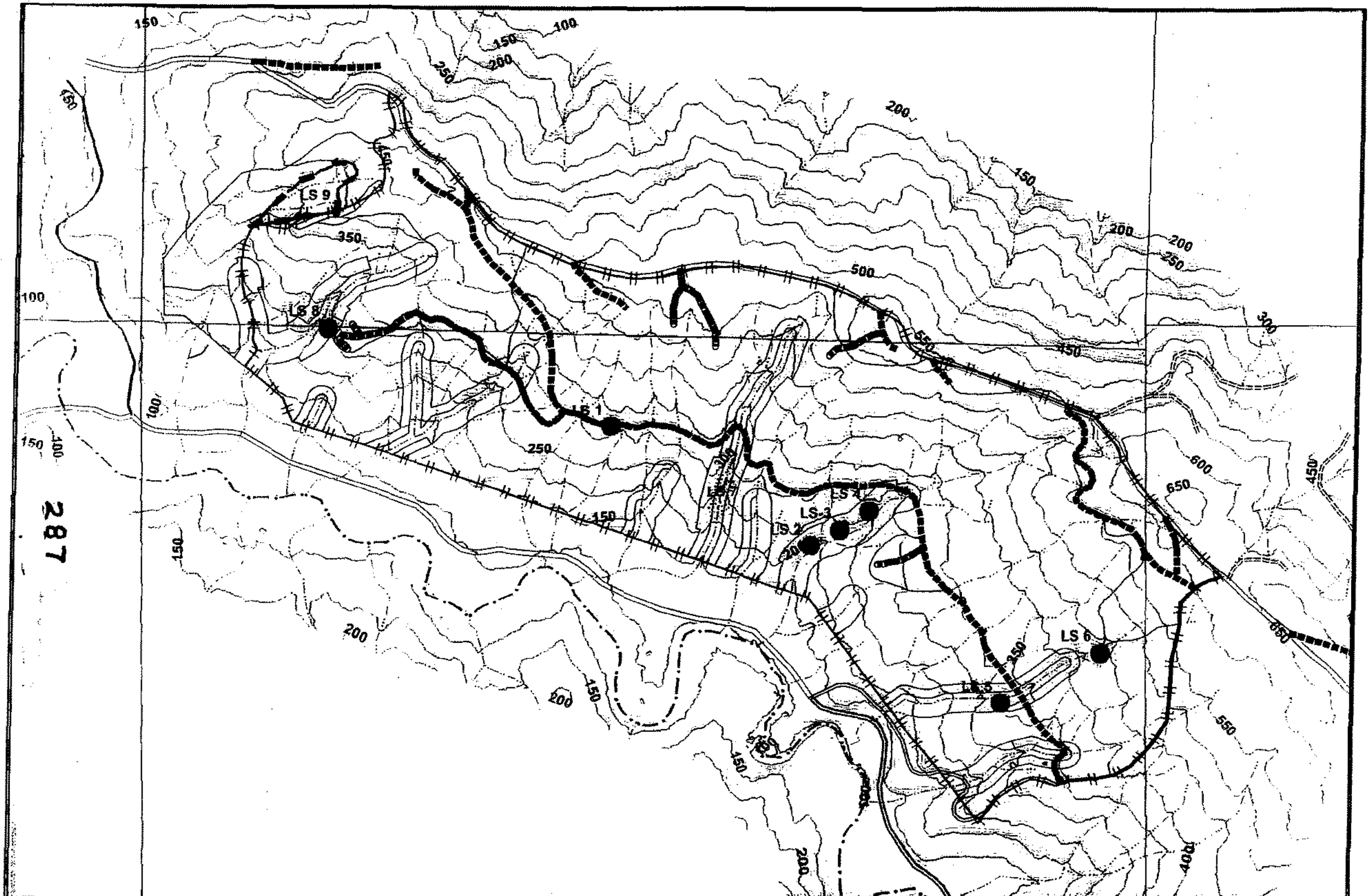
Evapotranspiration and canopy interception may influence the potential for shallow landsliding by influencing the antecedent conditions for large storms early in the storm season. Their effect diminishes as the storm season progresses.

2) Canopy interception may help attenuate pore pressure waves from precipitation microbursts in the upper soil layers. It is probably a relatively insignificant factor in the overall water budget of large storms.

3) Ground disturbance from road building and yarding are relatively important impacts of timber harvest due to potential for drainage disruption, unstable fills and soil compaction. Impacts are specific to road locations road construction practices, yarding techniques, and site geological conditions. Ground disturbance impacts must be evaluated relative to the road construction and yarding systems proposed and those used in the past.

Studies of deep-seated landslides show that activity of these features is controlled by a complex of structural, rheologic, hydrologic, and climatic factors. Initiation of activity or re-activation of sliding may be caused by large triggering events such as earthquakes, secular changes in climatic or hydrologic regime, or disturbance of the mass balance (head loading and toe cutting) of the slope. Mass balance disturbance may be due to natural or anthropogenic factors. The most significant anthropogenic mass balance and hydrologic disturbances are associated with roads and landings. Harvesting on active deep-seated landslides may increase their activity rate or extend their active seasonal period. From a land management standpoint, the most serious issues pertain to recognition of features that are likely to have their activity level affected by timber harvesting.

Given all of the above factors, recognition of deep landslide features potentially impacted by timber harvesting would be best facilitated by using the activity classification system contained in Keaton and DeGraff (1996). The Keaton and DeGraff (1996) system contains variations for slides in humid and arid climates. The activity classification of morphological features in humid climates is based on Wieczorek (1984). This approach has the merit of evaluating landslide sensitivity based on objectively observable morphological features that indicate age of activity. Morphological activity and sensitivity indicators would provide a means of estimating the severity of disturbance necessary to affect the activity of a deep-seated landslide.



PO Box 126
Loleta CA
95551

8/6/10-jao | 13-10-03

N

500 250 0 500 Feet

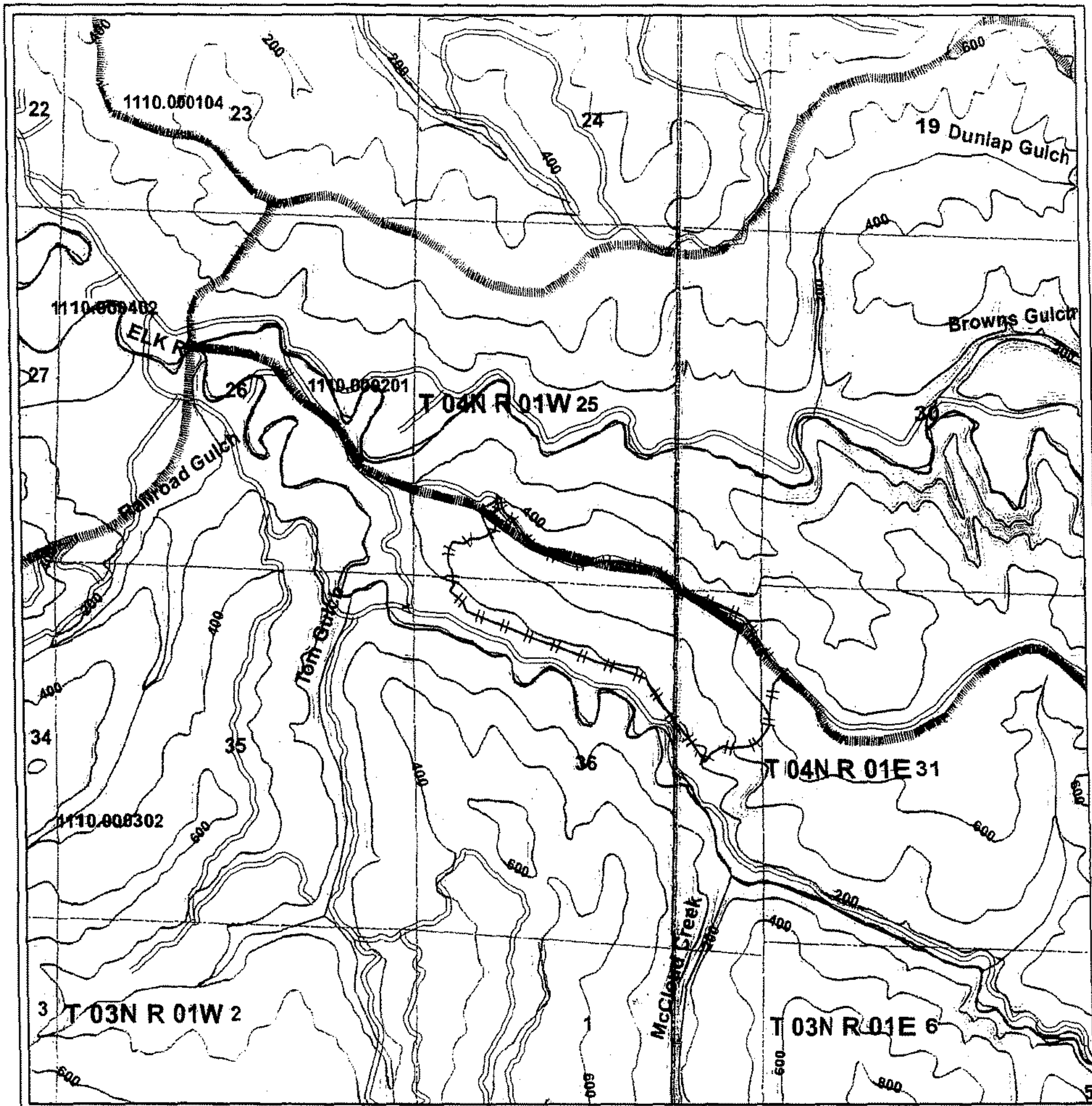
10-foot LiDAR contours. HRC LLC GIS data

see figure 3b for key

project:

Iron Gate THP

Figure 3a: Site Map



cal_wat221 polygon

Iron Gate THP

r1_rivers_2002 303d

LocalRoadsTiger

CalWater data CA GIS: cal_wat221.shp
stream data from CA GIS: r1_rivers_2002 303d.shp
topography from USGS 10 M DEM

PO Box 126
Loleta, CA
95551

7/26/10-jao | 12-10-03

2,000 1,000 0 2,000 Feet

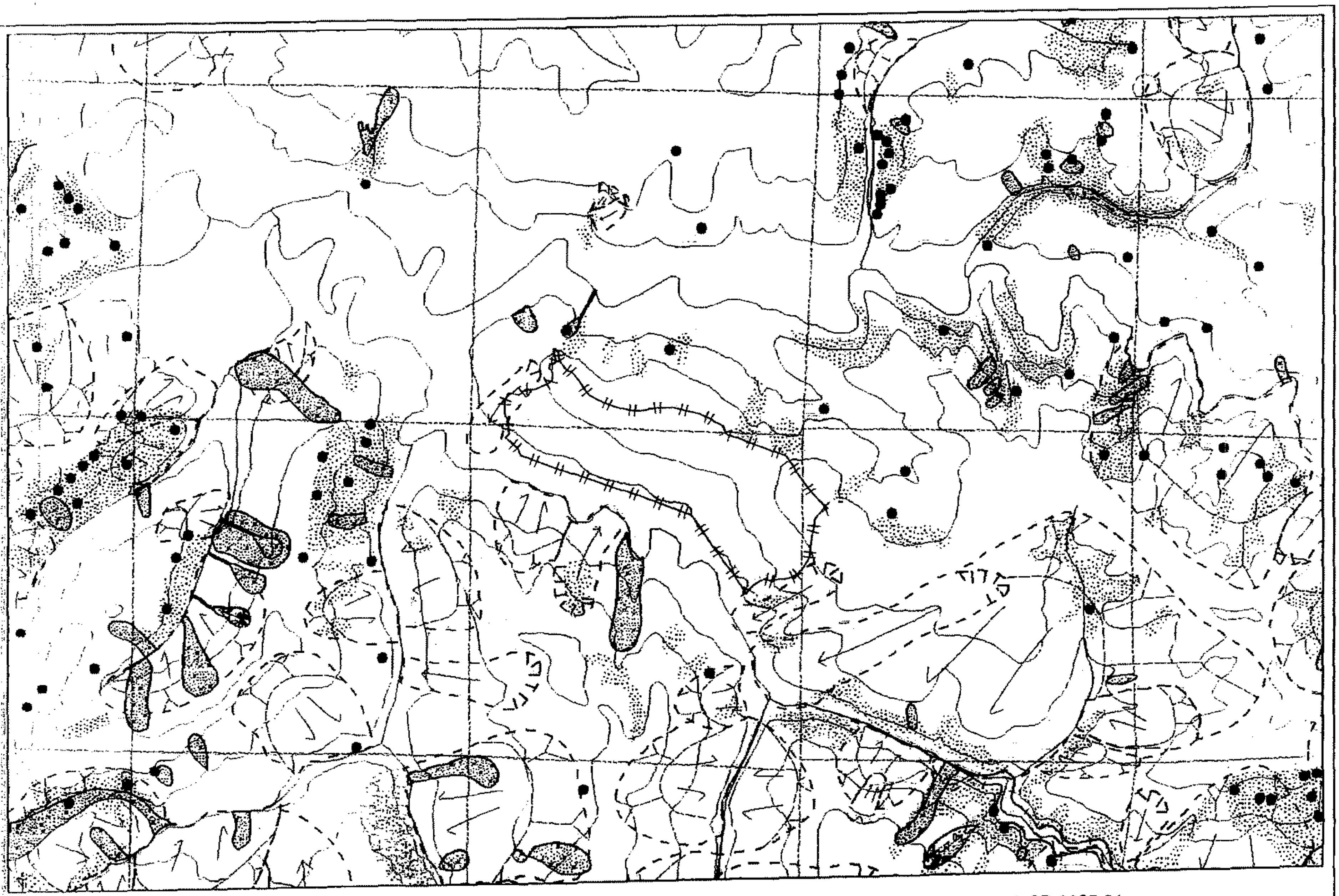
contour interval 40 feet

N

HB&M

project: **Iron Gate THP**

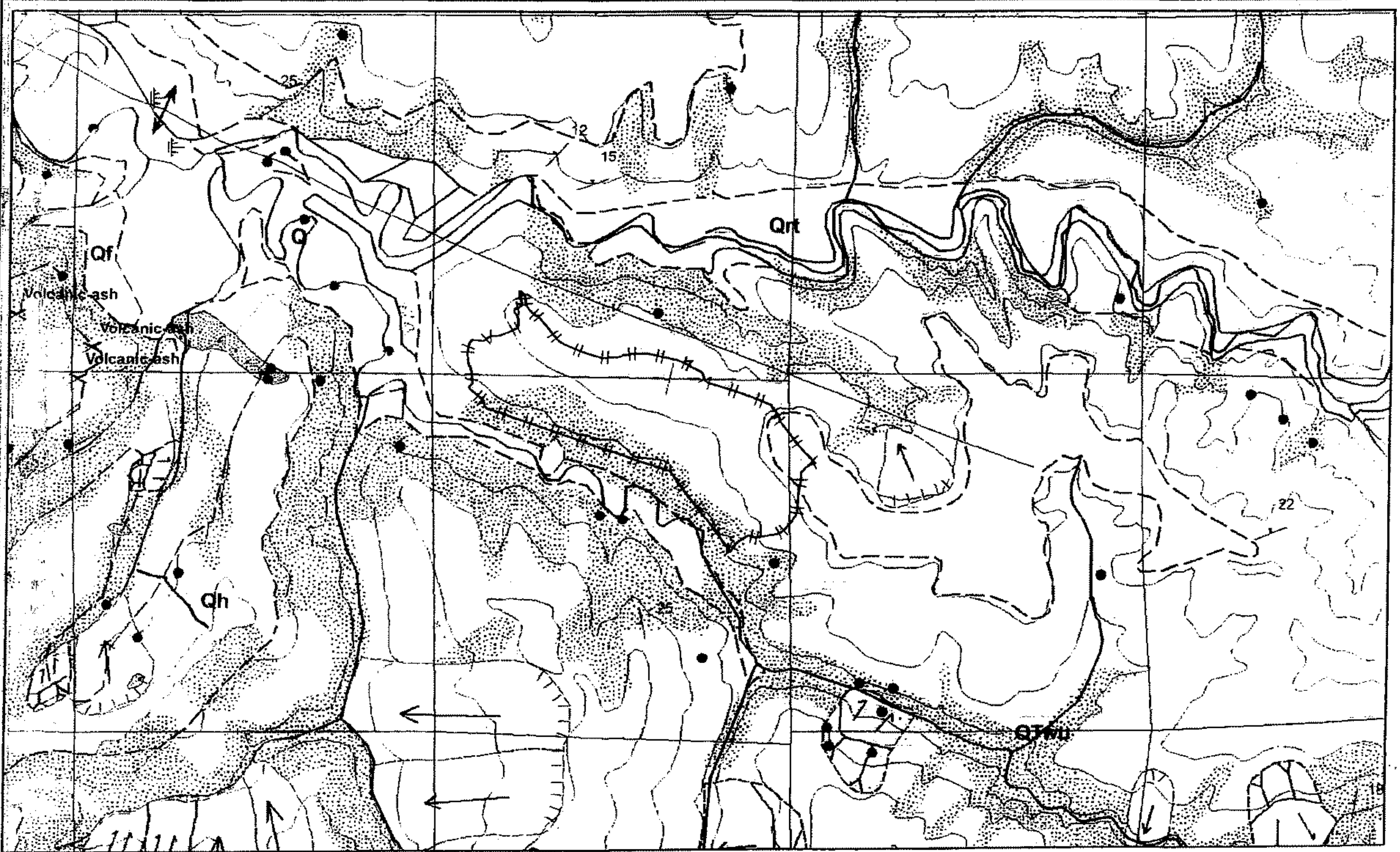
Figure 1 : Location Map



modified from CGS CD 2005-01
see figure 3b for key to geologic and geomprohic features

Figure 2a: Regional Geomorphic Map
Iron Gate THP

PO Box 126
Loleta CA 95551
7/27/10:jao | 13-10-03



Q - Quaternary alluvium
Qf - Quaternary fan
Qrt - Quaternary river terrace
Qh - Hookton Formation
QTwu - undifferentiated Wildcat Group

geologic data modified from: USGS MF 2336 and CGS CD-ROM 99-002

thrust fault, solid where certain, dashed where approximately located

10 dipping bedding

fold axis showing dip of bedding

USGS topography
stream data RWQCB 303D data

[redacted]

PO Box 126
Loleta CA
95551

7/26/10-jao | 13-10-03

N

2,000 1,000 0 2,000 Feet

contour interval 40 feet

project: **Iron Gate THP**

Figure 2b: Regional Geologic and Geomorphic Map

Legend

- • landslide

PLTHP_arc

mode

- inner gorge
- torrent track

THP polygon

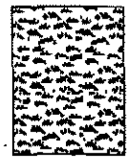
landform

- debris slide, recently active
- debris slide, dormant hstoric
- earthflow, recently active
- earthflow, dormant historic
- debris flow, recently active
- translational/rotational, recently active
- translational/rotational, dormant
- debris slide slope
- inner gorge
- bluff
- headwall swale, selection 150 sq. ft. retained
- headwall swale, effective no cut

additional CGS Key items

translational/rotational landslide
solid where active, dashed where dormant

earthflow solid where active,
dashed where dormant

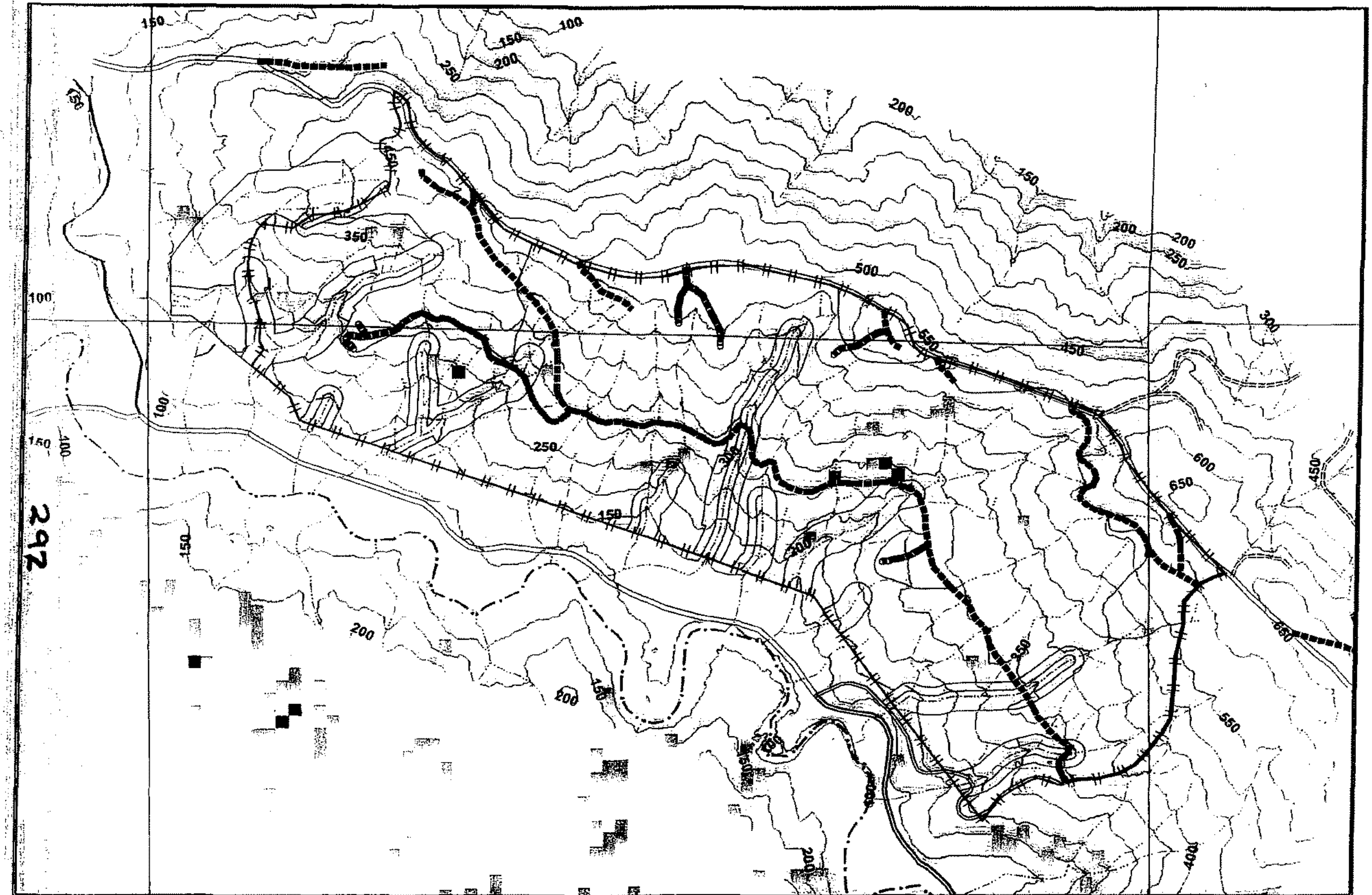


disturbed ground

PO Box 126
Loleta CA
9555

not all symbols may be used

Figure 3b: Site Map, key geomorphic key



292

PO Box 126
Loleta CA
95551

8/6/10-jao | 13-10-03

N

500 250 0 500 Feet

10-foot LiDAR contours. HRC LLC GIS data

■ unconditionally unstable
▨ unstable

project:
Iron Gate THP

Figure 4: Map of SHALSTAB Model Output

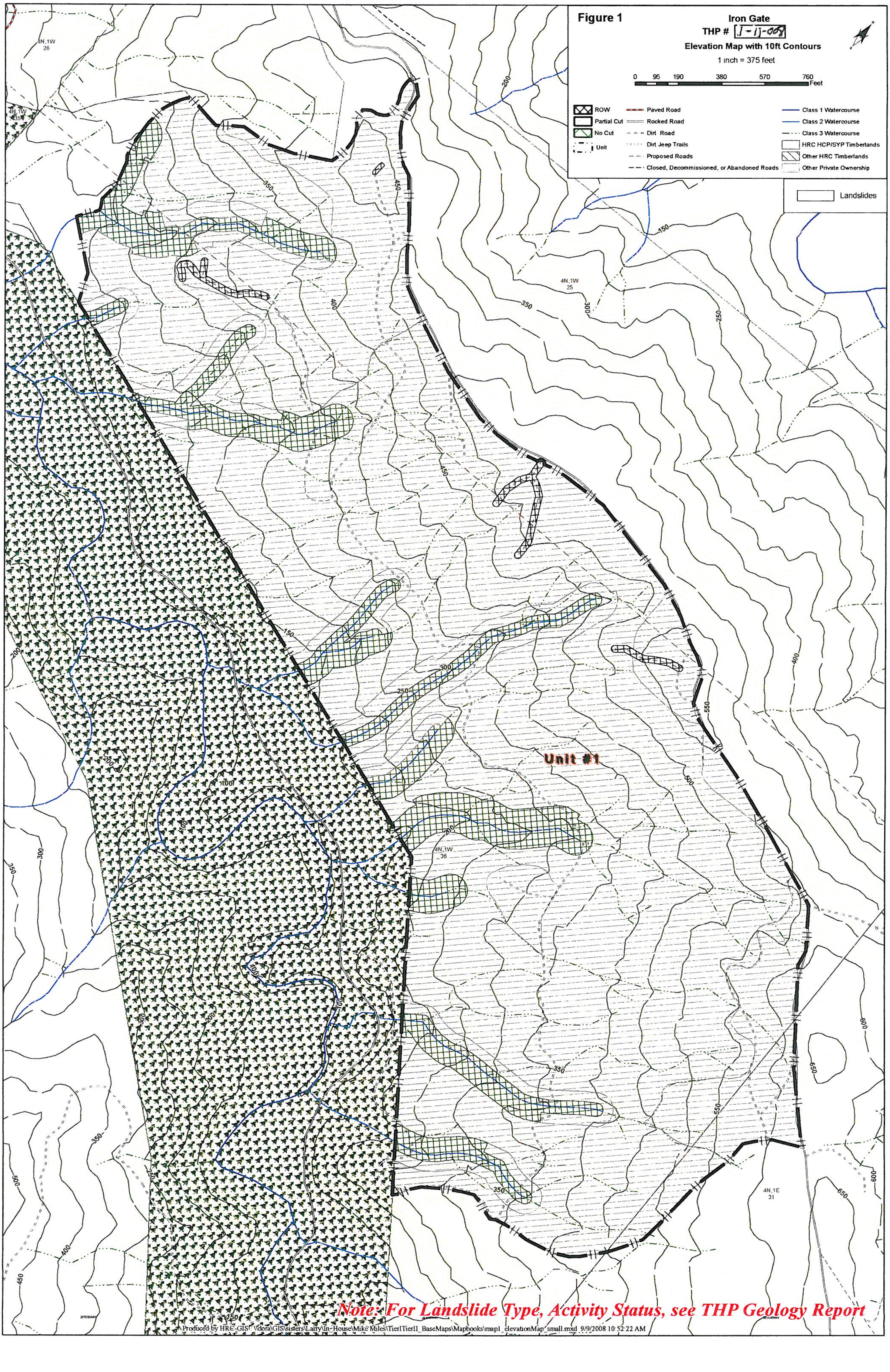


Figure 1
Iron Gate
THP # 1-11-008
Elevation Map with 10ft Contours
1 inch = 375 feet
0 95 190 380 570 760 Feet
ROW
Partial Cut
No Cut
Unit
Paved Road
Rocked Road
Dirt Road
Dirt Jeep Trails
Proposed Roads
Closed, Decommissioned, or Abandoned Roads
Class 1 Watercourse
Class 2 Watercourse
Class 3 Watercourse
HRC HCP/SYP Timberlands
Other HRC Timberlands
Other Private Ownership
Landslides
Unit #1
4N,1W 26
4N,1W 25
4N,1W 36
4N,1E 31
Note: For Landslide Type, Activity Status, see THP Geology Report
Produced by HRC-GIS \\dora\GIS\sisters\Larry\In-House\Mike Miles\TierI\TierII_BaseMaps\Mapbooks\map1_elevationMap_small.mxd 9/9/2008 10:52:22 AM

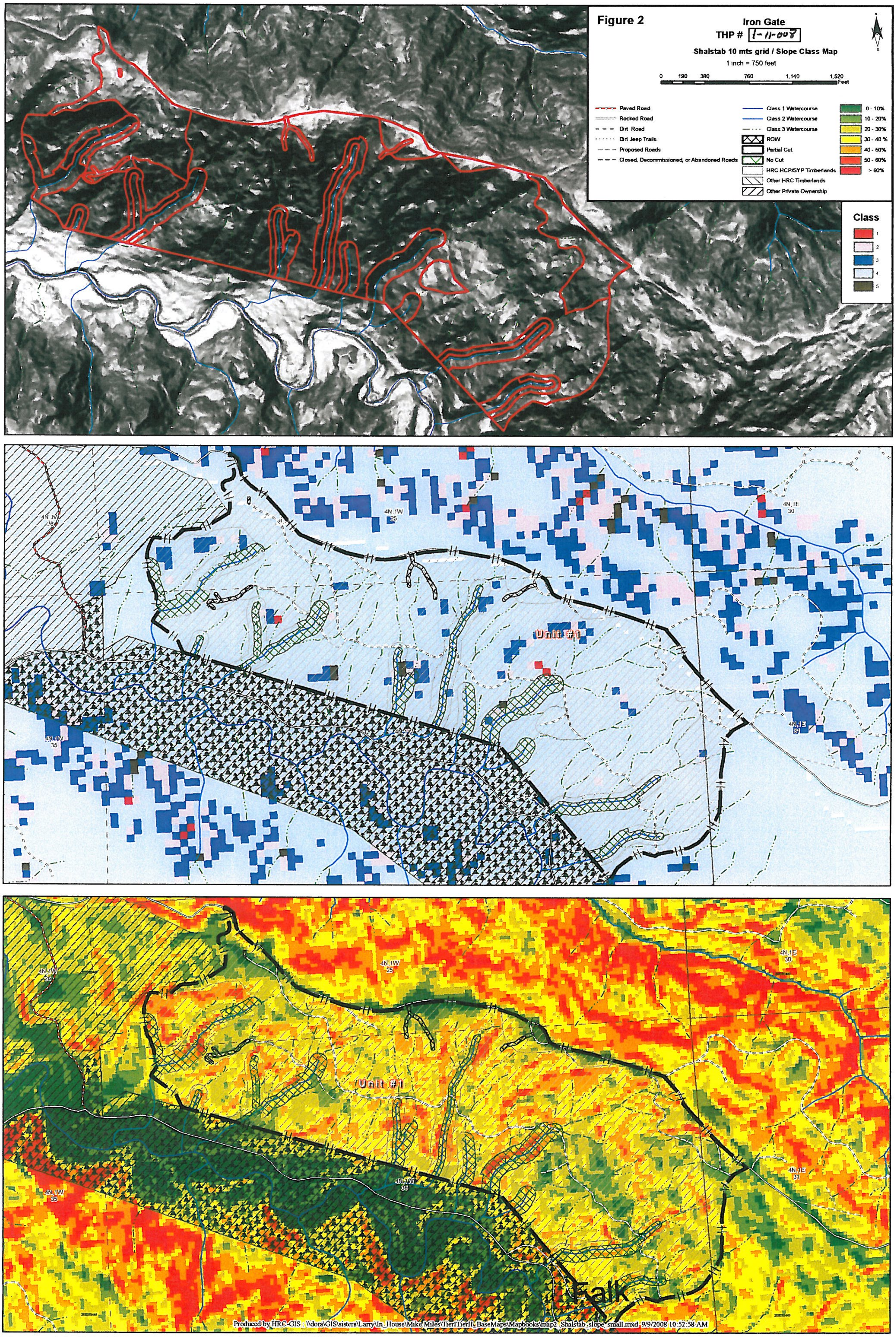
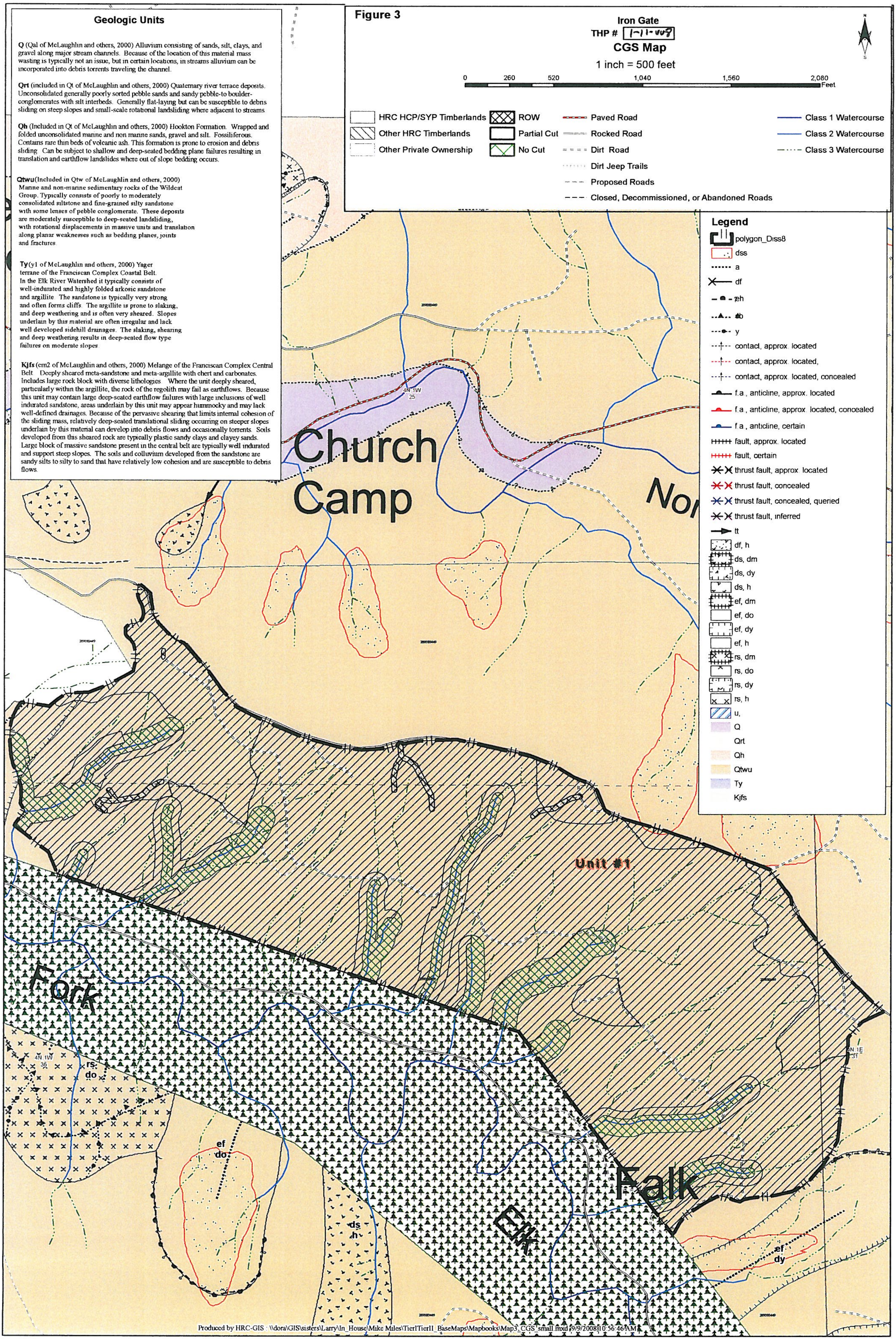


Figure 2
Iron Gate
THP # 1-11-008
Shalstab 10 mts grid / Slope Class Map
1 inch = 750 feet
0 190 380 760 1,140 1,520 Feet
Paved Road
Rocked Road
Dirt Road
Dirt Jeep Trails
Proposed Roads
Closed, Decommissioned, or Abandoned Roads
Class 1 Watercourse
Class 2 Watercourse
Class 3 Watercourse
ROW
Partial Cut
No Cut
HRC HCP/SYP Timberlands
Other HRC Timberlands
Other Private Ownership
0 - 10%
10 - 20%
20 - 30%
30 - 40 %
40 - 50%
50 - 60%
> 60%
Class
1
2
3
4
5
Unit #1
4N 1W 25
4N 1W 36
4N 1W 35
4N 1E 30
4N 1E 31
Falk
Produced by HRC-GIS \\dora\GIS\sisters\Larry\In_House\Mike\Miles\Tier\TierII_BaseMaps\Mapbooks\map2_Shalstab_slope_small.mxd 9/9/2008 10:52:58 AM



Geologic Units
Q (Qal of McLaughlin and others, 2000) Alluvium consisting of sands, silt, clays, 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 streams alluvium can be incorporated into debris torrents traveling the channel.
Qrt (included in Qt of McLaughlin and others, 2000) Quaternary river terrace deposits. Unconsolidated generally poorly sorted pebble sands and sandy pebble-to boulder-conglomerates with silt interbeds. Generally flat-laying 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. Wrapped and folded unconsolidated marine and non marine sands, 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 translation 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
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
KJfs (cm2 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 block with diverse lithologies Where the unit deeply sheared, particularly within the argillite, the rock of the 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 occasionally torrents. Soils developed from this sheared rock are typically plastic sandy clays and clayey sands. Large block 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 to sand that have relatively low cohesion and are susceptible to debris flows.
Figure 3
Iron Gate
THP # 1-11-009
CGS Map
1 inch = 500 feet
0 260 520 1,040 1,560 2,080 Feet
HRC HCP/SYP Timberlands
Other HRC Timberlands
Other Private Ownership
ROW
Partial Cut
No Cut
Paved Road
Rocked Road
Dirt Road
Dirt Jeep Trails
Proposed Roads
Closed, Decommissioned, or Abandoned Roads
Class 1 Watercourse
Class 2 Watercourse
Class 3 Watercourse
Legend
polygon_Diss8
dss
a
df
eh
eb
y
contact, approx located
contact, approx located,
contact, approx located, concealed
f.a., anticline, approx. located
f.a., anticline, approx located, concealed
f.a., anticline, certain
fault, approx. located
fault, certain
thrust fault, approx located
thrust fault, concealed
thrust fault, concealed, queried
thrust fault, inferred
tt
df, h
ds, dm
ds, dy
ds, h
ef, dm
ef, do
ef, dy
ef, h
rs, dm
rs, do
rs, dy
rs, h
u,
Q
Qrt
Qh
Qtwu
Ty
Kjfs
Church Camp
Nor
Unit #1
Fork
Elk
Falk
4N 1W 25
4N 1W 36
4N 1E 31
rs do
ef do
ds h
ef dy
Produced by HRC-GIS \\dora\GIS\sisters\Larry\In_House\Mike Miles\Tier1Tier1I_BaseMaps\Mapbooks\Map3_CGS_small.mxd 9/9/2008 10:56:46 AM

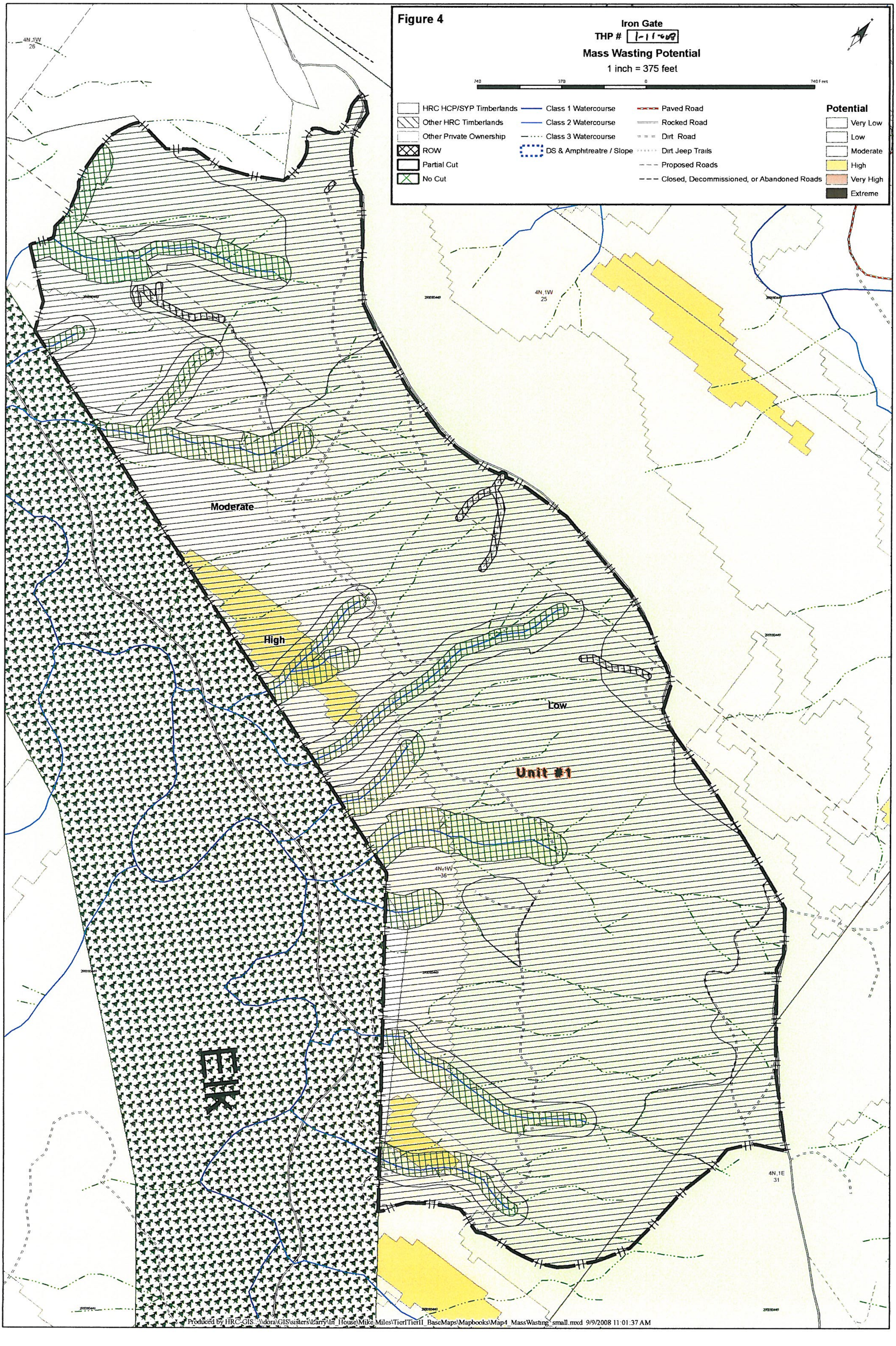


Figure 4
Iron Gate
THP # 1-11-068
Mass Wasting Potential
1 inch = 375 feet
740
370
0
740 Feet
HRC HCP/SYP Timberlands
Other HRC Timberlands
Other Private Ownership
ROW
Partial Cut
No Cut
Class 1 Watercourse
Class 2 Watercourse
Class 3 Watercourse
DS & Amphitreatre / Slope
Paved Road
Rocked Road
Dirt Road
Dirt Jeep Trails
Proposed Roads
Closed, Decommissioned, or Abandoned Roads
Potential
Very Low
Low
Moderate
High
Very High
Extreme
4N 1W 26
4N 1W 25
4N 1W 36
4N 1E 31
Moderate
High
Low
Unit #1
Elk
Produced by HRC-GIS \\dora\GIS\sisters\Larry\In_House\Mike_Miles\TierI\TierII_BaseMaps\Mapbooks\Map4_MassWasting_small.mxd 9/9/2008 11:01:37 AM

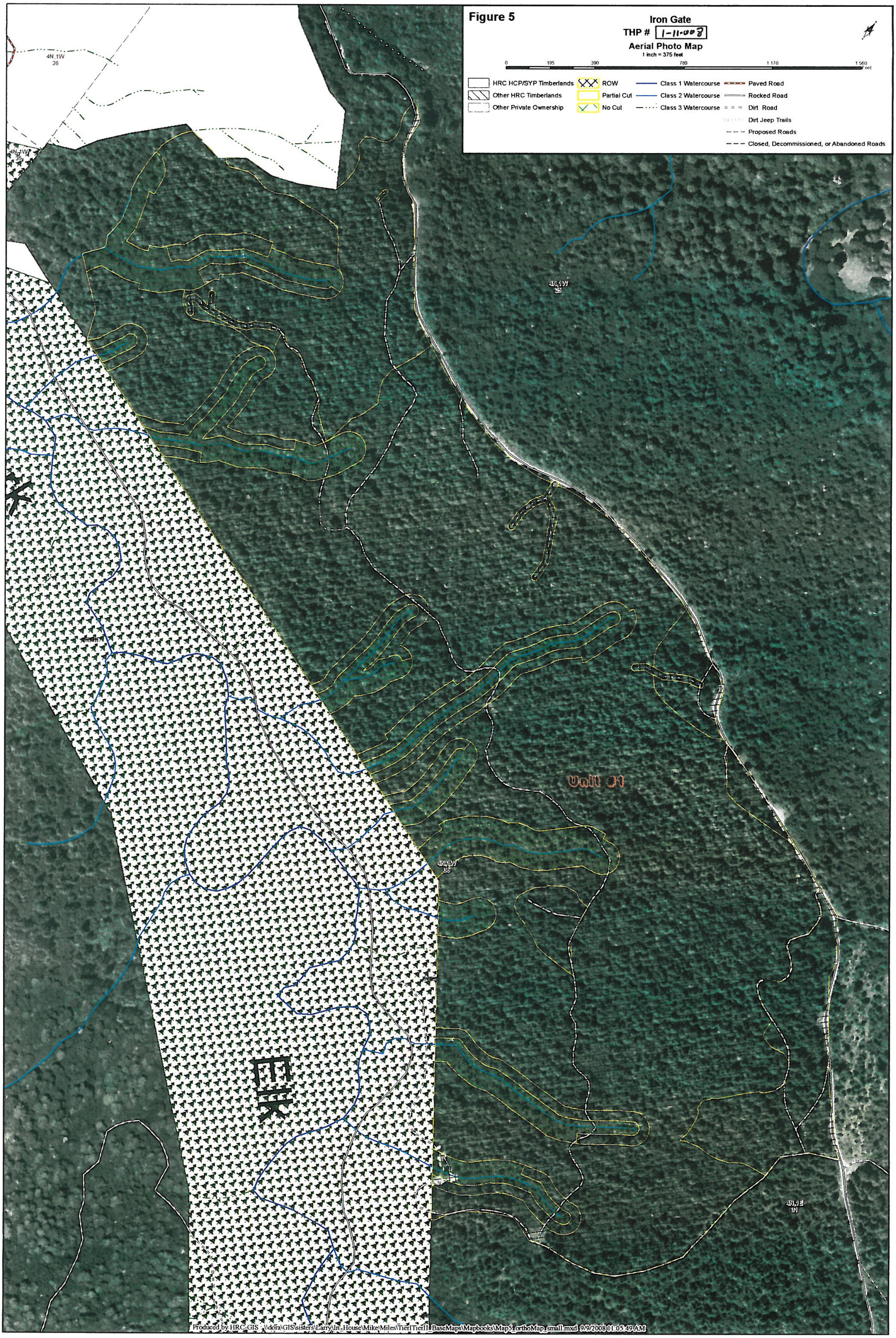
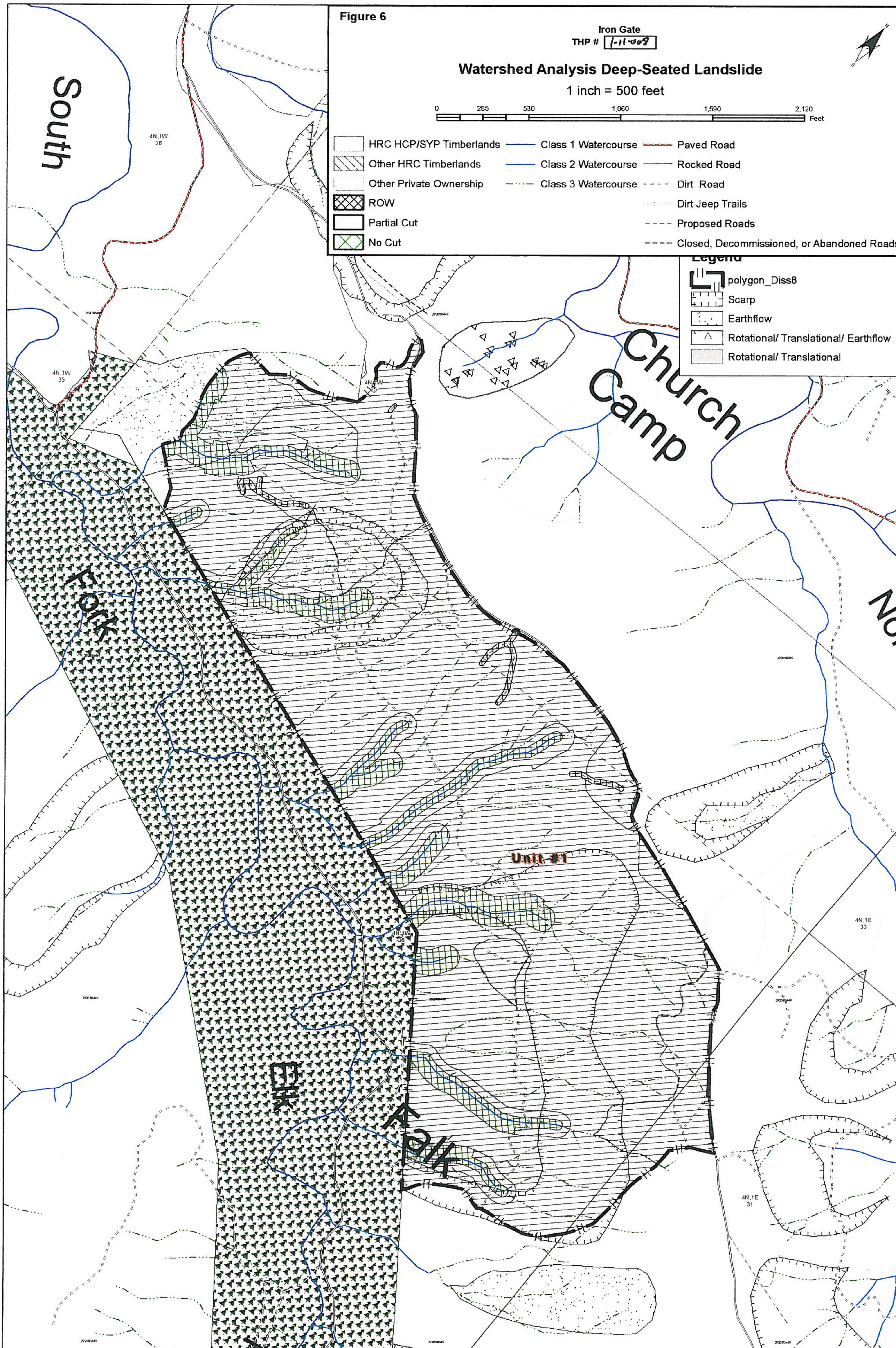


Figure 5
Iron Gate
THP # 1-11-008
Aerial Photo Map
1 inch = 375 feet
0
195
390
780
1,170
1,560
Feet
HRC HCP/SYP Timberlands
Other HRC Timberlands
Other Private Ownership
ROW
Partial Cut
No Cut
Class 1 Watercourse
Class 2 Watercourse
Class 3 Watercourse
Paved Road
Rocked Road
Dirt Road
Dirt Jeep Trails
Proposed Roads
Closed, Decommissioned, or Abandoned Roads
4N 1W
26
Unit #1
Elk
Produced by HRC-GIS \\dora\GIS\sisters\Larry\In_House\Mike\Miles\Tier\TierII_BaseMaps\Mapbooks\Map5_orthoMap_small.mxd 9/9/2008 11:05:49 AM

Figure 6



Produced by HRC-GIS, \\dora\GIS\sisters\Larry\In_House\Mike Miles\TierI\TierII_BaseMaps\Mapbooks\Map6_Deep_seated_small.mxd 9/9/2008 11:07:47 AM

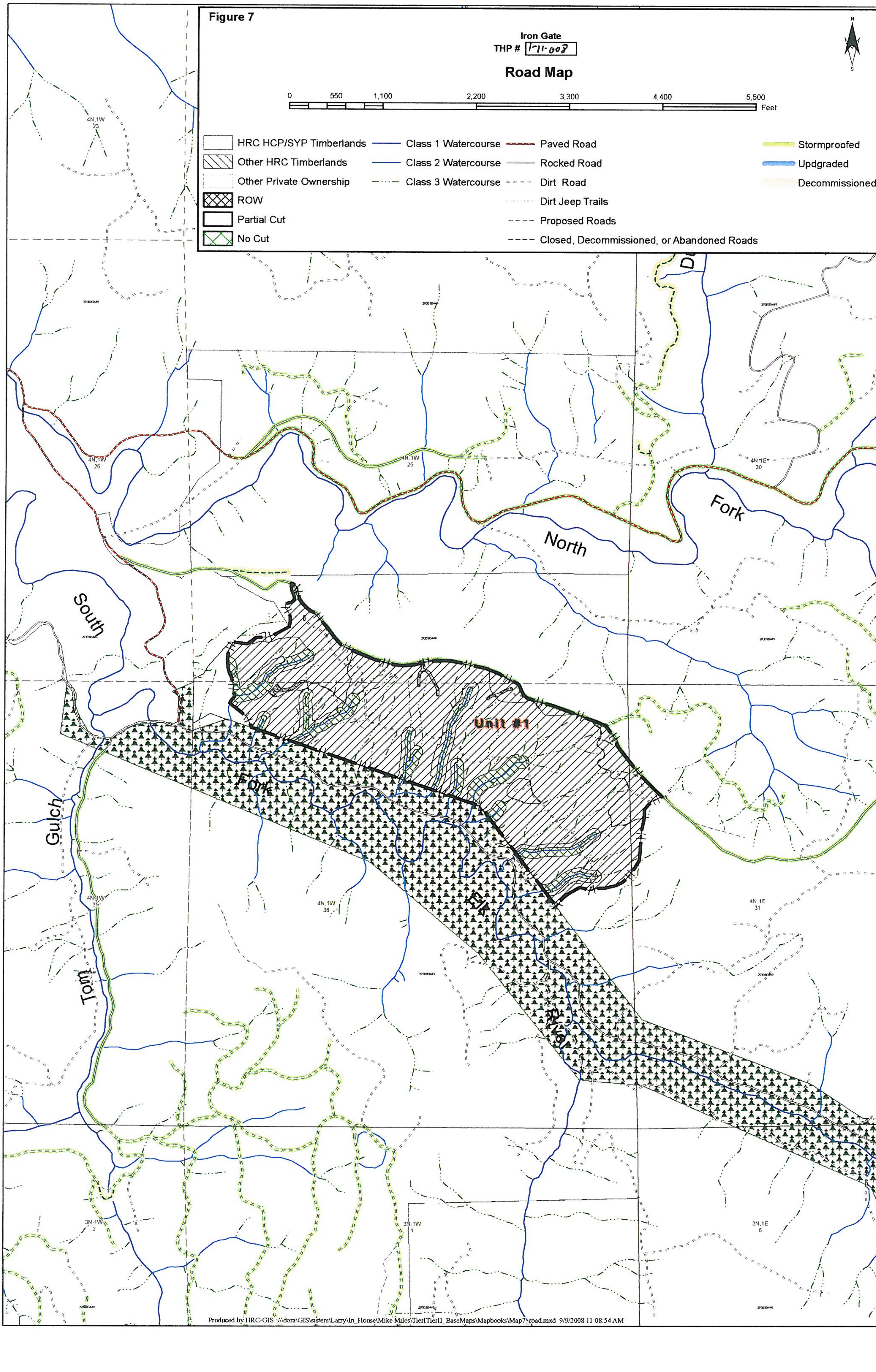


Figure 7
Iron Gate
THP # 1-11-008
Road Map
0
550
1,100
2,200
3,300
4,400
5,500
Feet
HRC HCP/SYP Timberlands
Other HRC Timberlands
Other Private Ownership
ROW
Partial Cut
No Cut
Class 1 Watercourse
Class 2 Watercourse
Class 3 Watercourse
Paved Road
Rocked Road
Dirt Road
Dirt Jeep Trails
Proposed Roads
Closed, Decommissioned, or Abandoned Roads
Stormproofed
Updgraded
Decommissioned
N
S
4N,1W 23
4N,1W 26
4N,1W 25
4N,1E 30
North
Fork
South
Unit #1
Fork
Elk
River
Gulch
Tom
4N,1W 35
4N,1W 36
4N,1E 31
3N,1W 2
3N,1W 1
3N,1E 6
Produced by HRC-GIS \\dora\GIS\sisters\Larry\In_House\Mike Miles\TierITierII_BaseMaps\Mapbooks\Map7-road.mxd 9/9/2008 11:08:54 AM