

APPLICATION FOR LISTING AN IMPROVED FOREST MANAGEMENT U.S. FOREST OFFSET PROJECT				
OPR Staff Use Only	Date Application Received:	OPR Tracking Number:	Date Application Reviewed:	OPR Staff Use Only
PART I. ENTITY APPLYING FOR LISTING				
Is this form being submitted by the Offset Project Operator (OPO) or by the Authorized Project Designee (APD)? Notes: 1. The person completing this form should be an OPO/APD employee. 2. If the APD is submitting this form, the OPO should submit the form <i>Designation of Authorized Project Designee</i> simultaneously.				☐ OPO ☒ APD
Name of Person Completing Form: James D. Clark		Organization, if applicable: NCRM, Inc.		
Date Form Completed: 10/15/2015		Phone Number: 707-485-7211	Email Address: jimclark@ncrm.com	
PART II. OFFSET PROJECT INFORMATION				
Offset Project Name: Mailliard Ranch				
Offset Project Commencement Date: March 24, 2015		First Reporting Period Start Date: March 24, 2015	First Reporting Period End Date: October 31, 2015	
Provide an explanation and justification for the commencement date. Specify the action(s) that identify the offset project commencement date. The date that field work on the inventory for the Project began is the offset project commencement date.				
PART III. OPO / APD INFORMATION				
A. OPO				
OPO Name: Mailliard Ranch, a California Limited Partnership			OPO's CITSS ID#: CA 1 9 1 2	
Mailing Address: 19400 Fish Rock Road		City: Yorkville	State: CA	Zip: 95494
Contact Person: Lawrence J. Mailliard		Phone Number: (707) 895-2431	Email Address: mmyard@pacific.net	
B. APD (if applicable) ☐ No APD / Not Applicable				
APD Name: James D. Clark			APD's CITSS ID#: CA 1 5 6 9	
Mailing Address: PO Box 435		City: Calpella	State: CA	Zip: 95418
Contact Person: James D. Clark		Phone Number: (707) 485-7211	Email Address: jimclark@ncrm.com	
PART IV. LAND OWNERSHIP				
A. Is the Offset Project Operator (OPO) the owner in fee for the Project Area? <i>Further documentation is required for all projects. Submit as attachment labeled "Attachment A." See Part X of this listing document for more information.</i> If "no," explain how the entity identified as the OPO has the right to undertake and list the project.				☒ Yes ☐ No
B. List all Forest Owners. This includes owners in fee as well as third parties with existing property interests within the Project Area that affect the trees and standing timber located in the Project Area (e.g. mineral rights, timber rights, easements, rights of way, leases, etc.). The Mailliard Ranch, a California Limited Partnership is the only Forest Owner with property				

interests within the Project Area that affect the trees and standing timber located on the Project Area.

C. Does the offset project occur on public or private lands?

If the project occurs on public lands, proceed to questions C1 and C2. Otherwise, skip to question D. Further documentation is required if project occurs on public lands. Submit as attachment labeled "Attachment B." See Part X of this listing document for more information.

☒ **Private**
☐ **Public**

1. Describe the public process that has been used to approve forest management activities and baseline.

N/A

2. Describe the documentation being submitted with this listing document demonstrating approval of planned forest management activities and baseline.

N/A

D. Will the project employ a Qualified Conservation Easement (QCE)?

If employing a QCE, proceed to questions D1, D2, and D3. Otherwise, skip to question E. Supporting documentation for a QCE is required. Submit as attachment labeled "Attachment C." See Part X of this listing document for more information.

☐ **QCE**
☐ **Public Ownership**
☒ **N/A**

1. Date that the QCE was or will be recorded.

N/A

2. Will the project take place in a state that requires third-party beneficiaries to sign the easement (i.e., to "accept and record that acceptance"), such as Arizona, Pennsylvania, or West Virginia?

☐ **Yes**
☐ **No**
☒ **N/A**

3. Provide the terms within the easement that affect forest management.

N/A

E. Does the offset project occur on any of the following categories of land? (check all that apply)

- ☐ Land that is owned by, or subject to, an ownership of possessory interest of a Tribe
☐ Land that is "Indian lands" of a Tribe as defined by 25 U.S.C. §81(a)(1)
☐ Land that is owned by any person, entity, or Tribe, within the external borders of such Indian lands
☒ **None of the above**

If "none of the above," skip to Part V. Otherwise, proceed to questions E1 and E2.

Further documentation is required for projects occurring on land listed in the first three categories. Submit supporting documents as attachments labeled "Attachment D." See Part X of this listing document for more information.

1. Does a limited waiver of sovereign immunity between ARB and the governing body of the Tribe exist?

☐ **Yes**
☐ **No**
☒ **N/A**

2. Describe how the land within the Project Area is owned.

N/A

PART V. OFFSET PROJECT AREA

Maps depicting specific elements of the Project Area are required for all projects. Submit supporting documentation as attachments labeled "Attachment E." See Part X of this listing document for more information.

Latitude of Offset Project Location:

39.92091

Longitude of Offset Project Location:

-123.3608984

Project Area Total Acreage:

12,360.68

A. Identify the assessment area (or assessment areas, if project crosses more than one) that contain Project Area lands and list the acreage of project lands within each assessment area.

See Addendum to Application for Listing V.A.

B. Identify the governing jurisdiction(s) applicable to the Project Area.

See Addendum to Application for Listing V.B.

C. Describe how the Project Area was determined.

See Addendum to Application for Listing V.C..

D. Describe the existing land cover, and land use of the Project Area.

See Addendum to Application for Listing V.D.

E. Describe the forest vegetation types within the Project Area boundary.

See Addendum to Application for Listing V.E.

F. Describe the site classes within the Project Area boundary.

See Addendum to Application for Listing V.F.

G. Describe the land pressures and climate zone/classification applicable to the Project Area.

See Addendum to Application for Listing V.G.

H. Describe the historical land uses, current zoning, and projected land use within the Project Area and surrounding areas. See Addendum to Application for Listing V.H.	
I. Describe generally the forest conditions within the Project Area, including species composition, age class distribution, and management history. See Addendum to Application for Listing V.I.	
PART VI. OFFSET PROJECT ELIGIBILITY	
A. Does the project take place on land that has greater than 10 percent tree canopy cover? <i>Supporting documentation is required. Submit as attachment labeled "Attachment F." See Part X of this listing document for more information.</i> See Addendum to Application for Listing VI.A.	☒ Yes ☐ No
B. Indicate how the offset project meets (or will meet) the definition of Natural Forest Management per Table 3.2 in the Compliance Offset Protocol US Forest Offset Projects, November 14, 2014:	
1. Native species: a) Will the project consist of at least 95 % native species based on the estimated sum of carbon in the standing live carbon pool? <i>If "no," proceed to question 1b. Otherwise, skip to question B2.</i>	
☒ Yes ☐ No	
b) Describe how the project will meet this requirement. (Improved Forest Management Projects will be assessed using estimates of basal area per acre.)	
2. Composition of native species: a) Does the Project Area naturally consist of a mixed species distribution where no single species' prevalence, measured as the percent of basal area of all live trees in the Project Area, exceeds the percentage value of standing live carbon shown under the heading 'Species Diversity Index' in the Assessment Area Data File? <i>If "no," proceed to questions 2b and 2c. Otherwise skip to question B3.</i> See Addendum to Application for Listing VI.B.2.	
☒ Yes ☐ No	
b) Explain how the project will demonstrate a trend toward achieving the Species Diversity Index of native species and meet this requirement within 25 years. N/A	
c) If the Project Area does not naturally consist of a mixed species distribution: Will or have you provided a written statement from the government agency in charge of forestry regulation in the state where the project is located stipulating that the Project site is not capable of meeting the requirement of mixed species distribution.	
☐ Yes ☐ No ☒ N/A	
3. Distribution of age classes/sustainable management: a) Indicate how the project will meet the requirement for sustainable management if commercial harvesting is either planned or ongoing within the Project Area demonstrating sustainable long term harvesting practices. This applies to all forest landholdings of the Forest Owner(s) (check one of the boxes). ☐ Not applicable; no commercial harvesting is occurring within the Project Area. ☐ Third party certification under the Forest Stewardship Council, Sustainable Forestry Initiative, or Tree Farm System, whose certification standards require adherence to and verification of harvest levels which can be permanently sustained over time. ☐ Adherence to a renewable long-term management plan that demonstrates harvest levels which can be permanently sustained over time and that is sanctioned and monitored by a state or federal agency. ☒ Employ uneven-aged silvicultural practices and maintain canopy retention averaging at least 40 % across the forest, as measured on any 20 acres within the entire forestland owned by the Forest Owner, including land within and outside of the Project Area (areas impacted by Significant Disturbance may be excluded from this test). See Addendum to Application for Listing VI.B.3(a).	
b) On a watershed scale up to 10,000 acres (or the Project Area, whichever is smaller), projects must maintain, or make progress toward maintaining, a maximum of 40 % of the project's forest lands in ages that are less than 20 years old. (Areas impacted by Significant Disturbance are exempt from this test until 20 years after reforestation of such areas.) Does the acreage within this project meet this requirement? <i>If "no," proceed to question 3c. Otherwise, skip to question B4.</i> See Addendum to Application for Listing VI.B.3(b).	
☒ Yes ☐ No	
c) Explain how the project intends to show continuous progress toward meeting this requirement within the next 25 years. N/A	

4. Structural elements (standing and lying dead wood):

How will the project ensure that structural elements are retained in sufficient quantities throughout the project life?

See Addendum to Application for Listing VI.B.4.

C. Describe the management activities that will lead to increased carbon stocks in the Project Area, compared to the baseline.

See Addendum to Application for Listing VI.C.

D. Is this project being implemented and conducted as the result of any law, statute, regulation, court order, or other legally binding mandate?

If "yes," explain:

N/A

☐ Yes

☒ No

E. Will the offset project employ broadcast fertilization?

☐ Yes

☒ No

F. Does the offset project take place on land that was part of a previously listed and verified Forest Offset Project?

If "yes," proceed to questions E1 and E2. Otherwise, skip to Part VII.

☐ Yes

☒ No

1. Was the previous Forest Offset Project terminated due to an Unintentional Reversal?

☐ Yes

☒ No

2. Is the project transitioning to the Compliance Offset Protocol U.S. Forest Projects, November 14, 2014, after previously being listed as an early action offset project?

☐ Yes

☒ No

PART VII. CARBON STOCK INVENTORY

A. Provide a general description of the inventory methodology to be used to quantify carbon stocks for each required carbon pool in the forest project's offset boundary. The inventory methodology must describe the information required in Appendix A.3 of the Compliance Offset Protocol U.S. Forest Projects, November 14, 2014.

IFM-1 Standing Live:

See Addendum to Application for Listing VII.A.

IFM-3 Standing Dead:

See Addendum to Application for Listing VII.A.

IFM-6 Soil (if applicable):

See Addendum to Application for Listing VII.A.

IFM-7 Carbon in in-use forest products:

See Addendum to Application for Listing VII.A.

IFM-8 Forest product carbon in landfills (if applicable):

See Addendum to Application for Listing VII.A.

IFM- 9 Biological emissions from site preparation:

See Addendum to Application for Listing VII.A.

IFM-14 Biological emissions/removals from change in harvesting on forestland outside project area:

See Addendum to Application for Listing VII.A.

IFM-17 Biological emissions from decomposition of forest products:

See Addendum to Application for Listing VII.A.

B. Describe the calculation methodologies to be used to determine metric tons per acre for each of the carbon pools included in the Offset Project Data Report.

IFM-1 Standing Live:

See Addendum to Application for Listing VII.B.

IFM-3 Standing Dead:

See Addendum to Application for Listing VII.B.

IFM-6 Soil (if applicable):

See Addendum to Application for Listing VII.B.

IFM-7 Carbon in in-use forest products:

See Addendum to Application for Listing VII.B.

IFM-8 Forest product carbon in landfills (if applicable):

See Addendum to Application for Listing VII.B.

IFM- 9 Biological emissions from site preparation:

See Addendum to Application for Listing VII.B.

IFM-14 Biological emissions/removals from change in harvesting on forestland outside project area:

See Addendum to Application for Listing VII.B.

IFM-17 Biological emissions from decomposition of forest products:

See Addendum to Application for Listing VII.B.

C. Provide a summary of the inventory of carbon stocks for each carbon pool (or approach used, if inventory is not applicable).

IFM-1 Standing Live:

See Addendum to Application for Listing VII.C.

IFM-3 Standing Dead:

See Addendum to Application for Listing VII.C.

IFM-6 Soil (if applicable):

See Addendum to Application for Listing VII.C.

IFM-7 Carbon in in-use forest products:

See Addendum to Application for Listing VII.C.

IFM-8 Forest product carbon in landfills (if applicable):

See Addendum to Application for Listing VII.C.

IFM-9 Biological emissions from site preparation:

See Addendum to Application for Listing VII.C.

IFM-14 Biological emissions/removals from change in harvesting on forestland outside project area:

See Addendum to Application for Listing VII.C.

IFM-17 Biological emissions from decomposition of forest products:

See Addendum to Application for Listing VII.C.

D. Provide a summary of the estimated inventory confidence statistics.

See Addendum to Application for Listing VII.D.

E. Provide the calculation of the offset project's reversal risk rating and expected contribution to the Forest Buffer Account.

See Addendum to Application for Listing VII.E.

PART VIII. OFFSET PROJECT BASELINE

A. Required for ALL Improved Forest Management Projects

1. Describe the project's modeling plan, following the requirements and methods in Appendix B, Section B.3 of the Compliance Offset Protocol U.S. Forest Projects, November 14, 2014.

Please see the Modeling Plan included as Attachment K.

2. Describe and estimate the project's baseline onsite carbon stocks. Explain any annual changes in baseline carbon stocks over time.

This information is contained in the Modeling plan included as Attachment K

A graph portraying the baseline onsite carbon stocks, labeled "Attachment G," and a diagram of the baseline incorporating all required carbon stocks, labeled "Attachment H," are required. See Part X of this listing document for more information.

3. Identify the approved growth model that will be used for the project.

FORSEE

4. Harvest Planning

a. Is harvesting planned in the Project Area?

If "yes," proceed to question 4b. Otherwise, skip to question A5.

☒ Yes
☐ No

b. Will the project use a harvest schedule model?

If "yes," proceed to question 4c. Otherwise, skip to question A5.

☐ Yes
☒ No

c. How do you plan to address age class and stratification as part of your harvest scheduling?

N/A

5. Provide an estimate of carbon that will be stored long-term in harvested wood products in the baseline.

See Addendum to Application for Listing VIII.A.5.

B. Required for Improved Forest Management Projects on Private Lands ONLY

1. Provide the estimated initial above ground standing live carbon stock per acre for the project, if known.

Estimated to be approximately 260.08 MgCO₂e per acre.

2. Provide the estimated adjusted above ground standing live carb stock per acre, if known.

Estimated to be approximately 178.62 MgCO₂e per acre.

3. Provide the Common Practice statistic associated with the Project Area.

The Common Practice statistic for the Project Area is 178.59 MgCO₂e per acre.

4. Are the Project Area's initial above-ground standing live carbon stocks per acre above or below Common Practice? If below Common Practice, what is the High Stocking Reference for the Project Area? N/A <i>Further documentation is required if project below Common Practice. Submit supporting documents as attachments labeled "Attachment I." See Part X of this listing document for more information.</i>			☒ Above ☐ Below
5. Does the Forest Owner(s) and its affiliate(s) own land in fee or hold timber rights on land outside the Project Area? <i>If "no," skip to question B.6.</i>			☒ Yes ☐ No
If "yes" does the Protocol require the use of a weighted average carbon stock on lands in the same Logical Management Unit (LMU, as defined in Section 6.2.1.1)? <i>If "no," skip to question B.6.</i>			☐ Yes ☒ No
If "yes," is inventory data available for the LMU or will the OPO use a stratified vegetation analysis?		☐ Data available for LMU ☐ Stratified Vegetation Analysis	
6. Provide a general description of the legal constraints affecting forest management activities in the Project Area; include a description of each constraint (referring to Section 6.2.1.2 in the Protocol) as well as a narrative those constraints have on forest management. This information is included in the Modeling Plan included as Attachment K.			
7. Provide a description of the modeling techniques used to simulate the effects of the constraint. This information is included in the Modeling Plan included as Attachment K.			
8. How does the OPO demonstrate financial feasibility of the growth and harvesting regime assumed for the baseline? (check one of the boxes) ☒ Conducting a financial analysis of the anticipated growth and harvesting regime that captures all relevant costs and returns, taking into consideration all legal, physical, and biological constraints, using regional norms or documented costs and returns for the project area or other properties in the Forest Project's Assessment Area ☐ Providing evidence that activities similar to the proposed baseline growth and harvesting regime have taken place on other properties within the Forest Project's Assessment Area within the past 15 years <i>Supporting documentation is required. Submit as attachment labeled "Attachment J." See Part X of this listing document for more information.</i> See Addendum to Application for Listing VIII.B.8.			
C. Required for Improved Forest Management Projects on <u>Public Lands ONLY</u>			
1. Has an initial forest carbon inventory been conducted for the Project Area?			☐ Yes ☐ No ☒ N/A
2. Provide a projection of future changes to Project Area forest carbon stocks extrapolating from historical trends. N/A			
3. Explain how current public policy will affect onsite carbon stocks and how the baseline modeling incorporates constraints imposed by all applicable statutes, regulations, policies, plans, and activity-based funding. N/A			
4. Have carbon stocks in the Project Area been increasing or declining over the preceding ten-year period?			☐ Increasing ☐ Declining ☒ N/A
PART IX. ADDITIONAL QUESTIONS			
A. Have any lands within the Project Area ever been listed or registered with an offset project registry or program in the past? <i>If "yes," identify the registry or program and provide details on the issued credits below.</i>			☐ Yes ☒ No
B. Have greenhouse gas emission reductions or removal enhancements associated with lands within the Project Area been credited or claimed for the purpose of greenhouse gas mitigation or reduction goals, whether in a voluntary or regulatory context? <i>If "yes," identify the registry or program and provide details on the issued credits below.</i>			☐ Yes ☒ No
Registry / Program: N/A	Reporting Period(s): N/A	Vintage(s): N/A	Number of Credits Issued: N/A

PART X. ATTACHMENTS

- A. If the answer to Part IV.A is "yes," provide documentation (e.g., deed of trust, title report, etc.) showing the OPO's ownership interest in the property and its interest in the trees and standing timber on the property. If the answer to Part IV.A is "no," provide documentation supporting the explanation of the OPO's right to undertake and list the project.
- B. If the answer to Part IV.C is "public," provide documentation demonstrating explicit approval of the offset project's management activities and baseline including any public vetting processes necessary to evaluate management and policy decisions concerning the offset project. ☒ N/A
- C. If a Qualified Conservation Easement (QCE) has been recorded, provide a copy. The listing information contained in this form and the documents attached to it will eventually be submitted to ARB so submitting a copy of the QCE as an attachment to this listing document fulfills the requirement in 9.1.1.1(18)(a) of the Compliance Offset Protocol U.S. Forest Projects, November 14, 2014 to provide ARB with a copy. ☒ N/A
- D. If the project is located on one of the categories of Tribal land listed in Part IV.E, provide documentation demonstrating that the land within the Project Area is owned by a tribe or private entity. Also provide documentation that demonstrates the existence of a limited waiver of sovereign immunity between ARB and the governing body of the Tribe entered into pursuant to section 95975(I) of the Cap-and-Trade Regulation. ☒ N/A
- E. Attach map(s) of the Project Area including:
1. Public and private roads
 2. Towns
 3. Major watercourses (4th order or greater), water bodies, and watersheds
 4. Topography
 5. Townships, ranges, and sections or latitude and longitude
 6. Existing land cover and land use (optional)
 7. Forest vegetation types (optional)
 8. Site classes (optional)
 9. Land pressures and climate zone/classification (optional)
 10. Historical land uses, current zoning, and projected land use within the Project Area (optional)
 11. A georeferenced shape file (or other electronic file that can be read in a geographic information system) that clearly identifies the Project Area and boundaries. *Note that the georeferenced shape file may constitute the required map if it includes the required map information listed above.*
- F. Provide supporting documentation demonstrating that the offset project takes places on land that has greater than 10 percent tree canopy cover.
- G. Attach a graph portraying the baseline onsite carbon stocks with time depicted on the x-axis and metric tons CO₂e depicted on the y-axis.
- H. Attach a diagram of the baseline incorporating all required carbon stocks.
- I. For projects on private lands ONLY: If the Project Area's initial above-ground standing live carbon stocks are below Common Practice, submit an affidavit testifying that the inventory depicted over the past 10 years (used to determine the High Stocking Reference for the Project Area) is reasonably accurate and a summary of volume harvested over the past 10 years. ☒ N/A
- J. For projects on private lands ONLY: Provide a description and supporting evidence, if applicable, that the growth and harvesting regime assumed for the baseline is financially feasible based on the qualifications in Section 6.2.1.3 of the Protocol. ☐ N/A

PART XI. ATTESTATIONS AND OPO SIGNATURE

 Initial	I certify under penalty of perjury under the laws of the State of California the GHG reductions and/or GHG removal enhancements for			
	Project Name: Mailliard Ranch		from	Crediting Period Start Date: 03/24/2015
			to	Crediting Period End Date: 03/23/2040
will be measured in accordance with the Compliance Offset Protocol U.S. Forest Projects, November 14, 2014, and all information required to be submitted to ARB is true, accurate, and complete.				
 Initial	I understand I am voluntarily participating in the California Greenhouse Gas Cap-and-Trade Program under title 17, article 5, and by doing so, I am now subject to all regulatory requirements and enforcement mechanisms of this program and subject myself to the jurisdiction of California as the exclusive venue to resolve any and all disputes arising from the enforcement of provisions in this article.			

 ----- Initial	I understand that the offset project activity and implementation of the offset project must be in accordance with all applicable local, regional, and national environmental and health and safety laws and regulations that apply to the offset project location. I understand that offset projects are not eligible to receive ARB or registry offset credits for GHG reductions and GHG removal enhancements that are not in compliance with the requirements of the cap-and-trade program.	
In signing this form, I certify under penalty of perjury of the laws of California that the information contained in this form is true, accurate, and complete. I further certify that I am an Account Representative of the Offset Project Operator (OPO).		
SIGNATURE: 	PRINTED NAME: James D. Clark	
TITLE: APD	DATE: 10/15/2015	

Background for Application of Listing an Improved Forest Management U.S. Forest Offset Project

Section 95975 of the Cap-and-Trade Regulation describes the requirements and process for an Offset Project Operator (OPO) or Authorized Project Designee (APD) to list an offset project with an approved Offset Project Registry. This form is designed to help an OPO or APD fulfill the requirements of Section 95975 of the Cap-and-Trade Regulation and of Section 9.1.1 of the Compliance Offset Protocol U.S. Forest Projects, November 14, 2014, for listing an offset project. The U.S. Forest protocol designates three project types: Avoided Conversion, Improved Forest Management, and Reforestation. This form is designed for Improved Forest Management projects only. The information in the completed form should be submitted to the approved Offset Project Registry with which the OPO or APD would like their offset project listed.

Where to Submit Information Contained in This Form

Please complete the information on the form using your computer. Then print, sign, and scan the form. The completed and signed information and all supporting documentation should be submitted to the appropriate [Offset Project Registry](#).

Copies of this form can be downloaded from the ARB website at:
<http://www.arb.ca.gov/cc/capandtrade/offsets/forms/forms.htm>

Detailed Instructions for Application for Listing an Improved Forest Management U.S. Forest Offset Project

This form is protected with restricted editing to facilitate completing the form. If the applicant wishes to unprotect the form, the password is "form".

Part I. Entity Applying for Listing:

- Indicate whether the Offset Project Operator (OPO) or Authorized Project Designee (APD) is submitting the information for project listing. Section 95975(a) of the Cap-and-Trade Regulation requires that the OPO and, if applicable, the APD must register with ARB for the Cap-and-Trade Program prior to listing a project. It also requires that neither the OPO nor APD be subject to any Holding Account restrictions imposed as part of an enforcement action. To register with ARB, please visit the website for Compliance Instrument Tracking System Services (CITSS): <https://www.wci-citss.org/>
- List the name, organization, phone number, and email address of the person submitting the information. This person should be an employee of the OPO or APD, whichever entity is making the submission. The person submitting the information need not be the same person as the contact person listed for the OPO or APD in Part III and also need not be the person signing the form in Part XI.
- The person submitting the information should indicate the date the form is completed.

Part II. Offset Project Information:

- Provide the name for the offset project. Indicate the offset project commencement date and the start and end dates of the first reporting period; approximations are acceptable if precise dates are unknown.
- Project commencement for an Improved Forest Management Project must be linked to a discrete, verifiable action that delineates a change in practice that increases sequestration and/or decreases emissions relative to the forest project's baseline. This date could be when the Project Area is transferred to public ownership, when a conservation easement on the Project Area is recorded, or when submitting the offset project listing information.

Part III. OPO/APD Information:

- Enter contact information for the OPO and APD requesting the offset project listing. Every offset project will have an OPO. If an offset project does not have an APD, please mark the box indicating the Offset Project does not have an APD and leave the remaining fields blank.
- For both the OPO and, if applicable, the APD, enter the entity's name, its mailing address, and the name, phone number, and email address of a contact person for the entity. Also include its CITSS ID number. The CITSS ID is six characters in length, with two letters followed by four numbers (e.g.,

“CA1234”). **DO NOT PROVIDE THE CONFIDENTIAL CITSS ACCOUNT NUMBER**, which begins with the CITSS ID number followed by a hyphen and more numbers.

Part IV. Land Ownership:

- This part includes questions regarding land ownership and property interests.
- Further documentation is required based on the responses to some questions. See Part X of this listing form for more information on the precise requirements.

Part V. Offset Project Area:

- This part asks for qualitative descriptions of the offset Project Area.
- Maps are required to complement the descriptions provided in this part. See Part X of this listing form for more information on the precise requirements.
- The Project Area should be determined following the requirements of Section 4 of the Compliance Offset Protocol U.S. Forest Projects, November 14, 2014.
- Assessment areas shall be determined by referencing the Assessment Area Data File available at: <http://www.arb.ca.gov/cc/capandtrade/protocols/usforestprojects.htm>

Part VI. Offset Project Eligibility:

- The questions in this part are designed to facilitate the determination of project eligibility for Improved Forest Management Projects.
- Further documentation is required based on the responses to some questions. See Part X of this listing form for more information on the precise requirements.
- Details on the eligibility requirements for Improved Forest Management Projects can be found in Sections 2.1.2, 3.1, and 3.8 of the Compliance Offset Protocol U.S. Forest Project, November 14, 2014.
- Details on the Natural Forest Management criteria can be found in Table 3.2 in the Compliance Offset Protocol U.S. Forest Project, November 14, 2014.

Part VII. Carbon Stock Inventory:

- Projects are not required to have completed a full carbon stock inventory at the time of listing, but OPOs/APDs should be familiar with Appendix A and have a plan for how they will meet the requirements therein. Therefore, a general description of the project's inventory methods and procedures, consistent with the requirements in Appendix A.3, is required at the time of listing. ARB recognizes that some information provided will be preliminary and based on best estimates. If the project's inventory methodology changes between the time of listing and submission of the first OPDR, this should be reported as a change to the information submitted at project listing when submitting the first OPDR.
- Section 6.2 of the Compliance Offset Protocol U.S. Forest Projects, November 14, 2014 outlines the approved quantification methodologies for Improved Forest Management Projects. Further details on completing a forest project carbon inventory can be found in Appendix A of the Protocol.
- Follow the steps in Appendix D of the Compliance Offset Protocol U.S. Forest Projects, November 14, 2014 to quantify the project's reversal risk rating.
- The project's expected contribution to the Forest Buffer Account is determined annually based upon the project's risk of reversal and is calculated by multiplying the project specific reversal risk rating by the total net GHG reductions/removals achieved by the project. An approximation of the contribution to the Forest Buffer Account is acceptable.

Part VIII. Offset Project Baseline:

- Projects are not required to have a finalized baseline at the time of listing, but OPOs/APDs should be familiar with Appendix B and have a plan for how they will meet the requirements therein. A complete modeling plan reflecting the requirements in Appendix B.3 is therefore required at the time of listing. ARB recognizes that some information provided will be preliminary or based on best estimates. If the project's modeling plan or baseline estimates change between the time of listing and submission of the first OPDR, this should be reported as a change to the information submitted at project listing when submitting the first OPDR.
- Note that IFM projects located on public land must present documentation demonstrating explicit approval of the offset project's management activities and baseline. These projects may report changes to the baseline within the initial OPDR if the changes have gone through a public review process and meet the Protocol requirements regarding explicit approval of the project's baseline.
- This part is divided into three sections: questions required for all Improved Forest Management Projects; questions for Improved Forest Management Projects on private lands; and questions for

Improved Forest Management Projects on public lands. Answer the questions applicable to the project.

- Section 6.2 of the Compliance Offset Protocol U.S. Forest Projects, November 14, 2014 outlines the approved quantification methodologies for Improved Forest Management Projects. Instructions for considering legal and financial constraints can be found in Sections 6.2.1.2 and 6.2.1.3, respectively. Further details on modeling carbon stocks can be found in Appendix B of the Protocol.
- ARB approved growth models can be found in Appendix B, Section B.1 of the Compliance Offset Protocol U.S. Forest Projects, November 14, 2014.
- When a requirement is not applicable to the project being listed, please select the "N/A" (Not Applicable) checkbox next to the requirement so that it is clear that the question was not inadvertently left unanswered.

Part IX. Additional Questions:

- Answer both questions. If the answer to either question is "yes," identify the registry or program and provide details on the issued credits in the space provided.

Part X. Attachments:

- Provide each attachment on a separate sheet of paper and submit along with the completed application for listing.
- To aid with tracking each attachment, it is recommended that the attachments are labeled to correspond with the letter in Part X that they refer to (e.g. "Attachment B").
- When an attachment is not applicable to the project being listed, please select the "N/A" (Not Applicable) checkbox next to the requirement so that it is clear that the attachment was not inadvertently left off.

Part XI. Attestations and OPO Signature:

- Section 95975(c) of the Cap-and-Trade Regulation requires three attestations for listing an offset project. The required attestations are provided in this section. Each attestation should be initialed by the person signing the form.
- The first attestation requires the applicant to provide the offset project name and the start and end dates of the crediting period to complete the statement. The offset project name should match the name entered in Part II. The dates for the offset project's crediting period must also be provided. Please note that the dates provided in the attestation are for the crediting period, not for the first reporting period provided in Part II. The crediting period dates may be approximate if precise dates are not known.
- Amendments adopted in April 2014 to section 95975(d) require the attestations "be provided to an Offset Project Registry with the listing information, if being listed with an Offset Project Registry."
- The individual signing the document must be registered in CITSS as the OPO's Primary Account Representative or Alternate Account Representative. The individual signing the document may be an APD employee and/or representative; but to sign the document, the individual must be an Account Representative on the OPO's CITSS account.
- Please provide the person's signature, printed name, corporate title, and date signed.

Please contact your Offset Project Registry with any questions.



Mailliard Ranch

CAR1180

Addendum to Application for Listing Form
Under
Air Resources Board
Compliance Offset Protocol – U.S. Forest Projects
Adopted: November 14, 2014

Prepared October 15, 2015

Offset Project Operator	Authorized Project Designee
Mailliard Ranch, a California limited partnership 19400 Fish Rock Road, Yorkville, CA 95494 (707) 895-2431	James D. Clark PO Box 435 Calpella, CA 95418 (707) 485-7211

Reporting Period

The first reporting period for this Project is from 3/24/2015 to 10/31/2015.

Protocol Version

Air Resources Board
Compliance Offset Protocol – U.S. forest Projects
Adopted: November 14, 2014

Introduction

Mailliard Ranch is an Improved Forest Management (IFM) Project that is seeking registration under the California Air Resources Board Compliance Offset Protocol – U.S. Forest Projects Adopted: November 14, 2014. The Offset Project Operator is the Mailliard Ranch, a California limited partnership. The Project is approximately 12,361 acres in size.

V.A.

The Project is located entirely within the Northern California Coast Supersection, and within the Coast Redwood/Douglas-fir Mixed Conifer Assessment Area and is classified as low to high site timberland. Approximately 7,305 acres are within the “High” “Site Class” portion of the Assessment Area and approximately 5,056 acres are within the “Low” “Site Class” portion of the Assessment Area.

V.B.

The Project Area is subject to the governing jurisdiction of the County of Mendocino, the State of California, and the United States of America.

V.C.

The Project Area has been determined based on the best available data representing the legal description described in the title reports included as Attachment A. The Project Area boundary is described and represented by the maps included as Attachment E, and the GIS data supplied in a geodatabase as a part of this Project submission. For the purpose of calculating GHG stocks, the Project Area acreage is taken from the GIS data provided with the application.

V.D.

The existing land cover on the Mailliard Ranch Project Area is generally timberland with small areas of brush land, grasslands and rock outcroppings. Current uses of the Property generally include rural residential, recreation, ranching, farming, and timber production.

V.E.

The following Wildlife Habitat Relationship (WHR) vegetation types occur on the Mailliard Ranch Project Area:

RDW	REDWOOD
DFR	DOUGLAS FIR
AGS	ANNUAL GRASS
COW	COASTAL OAK WOODLAND
MHW	MONTANE HARDWOOD
CRC	CHAMISE-REDSHANK CHAPARRAL

The majority of the Project Area is classified as the RDW “Redwood” type. Primary conifer species are coastal redwood and Douglas-fir. The principal hardwood species is tanoak with a mixture of madrone, oak (i.e. *Quercus*), California laurel, and other California hardwoods. On most sites redwood would dominate if vegetation succession were allowed to proceed naturally.

V.F.

The entire Project Area is classified as moderate to high site class III timberland. Please see the Modeling Plan included as Attachment K for a more detailed description of the determination of site index.

V.G.

The Mailliard Ranch Project Area as well as much of the surrounding land is utilized for timber production, recreation, agriculture and rural residential uses. Land pressures associated with these uses are typically conversion of timberland to home sites or agricultural uses such as vineyards. Residential uses would involve the development of home sites while road use and human activity on the property would increase. Historically, increased human activity has resulted in the disruption and displacement of native plants and animals. The Mailliard Ranch Project Area consists of both Maritime & Mediterranean climates influenced by the proximity to the Pacific Ocean and topography. Summers are warm and winters are mild and wet. Temperatures range from an average low of 37 degrees F to an

average high of 91 degrees F. Average annual rainfall for the property is approximately 50 inches per year.

V.H.

Historic land use began in the late 1800's with homesteading activities clustered around the grassland areas on the Property. Evidence of these activities can be found through remnants of early cabins, ranching related structures, fruit trees, and in vegetation composition surrounding these areas which responded to the frequent burning practices of the era. The Ornbaun Springs Hotel and Resort was established in 1912 at the current location of Mailliard Ranch Headquarters. The adjacent spring of effervescent water was claimed to have had healing powers and visitors from the Bay Area often stayed for the entire summer.

The Mailliard family purchased the original portion of the Ranch in 1925 for recreational purposes. Over time, additional adjacent properties were acquired, primarily from 1934-1965, until reaching to the current Ranch configuration. The Project Area contains sixty-eight legal parcels. The ranch recently eliminated four parcels, without changing the size or boundary of the Mailliard Ranch. The new parcel descriptions are included in Attachment A, along with a recent Title Report. These changes have been recently recorded, but have yet to be updated in the County of Mendocino's parcel maps. The Mailliard Ranch property is primarily zoned Timber Production (TP) and Range Land (RL). The permitted uses on TP and RL land are timber production, row crops (including vineyard) and one single-family residence per legal parcel.

Current uses of the Property generally include rural residential, recreation, ranching, farming, and timber production. These uses are expected to continue into the foreseeable future.

V.I.

The Mailliard Ranch Project Area is characterized by a mix of predominantly redwood, Douglas-fir, and tanoak, and hardwoods, consisting of Pacific madrone, bigleaf maple, interior live oak, California bay laurel, black oak, white oak, and other native hardwoods and conifers. It is

estimated that, as of 1/1/2015, the Project Area is composed of approximately 34% Douglas-fir, 13% redwood, 1% other conifers, 24% tanoak, 11% pacific madrone, and 17% other hardwoods by basal area. The Mailliard Ranch project forest owner intends to manage to reduce the hardwood component and increase the component of conifers.

Several age classes of timber stands exist across the Project Area as the result of past land management activities with age classes ranging from 2,000 years to 1 year. Timber harvesting on the Project Area occurs frequently. Presently, the Project Area has one approved timber harvest plan (1-15-040MEN) totalling 726 acres.

VI.A.

The Mailliard Ranch Project Area meets condition 1 under section 2.1.2 (page 10) of the Compliance Offset Protocol by maintaining greater than 10% tree canopy cover. Compliance is substantiated by the Orthophoto map of the Project site, that may be found in Attachment F, clearly showing canopy closure for the Project Area greater than 10% and, also, by modeling conducted in FORSEE based on the 2015 inventory, which indicated over 100% overlapping canopy for most stands.

VI.B.2.

The Mailliard Ranch Project Area is characterized by a mix of predominantly redwood, tanoak, and Douglas-fir, and hardwoods, consisting of Pacific madrone, bigleaf maple, interior live oak, California bay laurel, black oak, white oak, and other native hardwoods and conifers. It is estimated that, as of 1/1/2015, the Project Area is composed of approximately 34% Douglas-fir, 13% redwood, 1% other conifers, 24% tanoak, 11% pacific madrone, and 17% other hardwoods by basal area. The Mailliard Ranch owner intends to manage the timber stands to maintain or increase conifer stocking, ensuring that the Project continues to meet the requirements for composition of native species under Table 3.2 (page 20) of the Compliance Offset Protocol by maintaining species' basal area percentage below 60%, the Species Diversity Index from the Assessment Area Data File.

VI.B.3.

- (a) The Mailliard Ranch Project will employ natural forest management practices as described in items VI.B.1, VI.B.2, VI.B.3(b), and VI.B.4 as well as sustainable harvesting practices as commercial harvesting is currently planned on the Project Area. Sustainable long-term harvesting practices will be demonstrated using option 3 under section 3.8.1 of the Protocol, by employing uneven-aged silvicultural practices that maintain canopy cover averaging at least 40 percent across the entire forestland owned by the Mailliard Ranch in the same Assessment Area covered by the Mailliard Ranch Project Area, as measured on any 20 acres within the Mailliard Ranch's landholdings found in any of these Assessment Areas, including land within and outside the Mailliard Project Area.
- (b) The project proposes to employ primarily uneven-aged management which will maintain no more than 40% of the Project's forested acreage in ages less than 20 years at a watershed scale up to 10,000 acres.

CALWATER Watershed	IDNUM	Project Acreage	Project Acreage < 20 Years Old	% of Acreage < 20 Years
Adams Creek	1113.500102	317		0.0%
Billings Creek	1113.810004	0		0.0%
German Creek	1113.500105	2924		0.0%
Lamour Creek	1113.700101	2488		0.0%
Maple Creek	1113.500103	715		0.0%
Middle Rancheria Creek	1113.500106	1586		0.0%
Pardaloe Creek	1113.700105	4330	62	1.4%
Grand Total		12,361	62	0.5%

VI.B.4.

The Mailliard Ranch project removes incidental lying dead wood as a part of its stand management activities. It is expected that the accumulation of lying dead wood will be commensurate with recruitment from standing dead trees. The Mailliard Ranch project is committed to maintaining if not increasing, the number of standing dead trees within the Project Area as a component of its forest management objectives. The Mailliard Ranch project does not currently, nor does it intend in the future to actively pursue salvage operations on its timberlands. Mailliard Ranch has a policy of allowing standing dead trees to remain and recruiting large specimen trees across its ownership as components of its overall timber management strategy.

The Mailliard Ranch Project Area has not recently undergone any salvage harvesting. Therefore, all that must be demonstrated is that the greater of one metric ton of carbon per acre or 1% of standing live carbon stocks is present in standing dead wood, or that progress towards these targets is ongoing. Following the inventory, calculations will be made for standing live carbon stocks and percent of standing live carbon stocks in standing dead wood. The project will maintain the aforementioned standing dead wood target throughout the project life.

VI.C.

The OPO intends to allow conifer stocking levels to develop on the Project Area in excess of the minimum requirements of the California Forest Practice Rules. At a minimum, management activities conducted on the Project Area must exceed the minimum standards which define the baseline, while also conforming to specific requirements of the Forest Project Protocol. Changes in Project carbon stocks over time will also be governed by economic decisions such that more or less carbon may be sequestered over any given period. Therefore, a combination of economic decisions by the forest owner as to whether or not to commercially harvest the Project Area combined with the constraints imposed by the California Forest Practice Rules, and the specific terms of the Forest Project Protocol will guide carbon stock levels over time.

VII.A.

IFM-1 Standing Live:

Standing live carbon will be inventoried based on sample plots installed as part of a forest inventory in 2015. The inventory specifications are included as Attachment L. The cruise design consists of the installation of sample points randomly selected from a systematic grid 5 chains by 5 chains in size across the Project Area.

The sample design will include the installation of fixed area plots to measure both live and dead conifers and hardwoods. A 1/100th acre fixed area plot will be installed at each sample point to sample trees 1.0" DBH to 3.5" DBH; a 1/50th acre fixed area plot will be installed at each sample point to sample trees 3.6" DBH to 10.5" DBH, and a 1/10th acre fixed area plot will be installed at each sample point to sample trees 10.6" DBH and larger.

Attachment L describes the procedures for collecting field measurements, specific criteria pertaining to data collection, stratification rules, and documentation on quality assurance and quality control. Documentation of analytic methods and biomass equations used to translate field measurements into volume or biomass carbon estimates are included in part B below.

Cruise data from field cards were reviewed for completeness and entered into an Access database. Plot data within the database was extensively sorted and queried to look for data entry errors. This process has resulted in a final data set for cruise processing. The Access database serves as the repository for inventory data and is accessed by the growth and yield model during growth and yield simulations.

As timber management activities take place on the Mailliard Ranch Project Area, or disturbances such as fire or mortality resulting from pathogens or other factors occur, plots installed in 2015 will be relocated and remeasured within areas that have been harvested, treated for hardwood reduction, or subject to disturbance. By 2027, all of the plots installed in

2015 will have been remeasured regardless of whether or not the plot had been harvested, treated for hardwood reduction, or subject to other disturbance. On this basis, Mailliard Ranch will maintain a forest inventory system that will meet the inventory specifications and requirements contained in Appendix A of the Protocol, with plots which are no more than 12 years old.

The inventory methodology included as Attachment L to the Listing Application provides a detailed description of the method of maintaining an up to date inventory for the Mailliard Ranch project.

IFM-3 Standing Dead:

As described above, and in Attachment L, standing dead trees will be sampled in conjunction with standing live trees.

IFM-6 Soil (if applicable):

Excluded because the conditions in Table 5.2 of the Protocol that would require inclusion of this pool (site preparation involving deep ripping, furrowing, or plowing where soil disturbance exceeds 25 percent of the Project Area over the Project Life, or mechanical site preparation activities not conducted on contours) are not planned.

IFM-7 Carbon in in-use forest products:

Carbon in in-use forest products has been generated by the Project as harvesting has occurred since the Offset Project Commencement Date. Part B below will include documentation of analytic methods and biomass equations used to translate future harvest volumes delivered to the mill into appropriate carbon in in-use forest products values.

IFM-8 Forest product carbon in landfills (if applicable):

Carbon in landfills is a component of carbon related to forest products. Forest products have been generated by the Project since the Offset Project Commencement Date. Part B below will include documentation of analytic methods and biomass equations used to translate current and future harvest volumes delivered to the mill into appropriate forest products carbon in landfill values.

IFM-9 Biological emissions from site preparation:

As IFM-6 is an excluded carbon pool, IFM-9 is also an excluded pool.

IFM-14 Biological emissions/removals from change in harvesting on forestland outside Project Area:

Part B below will include documentation of analytic methods and biomass equations used to translate current and future harvest volumes delivered to the mill into appropriate values for the calculation of this carbon pool.

IFM-17 Biological emissions from decomposition of forest products:

This is quantified as a component of IFM-7 and IFM-8 per Appendix C of the Protocol.

VII.B.

IFM-1 Standing Live:

Above-ground standing live carbon in trees 1" DBH and larger were calculated using the appropriate biomass equation by species taken from the Compliance Offset Protocol U.S. Forest Offset Projects page on ARB's website. The current biomass equation documentation provided by ARB is included as Attachment M. The equations referenced below are not reproduced here for the sake of minimizing redundancy. These equations are used to generate biomass estimates for the above-ground portion of standing live trees, and hard snags. These equations will be referred to as the "FIA equations" herein.

Each species can have as many as four FIA equations in order to calculate tree biomass. The FIA equations used by species are as follows:

Species	Bole Cubic Ft Volume	Bark Biomass	Live Branches Biomass
Coast Redwood	Equation 24	Equations 13 or 17	Equation 10
Douglas-fir	Equation 3	Equation 8	Equation 6
Sugar pine	Equation 20	Equation 10	Equation 8
Ponderosa pine	Equation 5	Equation 9	Equation 7
Gray Pine	Equation 5	Equation 9	Equation 7
Incense Cedar	Equation 19	Equation 12	Equation 10
California Nutmeg	Equation 8	Equation 13	Equation 10
Other Conifer	Equation 17	Equation 21	Equation 17
Tanoak	Equation 34	None	None
Pacific madrone	Equation 40	None	None
Interior Live oak	Equation 43	None	None
Canyon Live Oak	Equation 42	None	None
Coast Live Oak	Equation 43	None	None
Black oak	Equation 38	None	None
Oregon White oak	Equation 41	None	None
California laurel	Equation 33	None	None
Golden chinkapin	Equation 32	None	None
Bigleaf maple	Equation 37	None	None
Red Alder	Equation 26	Equation 20	Equation 20
California Buckeye	Equation 43	None	None
Other hardwood	Equation 41	None	None

Tonnes of standing live biomass per sample plot are calculated as follows:

For equations that use total tree height in meters, tree height is calculated by multiplying the trees total height in feet by 0.3048. Trees per hectare are calculated by multiplying trees per acre by 2.471. Tree diameter at breast height ("DBH") in centimeters (cm) is calculated by multiplying its DBH by 2.54.

Bole Biomass:

The Cubic foot volume of each tree is calculated as the volume of the total stem from ground to tip (includes the top and stump). FIA refers to this value as CVTS. Bole biomass is calculated by multiplying the cubic volume by the wood density, and then dividing by

2.20462 to calculate weight in kilograms (kg). Above-ground biomass in kilograms (Kg) per acre is calculated by multiplying the FIA calculated kg per tree by each tree's per acre value.

Bark and Live Branches Biomass:

The above referenced FIA equations produce biomass in kg for the various parts of the above-ground portion of each tree. Above-ground biomass in kilograms (Kg) per acre is calculated by multiplying the FIA calculated kg per tree by each trees per acre value.

Missing volume of each tree is recorded as a percentage missing by 1/3rd segment of the tree (top, middle, bottom) as adapted from the Climate Action Reserve's "Quantification Guidance for Use with Forest Carbon Projects" dated November 15, 2012. The total heights of trees with broken tops were calculated from their measured top heights using FORSEE. If 1/3rd of the calculated tree height was less than the measured top height, then the break was assumed to be above the bottom 3rd of the tree. Likewise, if 2/3rds of the calculated tree height was less than the measured tree height, the break was assumed to be in the top 3rd of the tree.

Missing volumes of damaged trees that were recorded in the field were then added to the estimated volume missing if there was a broken top. The total missing percentage of each tree is calculated based on 65% of the trees biomass being in the bottom 1/3rd, 25% in the middle 1/3rd, and 10% in the top 1/3rd. The total percentage of the tree that is missing is then calculated and multiplied by various biomass components of the tree as calculated above to calculate the net biomass of each component.

The net Kg per acre value of each tree on the plot is summed to derive above-ground live biomass Kg per acre for the plot. This value is used to calculate the respective below-ground live biomass component for the plot.

Below-ground live carbon is calculated at the plot level using the model provided by Cairnes et. al. specified on page 89 of Appendix A of the Protocol. The formula has as its input, above-ground live biomass in Mg per hectare, and outputs below-ground biomass in Mg per hectare. Total net above-ground live carbon in Kg per acre for each plot is converted to Mg of biomass per hectare by multiplying by 2.471, and then dividing by 1000. After calculating the below ground component in Mg per hectare using the Cairnes model, the results are converted to Kg per acre by multiplying by 1000 and dividing by 2.471.

Total standing live biomass for each plot is the sum of the above-ground and below-ground live biomass Kg per acre. Mg of carbon (Mg C) per acre per plot is then calculated by multiplying by 0.5 to estimate carbon biomass. Mg C per acre is converted to CO₂-equivalent by multiplying by 3.664.

IFM-3 Standing Dead:

Data on standing dead trees will be collected as a part of the 2015 Mailliard Ranch inventory. In general, the amount of carbon stored in a standing dead tree is based on the proportion of the tree remaining standing, and the condition of the tree, or its decay class. The standing dead carbon pool includes trees 5" DBH and larger, with a minimum height of 15'.

Standing dead trees from the inventory data are classified into five decay classes based on descriptions contained in Research Paper NRS-15 (Harmon et al, 2011). These decay classes are generally described as follows:

Class 1 All limbs and branches are present; the top of the crown is still present; all bark remains; sapwood is intact, with minimal decay; heartwood is sound and hard.

-
- Class 2 There are few limbs and no fine branches; the top may be broken; a variable amount of bark remains; sapwood is sloughing with advanced decay; heartwood is sound at base but beginning to decay in the outer part of the upper bole.
- Class 3 Only limb stubs exist; the top is broken; a variable amount of bark remains; sapwood is sloughing; heartwood has advanced decay in upper bole and is beginning at the base.
- Class 4 Few or no limb stubs remain; the top is broken; a variable amount of bark remains; sapwood is sloughing; heartwood has advanced decay at the base and is sloughing in the upper bole.
- Class 5 No evidence of branches remains; the top is broken; <20 percent of the bark remains; sapwood is gone; heartwood is sloughing throughout.

Biomass for standing dead trees includes the bole and bark components calculated using the FIA biomass equations described above and following the same procedures as for live trees other than the manner in which missing volume is calculated.

Missing volume of each tree is recorded as a percentage missing by 1/3rd segment of the tree (top, middle, bottom) as adapted from the Climate Action Reserve's "Quantification Guidance for Use with Forest Carbon Projects" dated November 15, 2012. The total heights of trees with broken tops are calculated from their measured top heights using FORSEE. If 1/3rd of the calculated tree height is less than the measured top height, then the break is assumed to be above the bottom 3rd of the tree. Likewise, if 2/3rds of the calculated tree height is less than the measured tree height, the break is assumed to be in the top 3rd of the tree.

Missing volumes of damaged trees that are recorded in the field are then added to the estimated volume missing if there was a broken top. The total missing percentage of each tree is calculated based on 65% of the trees biomass being in the bottom 1/3rd, 25% in the middle 1/3rd, and 10% in the top 1/3rd. The total percentage of the tree that is missing is then calculated and multiplied by various biomass components of the tree as calculated above to calculate the net biomass of each component.

Once the net biomass of each tree has been calculated, a relative density is applied by species and decay class. The relative density is in relation to the green density of sound wood, or the tree's wood density. The table below lists the relative densities applied by species and decay class taken from Differences Between Standing and Downed Dead Tree Wood Density Reduction Factors (Harmon et al, 2011).

Relative Density by Species and Decay Class:

Species	Decay Class (DC)				
	DC1	DC2	DC3	DC4	DC5
Redwood	0.994	0.951	0.902	0.605	0.605
Douglas-fir	0.892	0.831	0.591	0.433	0.433
Ponderosa pine	0.925	1.007	1.154	0.481	0.481
Sugar pine	1.040	0.906	0.735	0.517	0.517
California nutmeg	0.994	0.951	0.902	0.605	0.605
Grey pine	0.953	0.950	0.927	0.598	0.598
Incense cedar	1.040	0.972	1.011	0.596	0.596
California black oak	1.020	0.700	0.858	0.591	0.591
California laurel	0.982	0.793	0.618	0.525	0.525
Canyon live oak	1.020	0.841	0.705	0.591	0.591
California live oak	1.020	0.841	0.705	0.591	0.591
Interior live oak	1.020	0.841	0.705	0.591	0.591
California buckeye	1.020	0.841	0.705	0.591	0.591
Pacific madrone	0.982	0.793	0.618	0.525	0.525
Oregon white oak	1.02	0.841	0.705	0.591	0.591
California laurel	0.982	0.793	0.618	0.525	0.525
Bigleaf maple	0.979	0.766	0.565	0.450	0.450
Golden chinkapin	0.982	0.793	0.618	0.525	0.525
Tanoak	0.982	0.793	0.618	0.525	0.525
Red alder	1.030	0.903	0.535	0.393	0.393
Other conifer	0.990	0.980	0.830	0.598	0.598
Other Coastal Hardwoods	1.020	0.700	0.858	0.591	0.591

Below-ground standing dead carbon is calculated at the plot level using the model provided by Cairnes et. al. specified on page 89 of Appendix A of the Protocol. The formula has as its input, above-ground biomass in Mg per hectare, and outputs below-ground biomass in Mg per hectare.

Total standing dead biomass for each plot is the sum of the above-ground and below-ground standing dead biomass Mg per acre. Mg of carbon (Mg C) per acre per plot is then calculated by multiplying by 0.5 to estimate carbon biomass. Mg C per acre is converted to CO₂- equivalent by multiplying by 3.664.

IFM-6 Soil (if applicable):

Excluded because the conditions in Table 5.2 of the Protocol that would require inclusion of this pool (site preparation involving deep ripping, furrowing, or plowing where soil disturbance exceeds 25 percent of the Project Area over the Project Life, or mechanical site preparation activities not conducted on contours) are not planned.

IFM-7 Carbon in in-use forest products:

Wood products delivered to the mill in any period is calculated beginning with the cubic volume of harvested conifer trees 10" DBH and larger. Conifers smaller than 10" DBH are not included as they are too small to be delivered to the mill. The dry weight of wood products in pounds is calculated by multiplying the wood density in lbs/cubic foot by the cubic volume for each softwood species harvested based on the CVTS values derived from the FIA equations listed above. Bark and branch biomass are not included in the volume harvested. The wood densities utilized are those specified in the FIA equation for biomass and volume equations. The dry weight is multiplied by 0.5 to convert the weight to carbon weight only. The weight of carbon in lbs is divided by 2,204.6 to get the carbon weight in metric tonnes (Mg).

Mg of carbon is then multiplied by 0.675 to account for mill efficiencies, taken from the Compliance Offset Protocol U.S. Forest Offset Projects page on ARB's website.

The resulting Mg carbon value after accounting for milling efficiencies is then passed to the wood products worksheets for calculating long-term in-use wood products storage. The wood products carbon is separated into product classes and multiplied by the respective 100-year average storage factor. The tables below list the assignment of wood products by class per the most current Assessment Area Data File taken from the Compliance Offset Protocol U.S. Forest Offset Projects page on ARB's website, as well as the 100-year average storage factors applied to each wood product class per table C.2 of Appendix C of the Protocol.

Wood Products by Class

% Softwood Lumber	97.067%
% Hardwood lumber	0.002%
% Softwood Plywood	1.874%
% Oriented Strandboard	0.000%
% Non Structural Panels	0.244%
% Miscellaneous Products	0.095%
% Paper	0.717%

100-year Storage Rates Average Values from Appendix C, In-Use Table C.2

Softwood Lumber	0.463
Hardwood lumber	0.250
Softwood Plywood	0.484
Oriented Strandboard	0.582
Non Structural Panels	0.380
Miscellaneous Products	0.176
Paper	0.058
Weighted Average	0.310

Average carbon stored in in-use wood products is calculated using equation C.1. Carbon is converted to CO₂-equivalent by multiplying by 3.664. This value is combined with IFM-8 using equation C.3 to represent $WP_{total, y}$ for the reporting period.

$WP_{total, y}$ for the reporting period represents $AC_{wp, y}$ in equation 6.1. Average in-use wood products produced by the baseline analysis ($BC_{wp, y}$) are deducted from actual wood products produced each reporting period ($AC_{wp, y}$) in equation 6.1 and the resulting calculation is multiplied by 80% to account for the "Market Response".

IFM-8 Forest product carbon in landfills (if applicable):

Wood products delivered to the mill in any period is calculated beginning with the cubic volume of harvested conifer trees 10" DBH and larger. Conifers smaller than 10" DBH are not included as they are too small to be delivered to the mill. The dry weight of wood products in pounds is calculated by multiplying the wood density in lbs/cubic foot by the cubic volume for each softwood species harvested. The wood densities utilized are those

specified in the FIA equation for biomass and volume equations.. The dry weight is multiplied by 0.5 to convert the weight to carbon weight only. The weight of carbon in lbs is divided by 2,204.6 to get the carbon weight in metric tonnes (Mg).

Mg of carbon is then multiplied by 0.664 to account for mill efficiencies, taken from the Compliance Offset Protocol U.S. Forest Offset Projects page on ARB's website.

The resulting Mg carbon value after accounting for milling efficiencies is then passed to the wood products worksheets for calculating long-term landfill wood products storage. The wood products carbon is separated into product classes and multiplied by the respective 100-year average storage factor. The tables below list the assignment of wood products by class per the most current Assessment Area Data File taken from the Compliance Offset Protocol U.S. Forest Offset Projects page on ARB's website, , as well as the 100-year average storage factors applied to each wood product class per table C.3 of Appendix C of the Protocol.

Wood Products by Class

% Softwood Lumber	97.067%
% Hardwood lumber	0.002%
% Softwood Plywood	1.874%
% Oriented Strandboard	0.000%
% Non Structural Panels	0.244%
% Miscellaneous Products	0.095%
% Paper	0.717%

100-year Storage Rates Average Values from Appendix C, In Landfill Table C.3

Softwood Lumber	0.298
Hardwood lumber	0.414
Softwood Plywood	0.287
Oriented Strandboard	0.233
Non Structural Panels	0.344
Miscellaneous Products	0.454
Paper	0.178
Weighted Average	0.199

Average wood products carbon stored in landfills is calculated using equation C.2. Carbon is converted to CO₂-equivalent by multiplying by 3.664. This value is combined with IFM-7 using equation C.3 to represent $WP_{total, y}$ for the reporting period.

$WP_{total, y}$ for the reporting period represents $AC_{wp, y}$ in equation 6.1. Average in-use wood products produced by the baseline analysis ($BC_{wp, y}$) are deducted from actual wood products produced each reporting period ($AC_{wp, y}$) in equation 6.1 and the resulting calculation is multiplied by 80% to account for the “Market Response”.

IFM-9 Biological emissions from site preparation:

As IFM-6 is an excluded carbon pool, IFM-9 is also an excluded pool.

IFM-14 Biological emissions/removals from change in harvesting on forestland outside Project Area:

The Protocol refers to this carbon pool as Secondary Effects which are calculated using equation 6.10 of the Protocol. Secondary Effects of harvesting less than the average wood products produced by the baseline growth and yield analysis are calculated by subtracting the average carbon in harvested trees prior to delivery to a mill (PDM) generated by the baseline analysis from the actual carbon in harvested trees prior to delivery to a mill, and then multiplying the difference by 20%. As Secondary Effects are only calculated in years when actual wood products produced are less than the annual average under the baseline analysis, the resulting calculation is either zero, or a negative number.

The PDM calculation each annual reporting period will be calculated based on a ratio between the average volume of wood delivered to the mill generated by the baseline analysis, and the average PDM value generated by the baseline analysis. Each reporting period, this ratio will be applied to the actual volume of wood delivered to a mill.

IFM-17 Biological emissions from decomposition of forest products:

This is quantified as a component of IFM-7 and IFM-8 as described above.

VII.C.

IFM-1 Standing Live: This carbon pool will be calculated each year as described in parts A and B above. A preliminary estimate of the current standing live carbon pool is 4,099,371 MgCO₂e.

IFM-3 Standing Dead: This carbon pool will be calculated each year as described in parts A and B above. A preliminary estimate of the current standing dead carbon pool is 79,599 MgCO₂e.

IFM-6 Soil (if applicable): N/A

IFM-7 Carbon in in-use forest products: This carbon pool will be calculated each year as described in parts A and B above. A harvest is planned during the initial reporting period.

IFM-8 Forest product carbon in landfills (if applicable): This carbon pool will be calculated each year as described in parts A and B above. A harvest is planned during the initial reporting period.

IFM-9 Biological emissions from site preparation: N/A

IFM-14 Biological emissions/removals from change in harvesting on forestland outside Project Area: This carbon pool will be calculated each year as described in parts A and B above. A preliminary estimate of biological emissions/removals due to this leakage is 5,499 MgCO₂e annually.

IFM-17 Biological emissions from decomposition of forest products: This is quantified as a component of IFM-7 and IFM-8 as described above.

VII.D.

Stratified random sampling formulas taken from Shiver and Borders (1996) will be used to calculate the sampling error for the Mailliard Ranch Project once mean standing live and standing dead pools have been determined for the new 2015 inventory.

VII.E.

The risk ratings shown on the next page assume that the Project will not employ a Qualified Conservation Easement.

Project Area Reversal Risk Rating:

Risk Category	Contribution to Reversal
	Risk Rating
Financial Failure	5.0%
Conversion	2.0%
Over-harvesting	2.0%
Social	2.0%
Wildfire	4.0%
Disease/Insect	3.0%
Other Catastrophic	3.0%
Total Buffer Pool Contribution	19.2%

The Project's reversal risk rating is calculated as follows:

$$100\% - (((1-0.05)*(1-0.02)*(1-0.02)*(1-0.02)*(1-0.04)*(1-0.03)*(1-0.03)*100)) = 19.2\%$$

The contribution to the Forest Buffer Account during the initial reporting period is estimated to be 264,238 ROCs.

VIII.A.5.

Following the calculation methodologies described in section VII B above, the baseline modeling presented in the Modeling Plan (Attachment K) generates an average annual value for each of the above described wood products carbon pools. Actual wood products values for In-use, Landfill, and Prior to Delivery to the Mill (“PDM”) are calculated based on a flow of wood products over the 100-year planning period. The table below presents an estimate of the average wood products stored long-term values that will be generated by the baseline analysis.

Woods Products Class	Mg C/ acre	Total Mg CO₂e
Average Annual Carbon 100-year In-Use	0.145	6,558
Average Annual Carbon 100-year Landfill	0.094	4,237
Average Annual Carbon in Harvested Trees Prior to Delivery to the Mill	0.998	45,210

VIII.B.8.

In modeling the baseline for standing live carbon stocks, the Forest Owner must incorporate financial constraints that could affect baseline growth and harvesting scenarios. The Mailliard Ranch will utilize a financial analysis of the baseline harvesting regime that captures all relevant costs and returns, taking into account all legal, physical, and biological constraints. A draft financial analysis is included as Attachment J of this listing application. Cost and revenue variables included in the financial analysis are based on documented costs and returns for the Project Area, and on other properties in the Assessment Area. This financial analysis illustrates that the baseline harvest scenario is financially feasible.

X Attachments

The following attachments are included as a part of this application for listing:

Attachment A - Title Report and Legal Descriptions for the Mailliard Ranch.

Attachment E – Map of the Project Area, including a KMZ file that represents the Project Area.

Attachment F – Orthophoto Map of the Project Area.

Attachment G – A Graph Portraying the Project’s Baseline.

Attachment H – A Diagram of the Project’s Baseline.

Attachment J – Financial Analysis of the Baseline Scenario

Attachment K –Modeling Plan

Attachment L –Inventory Specification

Attachment M – Volume and Biomass Equations

Attachment N - Legal Constraints Affecting Forest Management Activities on the Project Area

ATTACHMENT A



Redwood Empire Title Company of Mendocino County

617 South State Street, P. O. Box 238

Ukiah, CA 95482

Phone: (707)462-8666 • Fax: (707)462-5010

Our No.: 1302670RB

Your No.:

Seller: Mailliard Ranch

Buyer: Save the Redwoods League

When replying Please Contact:

ESCROW OFFICER: Rosanne Burlesci

rburlesci@redwoodtitle.com

3rd Updated PRELIMINARY REPORT

Property Address: **Mailliard Ranch, CA**

In response to the above referenced application for a policy of title insurance, **Redwood Empire Title Company of Mendocino County** hereby reports that it is prepared to issue, or cause to be issued, as of the date hereof, a Policy or Policies of Title Insurance describing the land and the estate or interest therein hereinafter set forth, insuring against loss which may be sustained by reason of any defect, lien or encumbrance not shown or referred to as an Exception below or not excluded from coverage pursuant to the printed Schedules, Conditions and Stipulations of said Policy forms.

The printed Exceptions and Exclusions from the coverage and Limitations on Covered Risks of said Policy or Policies are set forth in Exhibit A attached. Copies of the Policy forms should be read. They are available from the office which issued this report.

Please read the exceptions shown or referred to below and the exceptions and exclusions set forth in Exhibit A of this report carefully. The exceptions and exclusions are meant to provide you with notice of matters which are not covered under the terms of the title insurance policy and should be carefully considered.

It is important to note that this preliminary report is not a written representation as to the condition of title and may not list all liens, defects and encumbrances affecting title to the land.

This report (and any supplements or amendments hereto) is issued solely for the purpose of facilitating the issuance of a policy of title insurance and no liability is assumed hereby. If it is desired that liability be assumed prior to the issuance of a policy of title insurance, a Binder or Commitment should be requested.

Dated as of July 14, 2014 at 07:30AM.

John Baron
Chief Title Officer

jbaron@redwoodtitle.com

The form of policy of title insurance contemplated by this report is:
CLTA Standard 1990 Owners Policy

Underwritten by Old Republic National Title Insurance Company

SCHEDULE A

1. The estate or interest in the land hereinafter described or referred to covered by this Report is:
a Fee
2. Title to said estate or interest at the date hereof is vested in:
Mailliard Ranch, also known as Maillard Ranch, a California limited partnership
3. The land referred to in this report is situated in the State of California, County of Mendocino and is described as follows:

See Exhibit A attached hereto and made a part hereof.

SCHEDULE B

At the date hereof exceptions to coverage in addition to the printed Exceptions and Exclusions in the said policy form would be as follows:

1. Taxes and assessments, general and special, for the fiscal year 2014 - 2015, a lien not yet due or ascertainable.
2. The lien of supplemental taxes, if any, assessed pursuant to the provisions of Section 75, et seq. of the Revenue and Taxation Code of the State of California.
3. (a) Any adverse claim based upon the assertion that some portion of said land has been created by artificial means, or has accreted to such portion so created; some portion of said land has been brought within the boundaries thereof by an avulsive movement of Camp Creek, German Creek, Rancheria Creek and/or Yale Creek, or has been formed by accretion to any such portion.

(b) Rights and easements for navigation and fishery which may exist over that portion of said land lying beneath the waters of Garcia River, Camp Creek, German Creek, Rancheria Creek, Yale Creek and/or various other creeks running through the land.
4. Rights of the public, County and/or City, in and to that portion of said land lying within the lines of any public road or highway.
5. An easement for the purposes stated herein and incidental purposes as provided in the following instrument
Recorded: July 11, 1885 in Book 36 of Deeds, Page 123
In Favor of: County of Mendocino
For: public road
6. An easement for the purposes stated herein and incidental purposes as provided in the document:
Recorded: November 27, 1885 in Book 37 of Deeds, Page 156
For: pack trail
7. An easement for the purposes stated herein and incidental purposes as provided in the following instrument
Recorded: October 5, 1893 in Book 59 of Deeds, Page 171
In Favor of: County of Mendocino
For: public road
8. An easement for the purposes stated herein and incidental purposes as provided in the following instrument
Recorded: June 6, 1901 in Book 79 of Deeds, Page 647
In Favor of: County of Mendocino
For: public road
9. An easement for the purposes stated herein and incidental purposes as provided in the document:
Recorded: May 12, 1905 in Book 99 of Deeds, Page 116
For: water pipeline
10. An easement for the purposes stated herein and incidental purposes as provided in the document:
Recorded: May 29, 1906 in Book 102 of Deeds, Page 534
For: road
11. Waiver of any claims for damages to said property by reason of the location, construction, landscaping or maintenance of the highway adjoining said property, as contained in the deed to the State of California, recorded May 5, 1924 in Book 160 of Deeds, Page 199.

12. An easement for the purposes stated herein and incidental purposes as provided in the document:
Recorded: April 24, 1934 in Book 95, Page 77, Official Records
For: right of way to Ornbaun Graveyard
13. An easement for the purposes stated herein and incidental purposes as provided in the following instrument
Recorded: September 11, 1935 in Book 16, Page 478, Official Records
In Favor of: County of Mendocino
For: road
14. Rights for the development, marketing and transportation of oil, gas and minerals as reserved in the deed executed by James D. Lacey & Co. recorded June 2, 1937 in Book 116, Page 305, Official Records.
15. An easement for the purposes stated herein and incidental purposes as provided in the document:
Recorded: July 25, 1939 in Book 132, Page 141, Official Records
For: right of way
16. An easement for the purposes stated herein and incidental purposes as provided in the document:
Recorded: August 3, 1942 in Book 156, Page 178, Official Records
For: ingress, egress
17. An easement for the purposes stated herein and incidental purposes as provided in the document:
Recorded: August 3, 1942 in Book 156, Page 179, Official Records
For: ingress, egress
18. An easement for the purposes stated herein and incidental purposes as provided in the following instrument
Recorded: August 5, 1946 in Book 200, Page 361, Official Records
In Favor of: PG&E
For: electric transmission lines
19. An easement for the purposes stated herein and incidental purposes as provided in the following instrument
Recorded: July 3, 1947 in Book 218, Page 121, Official Records
In Favor of: PG&E
For: electric transmission lines
20. An easement for the purposes stated herein and incidental purposes as provided in the following instrument
Recorded: July 3, 1947 in Book 218, Page 122, Official Records
In Favor of: PG&E
For: electric transmission lines
21. An easement for the purposes stated herein and incidental purposes as provided in the following instrument
Recorded: May 27, 1948 in Book 236, Page 27, Official Records
In Favor of: PT&T
For: electric transmission lines
22. Waiver of any claims for damages to said property by reason of the location, construction, landscaping or maintenance of the highway adjoining said property, as contained in the deed to the State of California, recorded April 13, 1949 in Book 242, Page 198, Official Records.
23. An easement for the purposes stated herein and incidental purposes as provided in the document:
Recorded: October 23, 1950 in Book 273, Page 317, Official Records
For: road

- a. Terms and conditions contained in the document above referred to.
- 24. An easement for the purposes stated herein and incidental purposes as provided in the following instrument
Recorded: February 8, 1951 in Book 286, Page 79, Official Records
In Favor of: PG&E
For: electric transmission lines
- 25. An easement for the purposes stated herein and incidental purposes as provided in the document:
Recorded: May 25, 1951 in Book 290, Page 164, Official Records
For: road
 - a. Terms and conditions contained in the document above referred to.
- 26. An easement for the purposes stated herein and incidental purposes as provided in the document:
Recorded: January 29, 1954 in Book 363, Page 77, Official Records
For: road
 - a. Terms and conditions contained in the document above referred to.
- 27. Easements, terms and provisions as contained in an instrument,
Entitled : Reciprocal Grant of Easements
Recorded: September 4, 1959 in Book 520, Page 577, Official Records
- 28. An easement for the purposes stated herein and incidental purposes as provided in the document:
Recorded: June 10, 1960 in Book 542, Page 198, Official Records
For: road
 - a. Terms and conditions contained in the document above referred to.
- 29. The right to enter upon the land in order to maintain cuts and fills as granted to the County of Mendocino in the deeds recorded August 16, 1960 in Book 547, Page 373 and August 23, 1960 in Book 548, Page 33, Official Records.
- 30. An easement for the purposes stated herein and incidental purposes as provided in the document:
Recorded: March 19, 1963 in Book 621, Page 284, Official Records
For: road
 - a. Terms and conditions contained in the document above referred to.
- 31. Matters as contained or referred to in an instrument,
Entitled : Memorandum of Agreement
Recorded: December 4, 1964 in Book 677, Page 94, Official Records
 - a. Assignment recorded December 4, 1964 in Book 677, Page 98, Official Records.
- 32. An easement for the purposes stated herein and incidental purposes as provided in the document:
Recorded: December 4, 1964 in Book 677, Page 99, Official Records
For: road
 - a. Terms and conditions contained in the document above referred to.
- 33. An easement for the purposes stated herein and incidental purposes as provided in the document:
Recorded: December 4, 1964 in Book 677, Page 103, Official Records
For: road

- a. Terms and conditions contained in the document above referred to.
34. An easement for the purposes stated herein and incidental purposes as provided in the following instrument
Recorded: November 28, 1967 in Book 749, Page 221, Official Records
In Favor of: PT&T
For: road
35. Terms, provisions, covenants, restrictions and conditions contained in a document executed pursuant to the California Land Conservation Act of 1965 (Williamson Act) and recorded February 18, 1971 in Book 839, Page 561, Official Records.
- a. Notices of Implementation Under Williamson Act recorded December 29, 2010 as 2010-18377 and December 27, 2011 as 2011-17950 and December 27, 2012 as 2012-19731 and December 27, 2013 as 2013-19038, Official Records.
36. Terms, provisions, covenants, restrictions and conditions contained in a document executed pursuant to the California Land Conservation Act of 1965 (Williamson Act) and recorded August 25, 1971 in Book 859, Page 298, Official Records.
- a. Notice of Non-Renewal recorded February 24, 1978 in Book 1134, Page 518, Official Records.
 - b. Notices of Implementation Under Williamson Act recorded December 29, 2010 as 2010-18377 and December 27, 2011 as 2011-17950 and December 27, 2012 as 2012-19731 and December 27, 2013 as 2013-19038, Official Records.
37. Waiver of any claims for damages to said property by reason of the location, construction, landscaping or maintenance of the highway adjoining said property, as contained in the deed to the State of California, recorded September 26, 1975 in Book 1014, Page 366, Official Records.
38. An easement for the purposes stated herein and incidental purposes as provided in the document:
Recorded: April 13, 1976 in Book 1036, Page 309, Official Records
For: water system, together with the reservation of an existing water source
39. An easement for the purposes stated herein and incidental purposes as provided in the following instrument
Recorded: January 31, 1979 in Book 1191, Page 473, Official Records
In Favor of: County of Mendocino
For: conduits, cables, wires, poles, telephone lines, ingress, egress
40. An easement for the purposes stated herein and incidental purposes as provided in the following instrument
Recorded: May 22, 1979 in Book 1208, Page 111, Official Records
In Favor of: PT&T
For: wires, cables, poles, ingress, egress
41. Terms, provisions, covenants, restrictions and conditions contained in a document executed pursuant to the California Land Conservation Act of 1965 (Williamson Act) and recorded July 24, 1979 in Book 1218, Page 232, Official Records.
- a. Notices of Implementation Under Williamson Act recorded December 29, 2010 as 2010-18377 and December 27, 2011 as 2011-17950 and December 27, 2012 as 2012-19731 and December 27, 2013 as 2013-19038, Official Records.

42. Terms, provisions, covenants, restrictions and conditions contained in a document executed pursuant to the California Land Conservation Act of 1965 (Williamson Act) and recorded December 15, 1980 in Book 1286, Page 172, Official Records.
 - a. Notices of Implementation Under Williamson Act recorded December 29, 2010 as 2010-18377 and December 27, 2011 as 2011-17950 and December 27, 2012 as 2012-19731 and December 27, 2013 as 2013-19038, Official Records.
43. An easement for the purposes stated herein and incidental purposes as provided in the document:
Recorded: September 15, 1983 in Book 1420, Page 21, Official Records
For: roads
44. An easement for the purposes stated herein and incidental purposes as provided in the following instrument
Recorded: November 21, 1985 in Book 1533, Page 450, Official Records
In Favor of: Pacific Bell
For: communication facilities
45. The right to prospect for, mine and remove the minerals as reserved by the United States in the Patent recorded December 31, 1985 in Book 1539, Page 38, Official Records.
46. An easement for the purposes stated herein and incidental purposes as provided in the document:
Recorded: June 12, 1986 in Book 1564, Page 130, Official Records
For: travel, recreation and timber management
47. An easement for the purposes stated herein and incidental purposes as provided in the document:
Recorded: June 12, 1986 in Book 1564, Page 132, Official Records
For: travel, recreation and timber management
 - a. Said easement has been modified by the document recorded November 19, 2007 as 2007-21036, Official Records.
48. An easement for the purposes stated herein and incidental purposes as provided in the following instrument
Recorded: September 25, 1987 in Book 1647, Page 342, Official Records
In Favor of: AT&T
For: communication facilities
 - a. Terms and conditions contained in the document above referred to.
49. An easement for the purposes stated herein and incidental purposes as provided in the document:
Recorded: March 1, 1989 in Book 1736, Page 560, Official Records
For: road, utilities
50. An easement for the purposes stated herein and incidental purposes as provided in the following instrument
Recorded: July 18, 1989 in Book 1763, Page 598, Official Records
In Favor of: Pacific Bell
For: poles, wires, cables, ingress, egress
51. An easement for the purposes stated herein and incidental purposes as provided in the document:
Recorded: June 29, 1995 in Book 2261, Page 273, Official Records
For: hauling timber, forest products and logging equipment
 - a. Terms and conditions contained in the document above referred to.

52. Terms and provisions as contained in an instrument,
Entitled : Easement Grant Deed
Recorded: June 29, 1995 in Book 2261, Page 276, Official Records
53. An easement for the purposes stated herein and incidental purposes as provided in the following instrument
Recorded: April 12, 2000 as 2000-05557, Official Records
In Favor of: AT&T
For: communication systems
- a. Terms and conditions contained in the document above referred to.
54. A Conservation Easement for the purposes stated herein and incidental purposes as provided in the document:

Recorded: July 1, 2004 as 2004-14664, Official Records
For: protection and preservation
- a. Terms and provisions contained in the document above referred to.
55. Terms and provisions as contained in an instrument,
Entitled : Grant Deed
Recorded: January 25, 2008 as 2008-01064, Official Records
56. An easement for the purposes stated herein and incidental purposes as provided in the document:
Recorded: January 25, 2008 as 2008-01064, Official Records
For: ingress, egress and the right to take water from a spring
57. Tract Two of Parcel 72 herein described is only being included so as to avoid the Company being the cause of excluding it from deeds or encumbrances, but NO INSURANCE is to be provided as to said parcel.
Anything to the contrary in the policy or endorsements thereto notwithstanding, said parcel is NOT INSURED even though it may be included as part of the description of the land described or referred to in the policy.
58. The requirement that a copy of the partnership agreement for Mailliard Ranch and any amendments thereto, together with a current list of all partners, be furnished to us for review.
The Company reserves the right to make additional exceptions and/or requirements upon examination of the foregoing.

END OF SCHEDULE B

INFORMATIONAL NOTES:

1. Taxes and assessments, general and special, for the fiscal year 2013 - 2014, 1st and 2nd installments are paid.
2. NOTE: According to the public records, there have been no deeds conveying the property described in this report recorded within a period of 24 months prior to the date hereof except as follows:
NONE
3. NOTE: A certified copy of a Certificate of Limited Partnership (Form LP-1) filed in the office of the Secretary of State for Mailliard Ranch was recorded September 1, 1988 in Book 1705, Page 713, disclosing all the general partners as then being:

Charlotte S. Mailliard, William S. Mailliard and Lawrence J. Mailliard

All the general partners should sign on behalf of said partnership, or at least authorize or ratify in writing anything executed by less than all general partners.

EXHIBIT "A"

All that certain real property situated in the County of Mendocino, State of California, more particularly described as follows:

Parcel 1:

The Southeast quarter of the Southwest quarter and the Southwest quarter of the Southeast quarter of Section 21 and the West half of the Northeast quarter of Section 28, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 250, Mendocino County Records.

APN: 029-190-23 and 029-230-45

Parcel 2:

The West half of the Northwest quarter of Section 27 and the East half of the Northeast quarter of Section 28, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 254, Mendocino County Records.

APN: 029-230-46 and 029-240-38

Parcel 3:

The South half of the Northwest quarter and the Northwest quarter of the Northwest quarter of Section 26 and the Southeast quarter of the Northeast quarter of Section 27, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 258, Mendocino County Records.

APN: 029-240-39

Parcel 4:

The East half of the Southeast quarter, the Northwest quarter of the Southeast quarter and all that portion of the Southwest quarter of Section 28, Township 13 North, Range 14 West, Mount Diablo Meridian lying East of Camp Creek.

Also all that portion of the East half of the Northwest quarter of Section 33, Township 13 North, Range 14 West, Mount Diablo Meridian, lying East of Camp Creek.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 262, Mendocino County Records.

APN: 029-230-47

Parcel 5:

The North half of the Southwest quarter, the Southeast quarter of the Northwest quarter, and the Northwest quarter of the Southeast quarter of Section 27, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 266, Mendocino County Records.

APN: 029-240-40

Parcel 6:

The West half of the Southwest quarter of Section 26 and the Northeast quarter of the Southeast quarter and the Southwest quarter of the Southeast quarter of Section 27, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 269, Mendocino County Records.

APN: 029-240-41 and 029-240-42

Parcel 7:

The Northwest quarter of the Southeast quarter, the South half of the Southeast quarter and the East half of the Southwest quarter of Section 26 and the Northeast quarter of the Northwest quarter of Section 35, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 272, Mendocino County Records.

APN: 029-240-43 and 029-240-44

Parcel 8:

The Southwest quarter of the Southeast quarter of Section 28, Township 13 North, Range 14 West, Mount Diablo Meridian.

Also all those portions of the West half of the Northeast quarter, the Southwest quarter and the Southeast quarter of Section 33, Township 13 North, Range 14 West, Mount Diablo Meridian lying easterly of Camp Creek and lying southerly of German Creek.

Excepting therefrom the Southwest quarter of the Southwest quarter of Section 33, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 275, Mendocino County Records.

APN: 029-230-48

Parcel 9:

The South half of the Southwest quarter of Section 27 and the North half of the Northwest quarter of Section 34, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 278, Mendocino County Records.

APN: 029-240-45

Parcel 10:

The East half of the Northeast quarter of Section 33 and the South half of the Northwest quarter of Section 34, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 281, Mendocino County Records.

APN: 029-230-49, 029-240-46 and 029-240-47

Parcel 11:

The Northwest quarter of the Northeast quarter, the South half of the Northeast quarter and the Northeast quarter of the Southeast quarter of Section 34, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 284, Mendocino County Records.

APN: 029-240-48

Parcel 12:

The Southeast quarter of the Southeast quarter of Section 27, the Northeast quarter of the Northeast quarter of Section 34, and the West half of the Northwest quarter of Section 35, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 287, Mendocino County Records.

APN: 029-240-49 and 029-240-50

Parcel 13:

The Northwest quarter of the Northeast quarter, the South half of the Northeast quarter and the Southeast quarter of the Northwest quarter of Section 35, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 290, Mendocino County Records.

APN: 029-240-51

Parcel 14:

The West half of the Southwest quarter, the Northeast quarter of the Southwest quarter and the Northwest quarter of the Southeast quarter of Section 34, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 293, Mendocino County Records.

APN: 029-240-52 and 029-240-53

Parcel 15:

The West half of the Southwest quarter, the Southeast quarter of the Southwest quarter, and the Southwest quarter of the Southeast quarter of Section 36, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 299, Mendocino County Records.

APN: 029-240-13

Parcel 16:

The Southeast quarter of the Southwest quarter of Section 34, Township 13 North, Range 14 West, Mount Diablo Meridian.

Also Lots 2, 3, 6 and 7 of Section 2, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 305, Mendocino County Records.

APN: 029-240-58 and 049-010-34

Parcel 17:

The South half of the Southeast quarter of Section 34 and the Southwest quarter of the Southwest quarter of Section 35, Township 13 North, Range 14 West, Mount Diablo Meridian.

Also Lots 1 and 8 of Section 2 and Lot 5 of Section 1, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 308, Mendocino County Records.

APN: 029-240-59, 029-240-60 and 049-010-35

Parcel 18:

Lots 4 and 5 of Section 2, and Lots 1, 2 and 8 of Section 3, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 311, Mendocino County Records.

APN: 049-010-36

Parcel 19:

Lots 3, 4, 6 and 7 of Section 1, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 314, Mendocino County Records.

APN: 049-010-37

Parcel 20:

Lots 9, 10 and 11 of Section 3; Lots 9, 10, 11, 12, 14, 15, 16 and 17 of Section 2; and Lot 20 of Section 1, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 320, Mendocino County Records.

APN: 049-010-39

Parcel 21:

Lots 13 and 20 of Section 2 and Lots 15 and 16 of Section 3, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 323, Mendocino County Records.

APN: 049-010-40

Parcel 22:

The Northwest quarter of the Southwest quarter of Section 2, the North half of the Southeast quarter, Lot 18 and Lot 17 of Section 3 and those portions of Lot 19 and the Southwest quarter of Section 3, lying North of the Garcia River all in Township 12 North, Range 14 West, Mount Diablo Meridian.

Excepting therefrom all that portion conveyed to Ward M. Hanes and Ruth F. Hanes by grant deed recorded December 24, 1962 in Book 614 of Official Records, Page 274, Mendocino County Records.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 326, Mendocino County Records.

APN: 049-010-31, 049-010-41 and 049-010-42

Parcel 23:

The Southwest quarter of the Southwest of Section 2, the South half of the Southeast quarter of Section 3, and the Northwest quarter of the Northeast quarter of Section 10, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 329, Mendocino County Records.

APN: 049-010-43 and 049-021-16

Parcel 24:

Lot 19, the East half of the Southwest quarter and the Southwest quarter of the Southeast quarter of Section 2 and the Northeast quarter of the Northeast quarter of Section 11, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 332, Mendocino County Records.

APN: 049-010-44 and 049-021-11

Parcel 25:

The East half of the Southeast quarter, the Northwest quarter of the Southeast quarter and Lot 18 of Section 2, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 335, Mendocino County Records.

APN: 049-010-45

Parcel 26:

Lot 19 and the Southwest quarter of Section 1, the Northeast quarter of the Northwest quarter and the West half of the Northeast quarter of Section 12, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 338, Mendocino County Records.

APN: 049-010-46 and 049-021-12

Parcel 27:

Lots 4, 27, 28, 29 and 31 of Section 6, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 362, Mendocino County Records.

APN: 049-050-17

Parcel 28:

Lots 3, 7, 16, 18 and 19 of Section 6, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 365, Mendocino County Records.

APN: 049-050-18

Parcel 29:

Lot 4 of Section 5 and Lots 1, 6 and 17 of Section 6, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 368, Mendocino County Records.

APN: 049-050-19 and 049-060-x21

Parcel 30:

Lot 43 of Section 6 and Lots 3, 8 and 13 of Section 7, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 371, Mendocino County Records.

APN: 049-050-20 and 049-140-18

Parcel 31:

Lots 39, 41 and 42, and the Southwest quarter of the Southeast quarter of Section 6, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 377, Mendocino County Records.

APN: 049-050-06 and 049-050-22

Parcel 32:

Lot 40, the North half of the Southeast quarter and the Southeast quarter of the Southeast quarter of Section 6, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 380, Mendocino County Records.

APN: 049-050-23

Parcel 33:

The South half of the Southwest quarter and the Northwest quarter of the Southwest quarter of Section 5, and Lots 5 and 30 of Section 6, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 383, Mendocino County Records.

APN: 049-050-24 and 049-060-x21

Parcel 34:

The West half of Lot 9; Lot 12 and the Northeast quarter of the Southwest quarter of Section 5, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 386, Mendocino County Records.

APN: 049-060-x21

Parcel 35:

The West half of Lot 11 and the West half of the Southeast quarter of Section 5; the Northwest quarter, and the West half of the Northeast quarter of Section 8, Township 12 North, Range 13 West, Mount Diablo Meridian.

Excepting therefrom all that portion conveyed to the State of California by deed recorded March 4, 1954 in Book 365 of Official Records, Page 227, Mendocino County Records.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 389, Mendocino County Records.

APN: 049-060-x21 and 049-150-37

Parcel 36:

The West half of Lot 9 of Section 4, the East half of Lot 11, Lot 10, the East half of Lot 9; and Lot 8 of Section 5; and Lot 2 of Section 6, all in Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 392, Mendocino County Records.

APN: 049-050-25, 049-060-14, 049-060-x15, 049-060-x21 and 049-060-x22

Parcel 37:

Lots 1, 2, 3, 5 and the West half of Lot 6 of Section 5, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 395, Mendocino County Records.

APN: 049-060-x21

Parcel 38:

Lot 7 and East half of Lot 6 of Section 5; Lot 4 and the West half of Lot 5 of Section 4, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 398, Mendocino County Records.

APN: 049-060-x21, 049-070-11

Parcel 39:

Lot 8, the East half of Lot 5 and the East half of Lot 9 of Section 4, Township 12 North, Range 13 West, Mount Diablo Meridian.

Also that portion of Lot 10 of Section 4, Township 12 North, Range 13 West, Mount Diablo Meridian, described in the deed executed by Richard L. Elkins to John O. Ornbaun recorded November 27, 1894 in Book 64 of Deeds, Page 302, Mendocino County Records.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 401, Mendocino County Records.

APN: 049-060-x15, 049-060-x22 and 049-070-12

Parcel 40:

The West half of the Southwest quarter of Section 3 and the East half of the Southeast quarter of Section 4, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 413, Mendocino County Records.

APN: 049-060-x25, 049-080-60 and 049-080-61

Parcel 41:

The East half of Lots 10 and 11 of Section 4, Township 12 North, Range 13 West, Mount Diablo Meridian.

Excepting therefrom that portion of the East half of Lot 10 of Section 4, Township 12 North, Range 13 West, Mount Diablo Meridian described in the deed executed by Richard Lee Elkins and Mamie Ella Elkins to Fred George Parker and Linda R. Parker dated October 2, 1936 recorded in Book 109 of Official Records, Page 110, Mendocino County Records, more particularly described as follows:

Beginning at a point 108 feet East of the Northwest corner of the East half of Lot 10 in Section 4, Township 12 North, Range 13 West, Mount Diablo Meridian, and running thence West 108 feet to the corner of said East half of Lot 10, thence South 144 feet from said corner, thence in a direct line 178 feet to the place of beginning, being a triangular piece of land and $\frac{1}{4}$ of an acre more or less.

Also the West half of Lots 9 and 12 of Section 3, Township 12 North, Range 13 West, Mount Diablo Meridian.

Also that portion of the West half of Section 3 and Lot 7 of Section 4, Township 12 North, Range 13 West, Mount Diablo Meridian, described in the deed executed by Hattie Belle Ornbaun to J.W. Mailliard Jr., recorded October 5, 1945 in Book 192 of Official Records, Page 113, Mendocino County Records, more particularly described as follows:

All that portion of the following described land lying South and West of Rancheria Creek: Beginning at a point 20 chains West from the Southeast corner of Lot 5 of Section 3, Township 12 North, Range 13 West, Mount Diablo Meridian, thence West 8.75 chains to a picket fence, thence South 41° West 26.50 chains, thence East 24.14 chains, thence North 20 chains to the point of beginning.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 416, Mendocino County Records.

APN: 049-060-12, 049-060-x25 and 049-080-62

Parcel 42:

The Southeast quarter of the Southwest quarter of Section 3, the North half of the Northeast quarter of Section 9 and the Northwest quarter of the Northwest quarter of Section 10, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 419, Mendocino County Records.

APN: 049-080-63, 049-150-31, 049-150-38 and 049-160-58

Parcel 43:

The Northeast quarter of the Northwest quarter and the West half of the Northeast quarter of Section 10 and the Southwest quarter of the Southeast quarter of Section 3, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 422, Mendocino County Records.

APN: 049-080-10 and 049-160-59

Parcel 44:

The Northeast half of the Northeast quarter of the Southwest quarter and the South half of the Northwest quarter of Section 10, and the South half of the Northeast quarter of Section 9, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 425, Mendocino County Records.

APN: 049-150-39 and 049-160-60

Parcel 45:

The North half of the Southeast quarter, the Northeast half of the Southwest quarter of the Southeast quarter, and the Southeast quarter of the Northeast quarter of Section 10, the Northwest quarter of the Southwest quarter and the Southwest quarter of the Northwest quarter of Section 11, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 428, Mendocino County Records.

APN: 049-160-61 and 049-160-62

Parcel 46:

All of those portions of the Southeast quarter of the Southeast quarter of Section 3, the West half of the Southwest quarter and the Southeast quarter of the Southwest quarter of Section 2, the Northeast quarter of the Northeast quarter of Section 10, the North half of the Northwest quarter and the Southeast quarter of the Northwest quarter of Section 11 lying Southerly of the southerly boundary line of California State Highway 128.

Also the Northeast quarter of the Southwest quarter of Section 11 and all that portion of the Northwest quarter of the Southeast quarter of Section 11 lying North and West of the following described line:

Beginning at a point in the North line of the Northwest quarter of the Southeast quarter of Section 11, which is 35.68 chains East from the Southwest corner of the Southeast quarter of the Northwest quarter of said Section 11, thence along the center of an old traveled road South 13° West, 6.15 chains; South 14° West, 5.55 chains; South 45°30' West, 3.63 chains; South 5°30' West, 3.37 chains; South 20°30' West, 2 chains; South 40° West, 1.50 chains; South 71° West 6.25 chains; South 60°30' West, 3 chains to a point in the center of said old traveled road, 19.64 chains due North from the quarter section corner on the south boundary of said Section 11.

Excepting therefrom that portion conveyed to James A. Sager and Bertha Mae Sager by deed dated July 20, 1935 and recorded in Book 100 of Official Records, Page 449, Mendocino County Records.

Also excepting therefrom that portion conveyed to James A. Sager and Bertha Mae Sager by deed dated September 18, 1941 and recorded in Book 152 of Official Records, Page 301, Mendocino County Records.

Also excepting therefrom any portion granted to the State of California by deed recorded September 26, 1975 in Book 1014 of Official Records, Page 366, Mendocino County Records.

Also excepting therefrom that portion granted to Guido A. Pronsolino and Betty J. Pronsolino by deed recorded December 14, 1983 in Book 1434 of Official Records, Page 529, Mendocino County Records.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 437, Mendocino County Records.

APN: 049-080-64, 049-120-16, 049-160-44 and 049-160-63

Parcel 47:

Those portions of the East half of Lots 8, 9 and 12, the West half of Lot 11, the Northeast quarter of the Southwest quarter and the North half of the Southeast quarter of Section 3, Township 12 North, Range 13 West, Mount Diablo Meridian lying Southerly and Westerly of the southerly boundary line of the California State Highway 128.

Excepting therefrom that portion conveyed by Charles Burton Orchard to Leslie L. C. Hanelt et ux, in deed recorded January 18, 1967 in Book 732 of Official Records, Page 334, Mendocino County Records.

Also excepting therefrom that portion granted to the State of California by deed recorded September 26, 1975 in Book 1014 of Official Records, Page 366, Mendocino County Records.

Also excepting therefrom that portion granted to Guido A. Pronsolino and Betty J. Pronsolino by deed recorded December 14, 1983 in Book 1434 of Official Records, Page 529, Mendocino County Records.

Also excepting therefrom that portion granted to the County of Mendocino in the deed recorded March 17, 1977 in Book 1080 of Official Records, Page 471, Mendocino County Records.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 440, Mendocino County Records.

APN: 049-080-28, 049-080-65 and 049-080-66

Parcel 48:

The North half of the Southeast quarter and the Southwest quarter of the Northeast quarter of Section 10 and the Northwest quarter of the Southwest quarter of Section 11, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 443, Mendocino County Records.

APN: 049-021-17

Parcel 49:

The East half of the Northeast quarter of Section 10 and the West half of the Northwest quarter of Section 11, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 446, Mendocino County Records.

APN: 049-021-18

Parcel 50:

The East half of the Northwest quarter, the Northwest quarter of the Northeast quarter and the Northeast quarter of the Southwest quarter of Section 11, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 449, Mendocino County Records.

APN: 049-021-19

Parcel 51:

The South half of the Northeast quarter and the North half of the Southeast quarter of Section 11, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 452, Mendocino County Records.

APN: 049-021-20

Parcel 52:

The Southeast quarter of the Southeast quarter of Section 11, the South half of the Southwest quarter of Section 12, the Northwest quarter of the Northwest quarter of Section 13, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 455, Mendocino County Records.

APN: 049-021-21

Parcel 53:

The Northwest quarter of the Southwest quarter, the West half of the Northwest quarter and the Southeast quarter of the Northwest quarter of Section 12, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 458, Mendocino County Records.

APN: 049-021-14 and 049-021-22

Parcel 54:

The Northeast quarter of the Southwest quarter, the North half of the Southeast quarter and the Southeast quarter of the Southeast quarter of Section 12, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 461, Mendocino County Records.

APN: 049-021-23

Parcel 55:

The Southwest quarter of the Southeast quarter of Section 12 and all those fractional portions of the East half of the Northwest quarter and the Northwest quarter of the Northeast quarter of Section 13, Township 12 North, Range 14 West, Mount Diablo Meridian lying Northerly of Signal Ridge Road.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 464, Mendocino County Records.

APN: 049-021-24

Parcel 56:

Lots 1, 8, 9 and 10 of Section 18, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 473, Mendocino County Records.

APN: 049-140-22

Parcel 57:

Lots 2, 9, 12 and 19 of Section 7, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 476 Mendocino County Records.

APN: 049-140-23

Parcel 58:

Lots 10, 11 and 20 and the Southwest quarter of the Southeast quarter of Section 7, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 479, Mendocino County Records.

APN: 049-140-24 and 049-140-25

Parcel 59:

Lot 1 and the West half of the Northeast quarter and the Northwest quarter of the Southeast quarter of Section 7, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 482, Mendocino County Records.

APN: 049-140-26 and 049-140-27

Parcel 60:

The East half of the Northeast quarter and the East half of the Southeast quarter 7, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 485, Mendocino County Records.

APN: 049-140-28

Parcel 61:

The Northeast quarter of the Northwest quarter and the Northwest quarter of the Northeast quarter of Section 17, the South half of the Southeast quarter, the Northwest quarter of the Southeast quarter and the East half of the Southwest quarter of Section 8, Township 12 North, Range 13 West, Mount Diablo Meridian.

Excepting therefrom all that portion conveyed to the State of California by deed recorded March 4, 1954 in Book 365 of Official Records, Page 227, Mendocino County Records.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 491, Mendocino County Records.

APN: 049-150-42 and 049-150-43

Parcel 62:

The East half of the Northeast quarter and the Northeast quarter of the Southeast quarter of Section 8, the West half of the Northwest quarter and the Southeast quarter of the Northwest quarter of Section 9, Township 12 North, Range 13 West, Mount Diablo Meridian.

Also that portion of the Northwest quarter of the Southwest quarter of Section 9, Township 12 North, Range 13 West, Mount Diablo Meridian conveyed by Ornbaun Estate, Inc. to J.W. Mailliard and Kate P. Mailliard by deed dated April 16, 1934 recorded in Book 95 of Official Records, Page 77, Mendocino County Records and described as follows:

Beginning at the one quarter section corner between Sections 8 and 9, Township 12 North, Range 13 West, Mount Diablo Meridian, and run first sight South 89°30' East, 5.47 chains to a post marked H.N.O. #12, thence South 41° West, 4.36 chains to a post marked H.N.O.J.S. #10, thence South 79° West 2.50 chains to a point 4.10 chains South of the one quarter section corner, set a redwood post marked H.N.O.J.S.O., from which a tan oak 10 inches in diameter bears South 42°30' East, 25 links distant and marked H.N.O. #11 B.T., a tan oak 4 inches in diameter bears South 68°30' East, 31 links distant, marked on the outside bark H.N.O. #11 B.T., thence North 0°30' East, 4.10 chains to the point of beginning.

Excepting therefrom that portion of the Southwest quarter of the Northwest quarter of Section 9, Township 12 North, Range 13 West, Mount Diablo Meridian, recorded in deed dated April 16, 1934 recorded in Book 95 Official Records, Page 77, Mendocino County Records, and described as follows:

Beginning at a redwood post marked H.N.O.J.S.O. from which a fir 10 inches in diameter bears South 64°45' East, 68 links distant and a maple 12 inches in diameter bears North 85°50' West, 53 links distant, both trees marked H.N.O.H.S.O., this post stands South 89°30' East, 19.87 chains distant from the one quarter section corner between Sections 8 and 9, Township 12 North, Range 13 West, Mount Diablo Meridian, run first sight South 89°

East, 3.70 chains to a post marked H.N.O.J.S.O. #1, thence North 57°30' West, 6.83 chains to a post marked H.N.O.J.S.O. #2, thence North 47°15' West, 5.87 chains to a post marked H.N.O.J.S.O. #3, this is a redwood fence post 4 by 4 inches square and stands on the North bank of a creek, thence South 56°30' West, 1.78 chains to a post marked H.N.O.J.S.O. #4, thence South 44°30' West, 1.07 chains to a post marked H.N.O.J.S.O. #5, thence South 56°15' West, 1.90 chains to a post marked H.N.O.J.S.O. #6, thence South 48°15' West, 2.11 chains to a post marked H.N.O.J.S.O. #7, thence South 56° West, 1.70 chains to a post marked H.N.O.J.S.O. #8, thence South 46° West, 2.57 chains, set a redwood fence post 4 by 4 inches square on the East side of a road, marked H.N.O.J.S.O. #9, thence South 41° West, 1.64 chains to a post 5.47 chains East of the one quarter section corner between Sections 8 and 9, Township 12 North, Range 13 West, Mount Diablo Meridian, marked H.N.O.J.S.O. #12, thence South 89°30' East, 18.10 chains to the point of beginning. Magnetic Variation N 17°30' E.

Also excepting therefrom all that portion conveyed to the State of California by deed recorded March 4, 1954 in Book 365 of Official Records, Page 227, Mendocino County Records.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 494, Mendocino County Records.

APN: 049-150-44

Parcel 63:

The Southeast quarter of the Southeast quarter of Section 5; the Northeast quarter of the Northwest quarter of Section 9; the South half of the Southwest quarter, and the South 150 feet of the East half of the Northeast quarter of the Southwest quarter of Section 4, all in Township 12 North, Range 13 West, Mount Diablo Meridian.

Excepting therefrom the East 150 feet of the South half of the Southeast quarter of the Southwest quarter of Section 4, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Boundary Line Adjustment B 11-2004 by deed recorded January 27, 2005 as 2005-01859, Mendocino County Records.

APN: 049-060-26, 049-060-28 and 049-150-30

Parcel 64:

The West half of the Southeast quarter, the East 150 feet of the South half of the Southeast quarter of the Southwest quarter, the Southwest quarter of the Northeast quarter, and the Southeast quarter of the Northwest quarter of Section 4, Township 12 North, Range 13 West, Mount Diablo Meridian.

Excepting therefrom the South 150 feet of the East half of the Southeast quarter of the Northwest quarter of Section 4, all in Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Boundary Line Adjustment B 11-2004 by deed recorded January 27, 2005 as 2005-01860, Mendocino County Records.

Also excepting all of that certain piece or parcel of land known as Ornbaun Graveyard, situated in what is known as the Graveyard Field and consisting of approximately 3 acres of land more or less, and which is enclosed by a metal post and wire fence, as reserved in the deed executed by Ornbaun Estate, Inc. recorded April 24, 1934 in Book 95 of Official Records, Page 77, Mendocino County Records.

APN: 049-060-24

Parcel 65:

The North half of the Southwest quarter, the South 150 feet of the East half of the Southeast quarter of the Northwest quarter, and the Southwest quarter of the Northwest quarter of Section 4; and the Northeast quarter of the Southeast quarter of Section 5, Township 12 North, Range 13 West, Mount Diablo Meridian.

Excepting therefrom the South 150 feet of the East half of the Northeast quarter of the Southwest quarter of Section 4, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Boundary Line Adjustment B 11-2004 by deed recorded January 27, 2005 as 2005-01861, Mendocino County Records.

APN: 049-060-23 and 049-060-27

Parcel 66:

The Southwest quarter of the Southwest quarter of Section 11, the Southeast quarter of the Southeast quarter of Section 10, the Northeast quarter of the Northeast quarter of Section 15 and the Northwest quarter of the Northwest quarter of Section 14, all in Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Boundary Line Adjustment B 74-2005 by deed recorded July 12, 2006 as 2006-13602, Mendocino County Records.

APN: 049-160-52 and 049-160-53

Parcel 67:

The Southeast quarter of the Southwest quarter of Section 11, the East half of the Northwest quarter, the Southwest quarter of the Northwest quarter and those portions of the Northeast quarter of the Southwest quarter and of the Northwest quarter of the Southeast quarter of Section 14 lying Northerly of Yale Creek, all in Township 12 North, Range 13 West, Mount Diablo Meridian.

Together with all that portion of the West half of the Northeast quarter of said Section 14 that lies Westerly of the Easterly edge of the existing ranch road that runs in a generally north/south direction through the West half of the Northeast quarter and the East half of the Northwest quarter of said Section 14.

Pursuant to Boundary Line Adjustment B 74-2005 by deed recorded July 12, 2006 as 2006-13603, Mendocino County Records.

APN: 049-160-54 and 049-160-55

Parcel 68:

All that certain real property more particularly described in the Quitclaim Deed for Boundary Line Adjustment B 9-2007 to Mailliard Ranch, a California limited partnership recorded May 4, 2009 as 2009-06282, Mendocino County Records.

APN: 029-240-61, 029-240-62 and 049-050-26

Parcel 69:

All that certain real property more particularly described in the Quitclaim Deed for Boundary Line Adjustment B 9-2007 to Mailliard Ranch, a California limited partnership recorded May 4, 2009 as 2009-06283, Mendocino County Records.

Excepting from Lot 13 of Section 1, Township 12 North, Range 14 West, Mount Diablo Meridian the oil, gas and other minerals as reserved in the deed executed by James D. Lacey & Co. to J.W. Mailliard recorded June 2, 1937 in Book 116, Page 305, Official Records.

APN: 029-240-63, 029-240-64, 049-010-12, 049-010-53, 049-010-54, 049-021-13 and 049-140-31

Parcel 70:

All that certain real property more particularly described in the Quitclaim Deed for Boundary Line Adjustment B 9-2007 to Mailliard Ranch, a California limited partnership recorded May 4, 2009 as 2009-06284, Mendocino County Records.

APN: 049-140-32

Parcel 71:

All that certain real property more particularly described in the Quitclaim Deed for Boundary Line Adjustment B 9-2007 to Mailliard Ranch, a California limited partnership recorded May 4, 2009 as 2009-06285, Mendocino County Records.

APN: 049-050-16, 049-050-27 and 049-050-28

Parcel 72:

Tract One:

Township 13 North, Range 14 West, Mount Diablo Base and Meridian Section 28; East 1/2 of the Northwest 1/4.

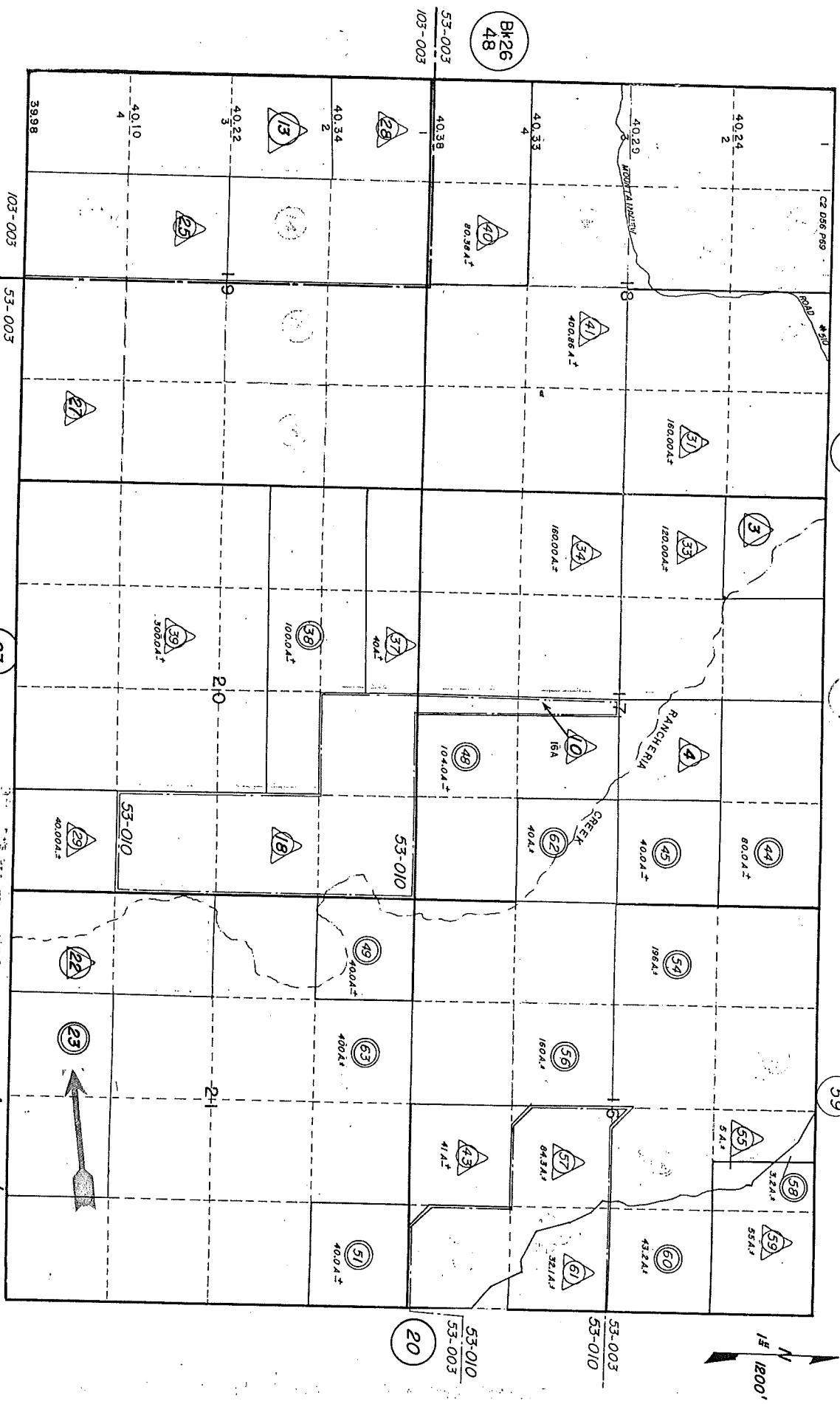
Excepting therefrom, all the oil and gas subject to disposition under the general mining laws, the general mineral leasing laws, the Materials Act., and the Geothermal Steam Act as reserved in the Patent from the United States of America to Valley Health Care Corporation recorded December 31, 1985 in Book 1539 Official Records, Page 38, Mendocino County Records.

APN: 029-230-07-05

Tract Two:

That certain non-exclusive easement for travel, recreation, timber management and transportation of timber and agricultural products contained in the Grant of Easement executed by Mailliard Ranch, a limited partnership, recorded November 19, 2007 as 2007-21036 of Official records.

29-19



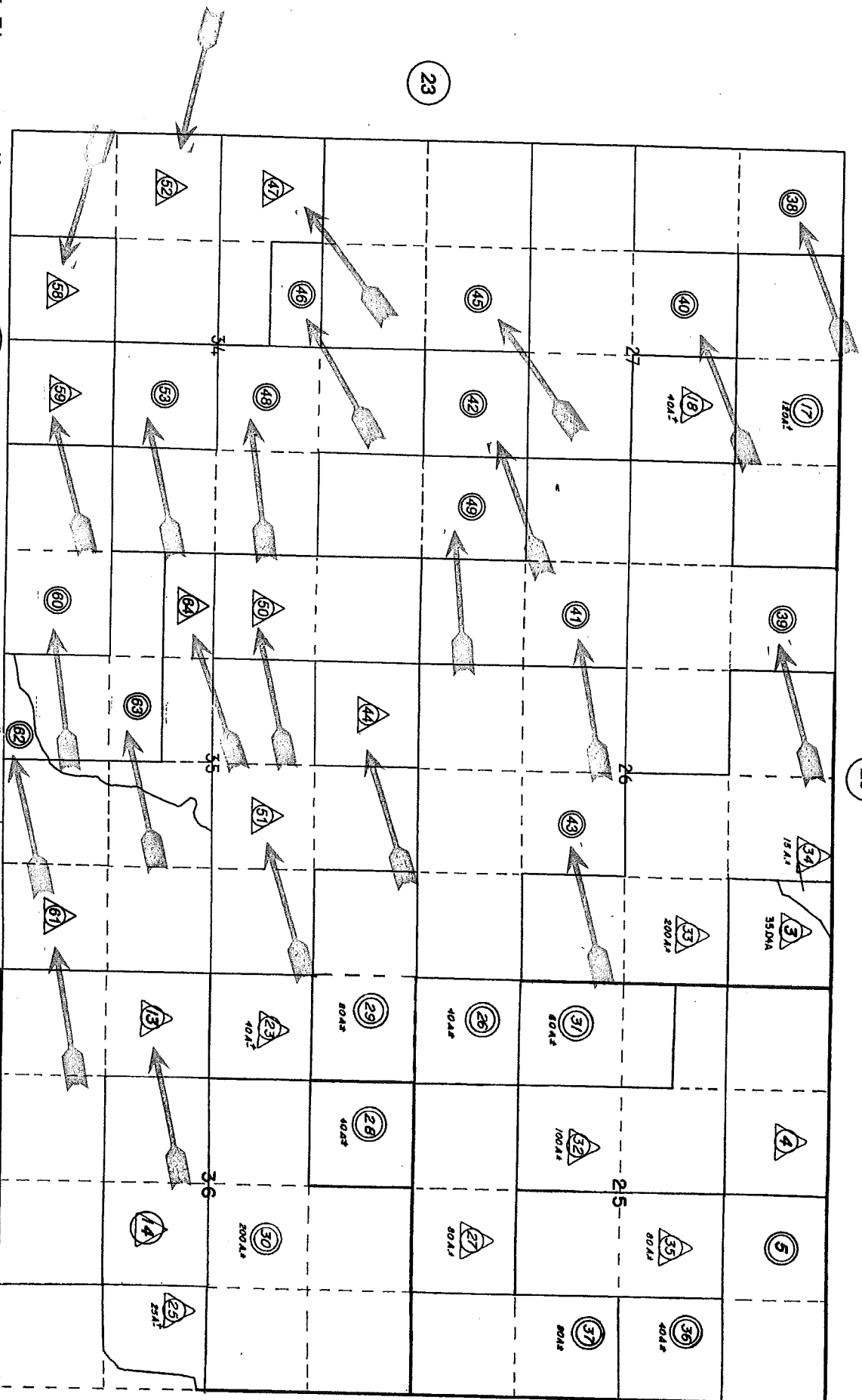
Assessors Map
County of Mendocino, Calif.
March, 1953
Aug. 10, 1953

"Notice: This is neither a plat nor a survey. It is furnished merely as a convenience to aid you in locating the land indicated hereon with reference to streets and other land. No liability is assumed by reason of any reliance hereon."

Sec. 25, 26, 27, 34, 35, 36 T.13N. R.14W. M.D.B.&M.

103-003

29-24



NOTE: This map was prepared for assessment purposes only. No liability is assumed for the data delineated.

Bk 49 01

Bk 49 05

Sec. 1, Sec. 6

Notice: This is neither a plat nor a survey. It is furnished merely as a convenience to aid you in locating the land indicated hereon with reference to streets and other land. No liability is assumed by reason of any reliance hereon.

Sec. 1, 2, 3 T. 12N. R. 14W. M.D.B. & M.

53-003
53-010

49-01

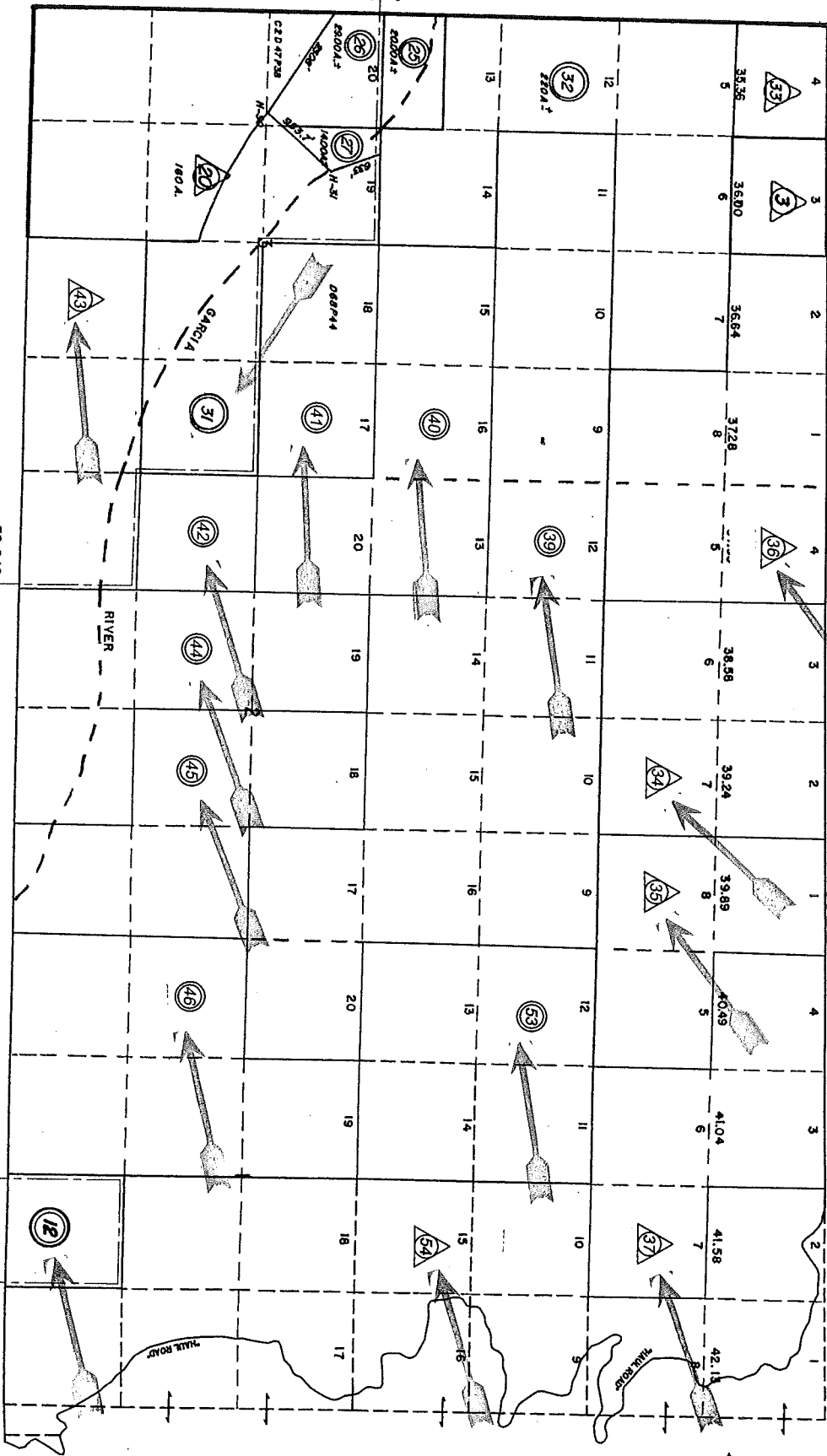
Bk
29
23

Bk
29
24

Bk
141
03

05

02



TE: This map was prepared for assessment purposes only. No liability assumed for the data delineated.

"Notice: This is neither a plat nor a survey. It is furnished merely as a convenience to aid you in locating the land indicated hereon with reference to streets and other land. No liability is assumed by reason of any reliance hereon."

Sec. 10, 11, 12, 13, 14, 15 T. 12N. R. 14W. M.D.B. & M.

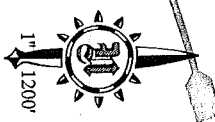
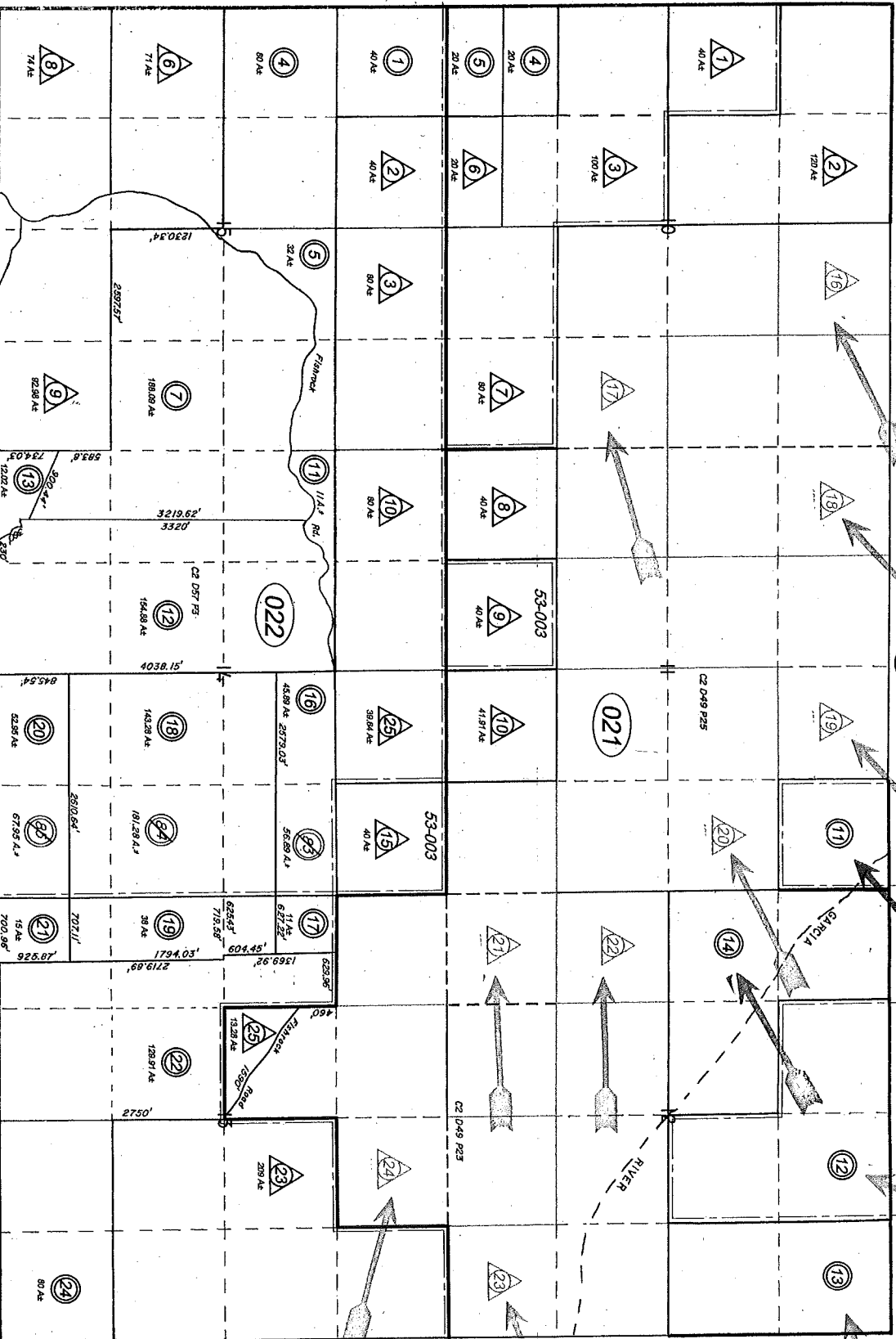
53-003
53-002
53-010

49-02

53-010
53-003

53-003
52-003

Bk
141
04



53-010
53-003
14

JAN 31 2008

NOTE: This map was prepared for assessment purposes only. No liability is assumed for the data delineated

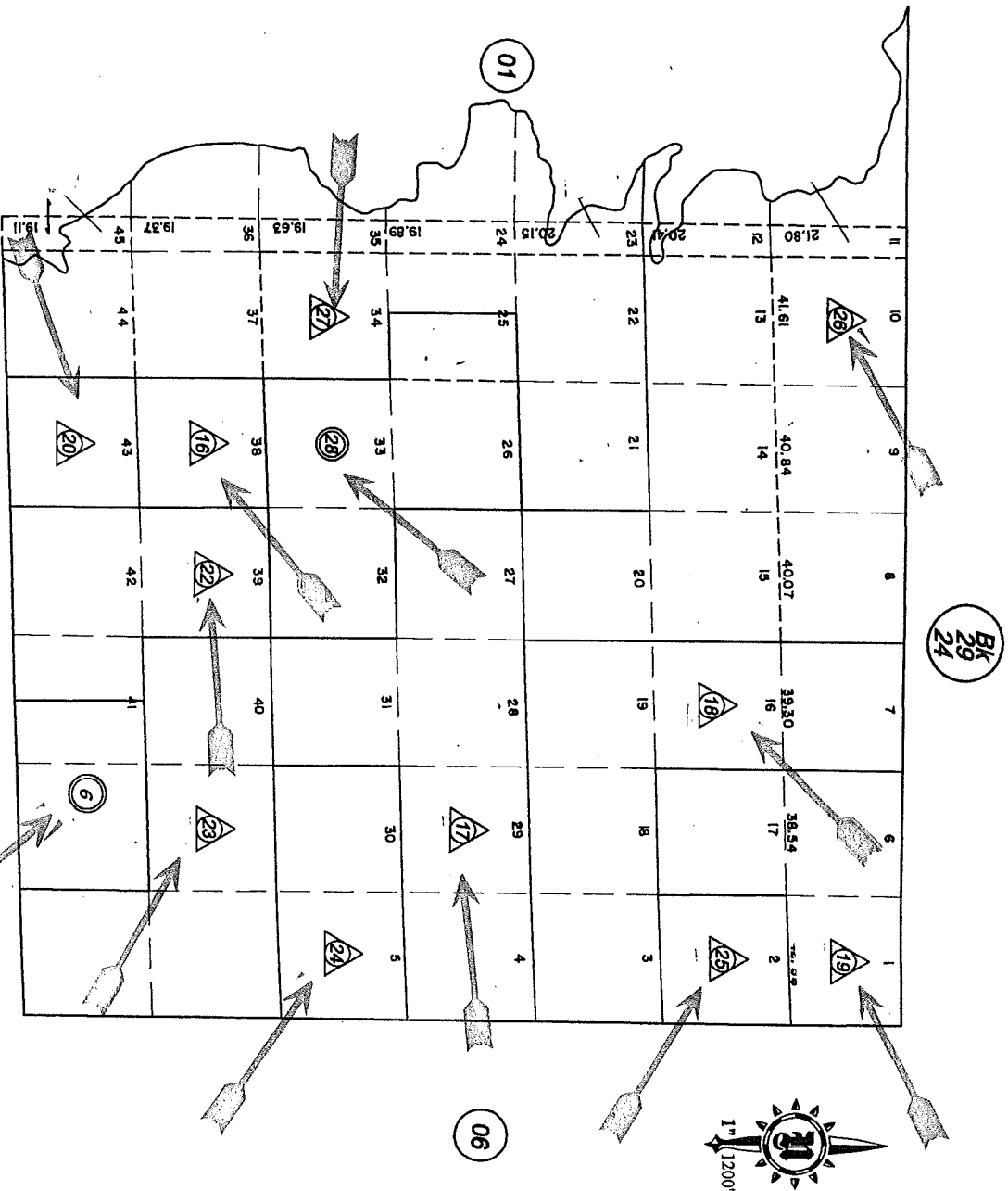
Assessor's Map
County of Mendocino, Calif.
Issued January 9, 2008

"Notice: This is neither a plat nor a survey. It is furnished merely as a convenience to aid you in locating the land indicated hereon with reference to streets and other land. No liability is assumed by reason of any reliance hereon."

Sec. 6 T.12N. R.13W. M.D.B.&M.

53-003

49-05



NOTE: This map was prepared for assessment purposes only. No liability is assumed for the data delineated hereon.

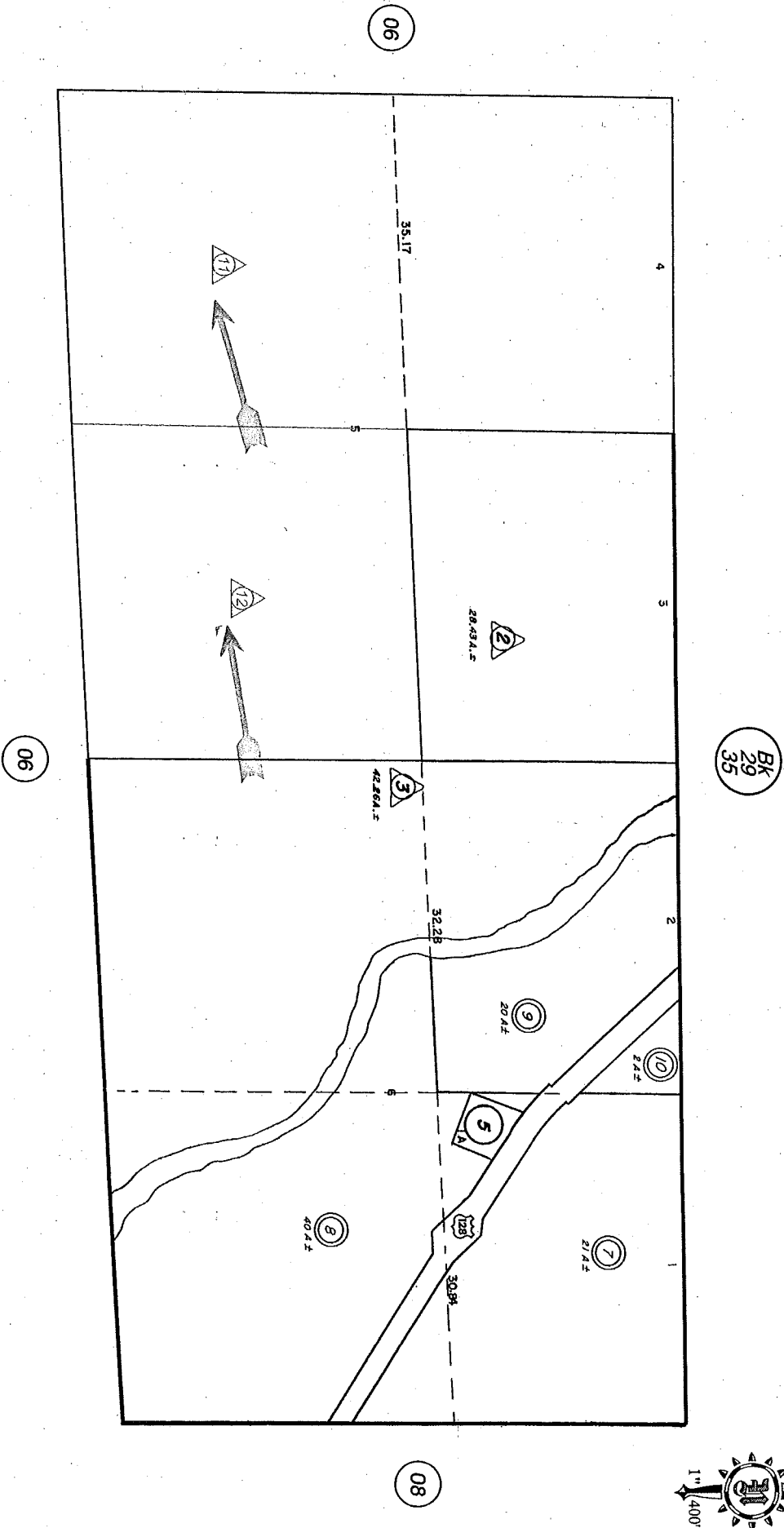
Assessor's Map
County of Mendocino, Calif.
Updated March, 2005

"Notice: This is neither a plat nor a survey. It is furnished merely as a convenience to aid you in locating the property indicated hereon with reference to streets, landmarks, and No liability is assumed by reason of any reliance hereon."

Lots 1,2,3,4,5,6 of Sec. 4 T.12N. R.13W. M.D.B.&M.

53-002

49 - 07



JAN 31 2008

Assessor's Map
County of Mendocino, Calif.
Updated January 10, 2008

NOTE: This map was prepared for
assessment purposes only. No liability
is assumed for the data delineated
hereon

49-08



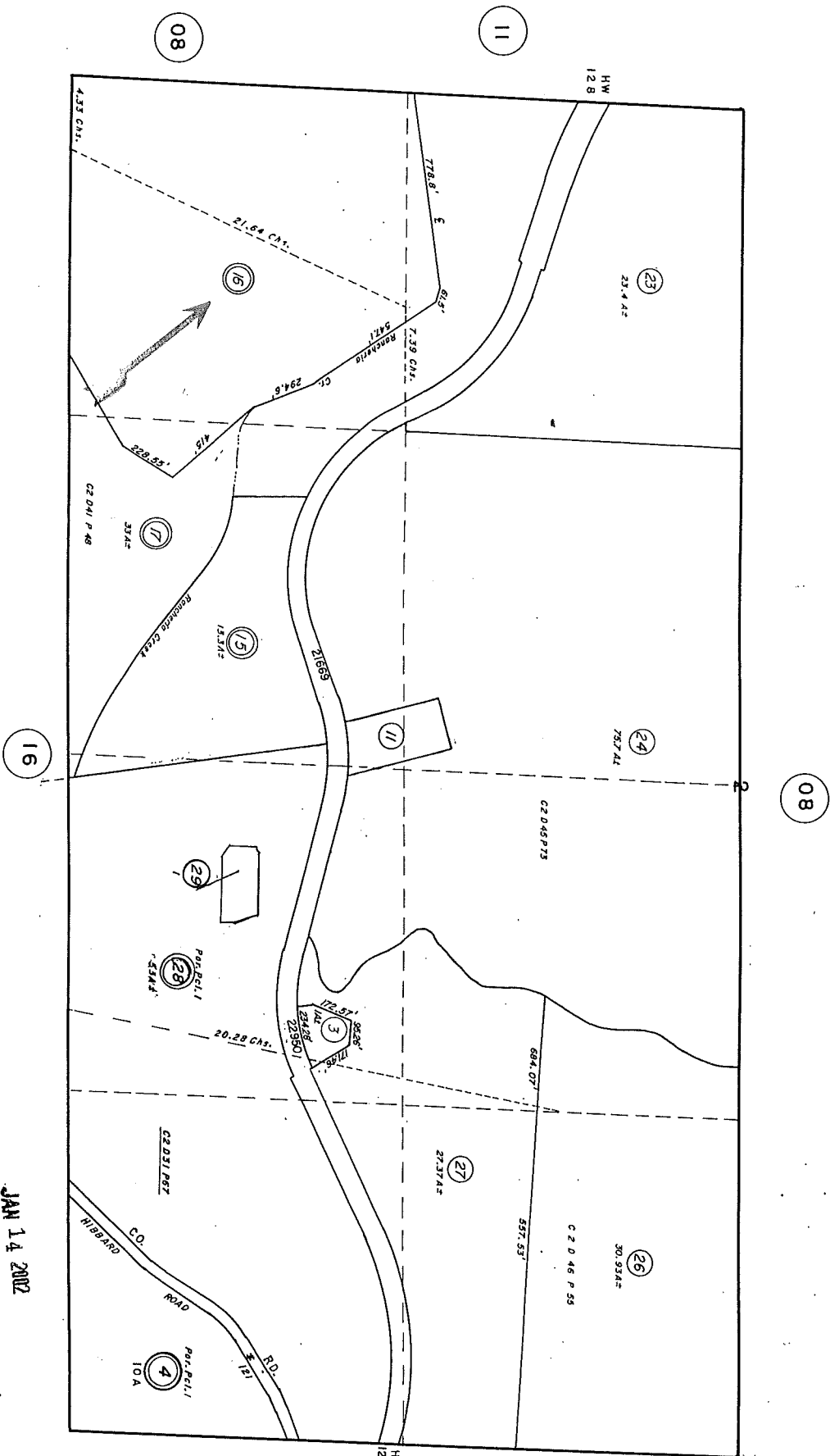
County of Mendocino, Calif.
 Dated January 10, 2008

"Notice: This is neither a plat nor a survey. It is furnished merely as a convenience to aid you in locating the land indicated hereon with reference to streets and other land. No liability is assumed by reason of any reliance hereon."

S 1/2 Sec. 2 T.12N. R.13W, M.D.B. & M.

53-002

49-12



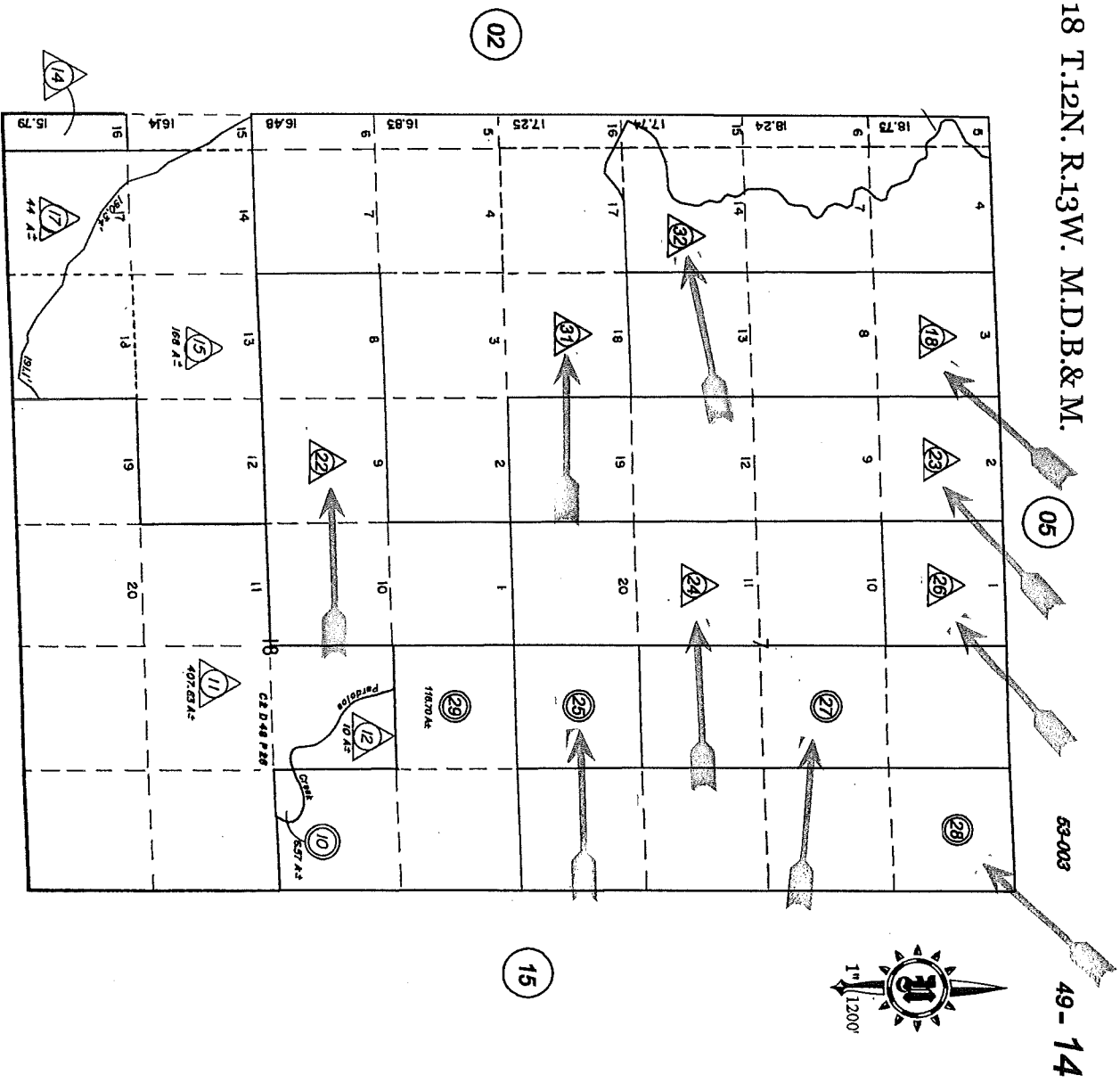
NOTE: This map was prepared for the purpose of public use only. No liability is assumed for the data delineated hereon.

JAN 14 2002

Assessor's Map
County of Mendocino, Calif.
March, 1952

"Notice: This is neither a plat nor a survey. It is furnished merely as a convenience to aid you in locating the land indicated hereon with reference to streets and other land. No liability is assumed by reason of any reliance hereon."

Sec. 7 & 18 T.12N. R.13W. M.D.B.&M.



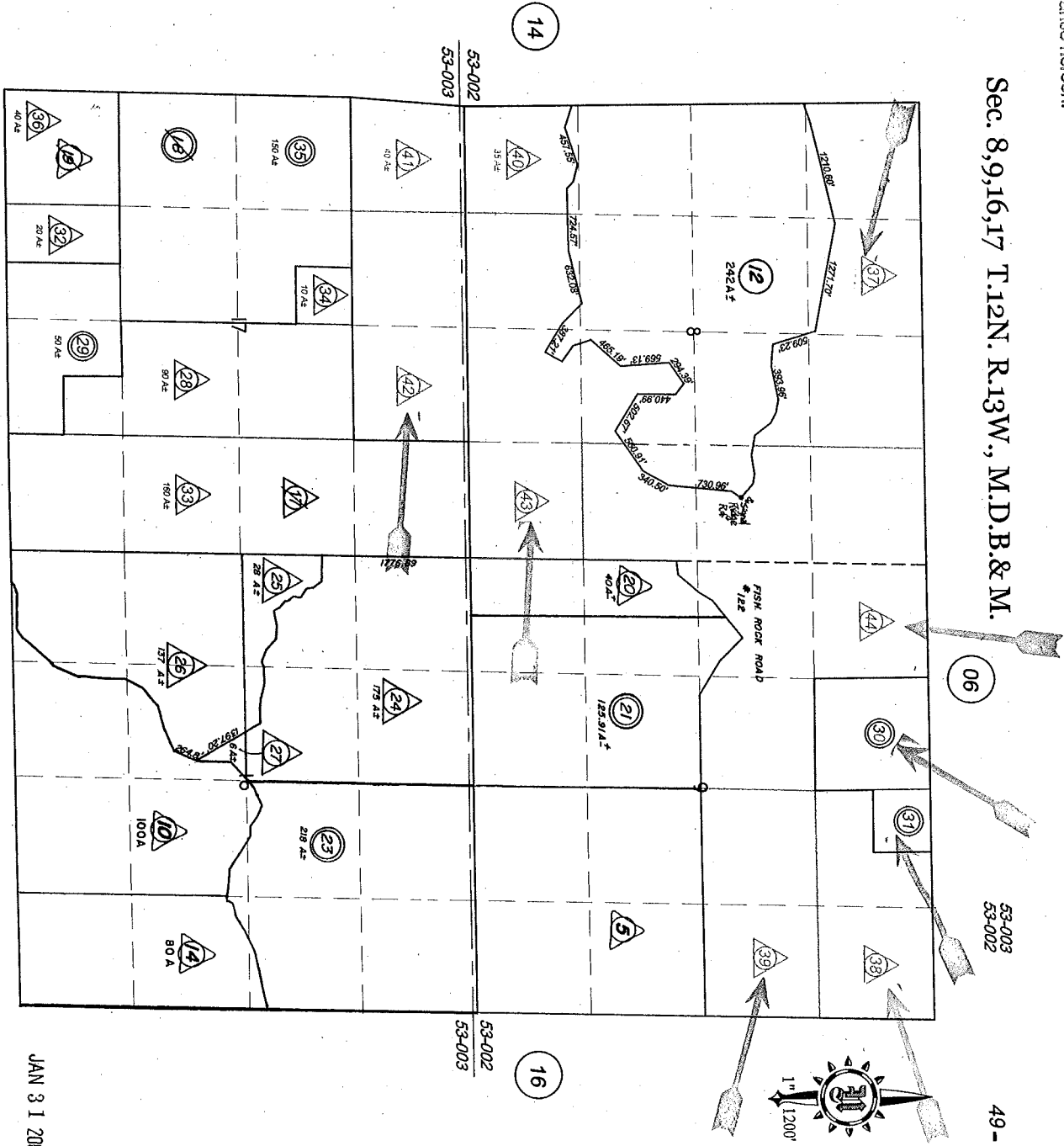
NOTE: This map was prepared for assessment purposes only. No liability is assumed for the data delineated hereon.

"Notice: This is neither a plat nor a survey. It is furnished merely as a convenience to aid you in locating the land indicated herein with reference to streets and other land. No liability is assumed by reason of any reliance hereon."

Sec. 8, 9, 16, 17 T.12N. R.13W., M.D.B. & M.

53-003
53-002

49-15



53-002
53-003

53-002
53-003

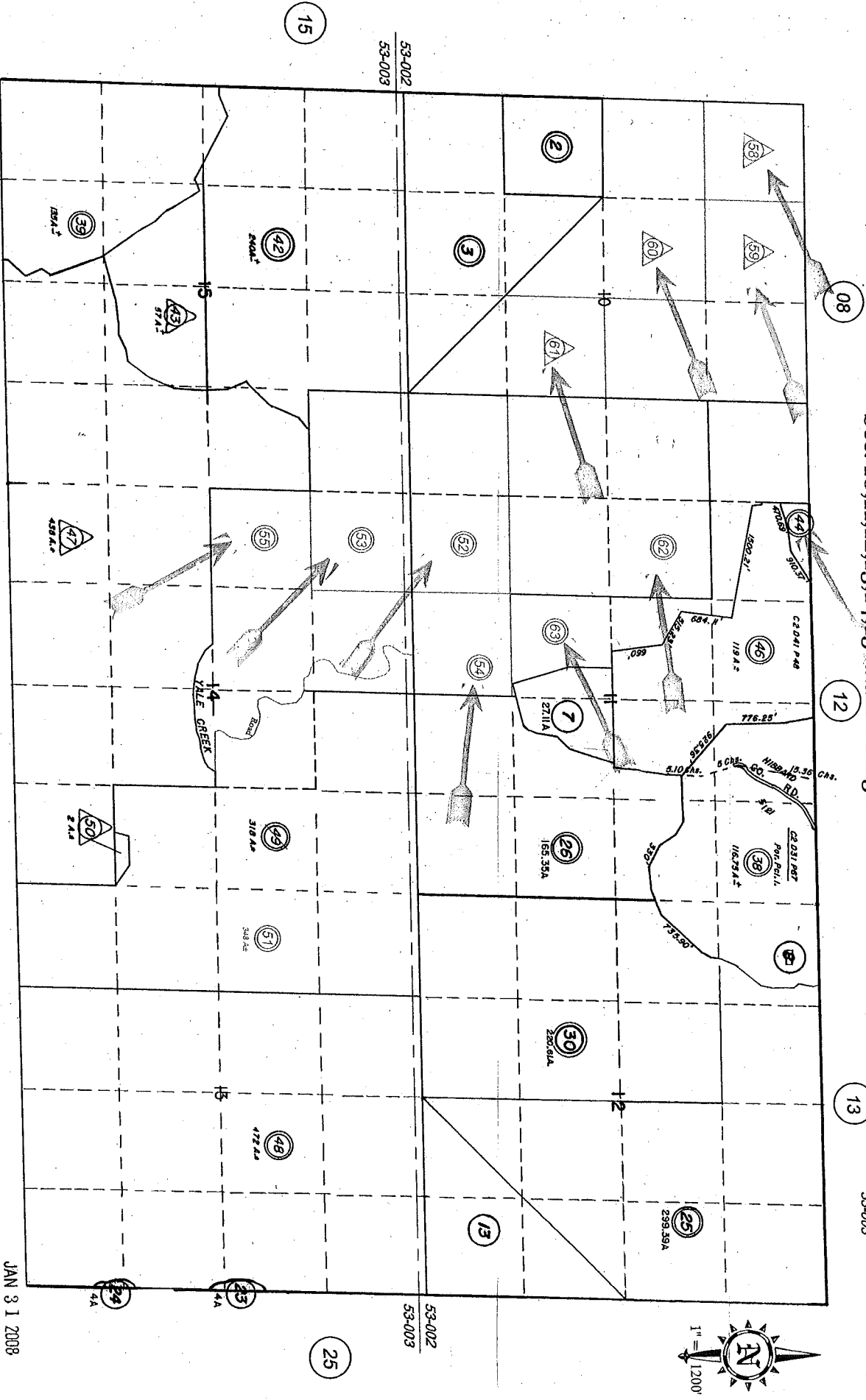
JAN 31 2008

NOTE: This map was prepared for assessment purposes only. No liability is assumed for the data delineated hereon.

Assessor's Map
County of Mendocino, Calif.
Updated January 8, 2008

Notice: This is neither a plat nor a survey. It is furnished merely as a convenience to aid you in locating the land indicated hereon with reference to streets and other land. No liability is assumed by reason of any reliance hereon.

Sec. 10, 11, 12, 13, 14, 15 T.12N. R.13W. M.D.B. & M.



53-002
53-003

49-16



JAN 31 2008

Assessor's Map

County of Mendocino, Calif.

Undated January 11, 2008

NOTE: This map was prepared for assessment purposes only.

No liability is assumed for the data delineated hereon.

CLTA PRELIMINARY REPORT FORM (EXHIBIT A) (01-01-08)

**CALIFORNIA LAND TITLE ASSOCIATION
STANDARD COVERAGE POLICY - 1990**

EXCLUSIONS FROM COVERAGE

The following matters are expressly excluded from the coverage of this policy and the Company will not pay loss or damage, costs, attorneys' fees or expenses which arise by reason of:

1. (a) Any law, ordinance or governmental regulation (including but not limited to building or zoning laws, ordinances, or regulations) restricting, regulating, prohibiting or relating (i) the occupancy, use, or enjoyment of the land; (ii) the character, dimensions or location of any improvement now or hereafter erected on the land; (iii) a separation in ownership or a change in the dimensions or area of the land or any parcel of which the land is or was a part; or (iv) environmental protection, or the effect of any violation of these laws, ordinances or governmental regulations, except to the extent that a notice of the enforcement thereof or a notice of a defect, lien, or encumbrance resulting from a violation or alleged violation affecting the land has been recorded in the public records at Date of Policy.
(b) Any governmental police power not excluded by (a) above, except to the extent that a notice of the exercise thereof or notice of a defect, lien or encumbrance resulting from a violation or alleged violation affecting the land has been recorded in the public records at Date of Policy.
2. Rights of eminent domain unless notice of the exercise thereof has been recorded in the public records at Date of Policy, but not excluding from coverage any taking which has occurred prior to Date of Policy which would be binding on the rights of a purchaser for value without knowledge.
3. Defects, liens, encumbrances, adverse claims or other matters:
 - (a) whether or not recorded in the public records at Date of Policy, but created, suffered, assumed or agreed to by the insured claimant;
 - (b) not known to the Company, not recorded in the public records at Date of Policy, but known to the insured claimant and not disclosed in writing to the Company by the insured claimant prior to the date the insured claimant became an insured under this policy;
 - (c) resulting in no loss or damage to the insured claimant;
 - (d) attaching or created subsequent to Date of Policy; or
 - (e) resulting in loss or damage which would not have been sustained if the insured claimant had paid value for the insured mortgage or for the estate or interest insured by this policy.
4. Unenforceability of the lien of the insured mortgage because of the inability or failure of the insured at Date of Policy, or the inability or failure of any subsequent owner of the indebtedness, to comply with the applicable doing business laws of the state in which the land is situated.
5. Invalidity or unenforceability of the lien of the insured mortgage, or claim thereof, which arises out of the transaction evidenced by the insured mortgage and is based upon usury or any consumer credit protection or truth in lending law.
6. Any claim, which arises out of the transaction vesting in the insured the estate of interest insured by this policy or the transaction creating the interest of the insured lender, by reason of the operation of federal bankruptcy, state insolvency or similar creditors' rights laws.

EXCEPTIONS FROM COVERAGE - SCHEDULE B, PART I

This policy does not insure against loss or damage (and the Company will not pay costs, attorneys' fees or expenses) which arise by reason of:

1. Taxes or assessments which are not shown as existing liens by the records of any taxing authority that levies taxes or assessments on real property or by the public records.
Proceedings by a public agency which may result in taxes or assessments, or notices of such proceedings, whether or not shown by the records of such agency or by the public records.
2. Any facts, rights, interests, or claims which are not shown by the public records but which could be ascertained by an inspection of the land or which may be asserted by persons in possession thereof.
3. Easements, liens or encumbrances, or claims thereof, not shown by the public records.
4. Discrepancies, conflicts in boundary lines, shortage in area, encroachments, or any other facts which a correct survey would disclose, and which are not shown by the public records.
5. (a) Unpatented mining claims; (b) reservations or exceptions in patents or in Acts authorizing the issuance thereof; (c) water rights, claims or title to water, whether or not the matters excepted under (a), (b) or (c) are shown by the public records.

2006 ALTA LOAN POLICY (06-17-06)

EXCLUSIONS FROM COVERAGE

The following matters are expressly excluded from the coverage of this policy, and the Company will not pay loss or damage, costs, attorneys' fees, or expenses that arise by reason of:

1. (a) Any law, ordinance, permit, or governmental regulation (including those relating to building and zoning) restricting, regulating, prohibiting, or relating to
 - (i) the occupancy, use, or enjoyment of the Land;
 - (ii) the character, dimensions, or location of any improvement erected on the Land;
 - (iii) the subdivision of land; or
 - (iv) environmental protection;or the effect of any violation of these laws, ordinances, or governmental regulations. This Exclusion 1(a) does not modify or limit the coverage provided under Covered Risk 5.
(b) Any governmental police power. This Exclusion 1(b) does not modify or limit the coverage provided under Covered Risk 6.
2. Rights of eminent domain. This Exclusion does not modify or limit the coverage provided under Covered Risk 7 or 8.
3. Defects, liens, encumbrances, adverse claims, or other matters:
 - (a) created, suffered, assumed, or agreed to by the Insured Claimant;

- (b) not Known to the Company, not recorded in the Public Records at Date of Policy, but Known to the Insured Claimant and not disclosed in writing to the Company by the Insured Claimant prior to the date the Insured Claimant became an Insured under this policy;
 - (c) resulting in no loss or damage to the Insured Claimant;
 - (d) attaching or created subsequent to Date of Policy (however, this does not modify or limit the coverage provided under Covered Risk 11, 13, or 14); or
 - (e) resulting in loss or damage that would not have been sustained if the Insured Claimant had paid value for the Insured Mortgage.
4. Unenforceability of the lien of the Insured Mortgage because of the inability or failure of an Insured to comply with applicable doing-business laws of the state where the Land is situated.
 5. Invalidity or unenforceability in whole or in part of the lien of the Insured Mortgage that arises out of the transaction evidenced by the Insured Mortgage and is based upon usury or any consumer credit protection or truth-in-lending law.
 6. Any claim, by reason of the operation of federal bankruptcy, state insolvency, or similar creditors' rights laws, that the transaction creating the lien of the Insured Mortgage, is
 - (a) a fraudulent conveyance or fraudulent transfer, or
 - (b) a preferential transfer for any reason not stated in Covered Risk 13(b) of this policy.
 7. Any lien on the Title for real estate taxes or assessments imposed by governmental authority and created or attaching between Date of Policy and the date of recording of the Insured Mortgage in the Public Records. This Exclusion does not modify or limit the coverage provided under Covered Risk 11(b).
- The above policy form may be issued to afford either Standard Coverage or Extended Coverage. In addition to the above Exclusions from Coverage, the Exceptions from Coverage in a Standard Coverage policy will also include the following Exceptions from Coverage:

EXCEPTIONS FROM COVERAGE

This policy does not insure against loss or damage (and the Company will not pay costs, attorneys' fees or expenses) that arise by reason of:

1. (a) Taxes or assessments that are not shown as existing liens by the records of any taxing authority that levies taxes or assessments on real property or by the Public Records; (b) proceedings by a public agency that may result in taxes or assessments, or notices of such proceedings, whether or not shown by the records of such agency or by the Public Records.
2. Any facts, rights, interests, or claims that are not shown by the Public Records but that could be ascertained by an inspection of the Land or that may be asserted by persons in possession of the Land.
3. Easements, liens or encumbrances, or claims thereof, not shown by the Public Records.
4. Any encroachment, encumbrance, violation, variation, or adverse circumstance affecting the Title that would be disclosed by an accurate and complete land survey of the Land and not shown by the Public Records.
5. (a) Unpatented mining claims; (b) reservations or exceptions in patents or in Acts authorizing the issuance thereof; (c) water rights, claims or title to water, whether or not the matters excepted under (a), (b), or (c) are shown by the Public Records.

2006 ALTA OWNER'S POLICY (06-17-06)

EXCLUSIONS FROM COVERAGE

The following matters are expressly excluded from the coverage of this policy, and the Company will not pay loss or damage, costs, attorneys' fees, or expenses that arise by reason of:

1. (a) Any law, ordinance, permit, or governmental regulation (including those relating to building and zoning) restricting, regulating, prohibiting, or relating to
 - (i) the occupancy, use, or enjoyment of the Land;
 - (ii) the character, dimensions, or location of any improvement erected on the Land;
 - (iii) the subdivision of land; or
 - (iv) environmental protection;
 or the effect of any violation of these laws, ordinances, or governmental regulations. This Exclusion 1(a) does not modify or limit the coverage provided under Covered Risk 5.
- (b) Any governmental police power. This Exclusion 1(b) does not modify or limit the coverage provided under Covered Risk 6.
2. Rights of eminent domain. This Exclusion does not modify or limit the coverage provided under Covered Risk 7 or 8.
3. Defects, liens, encumbrances, adverse claims, or other matters:
 - (a) created, suffered, assumed, or agreed to by the Insured Claimant;
 - (b) not Known to the Company, not recorded in the Public Records at Date of Policy, but Known to the Insured Claimant and not disclosed in writing to the Company by the Insured Claimant prior to the date the Insured Claimant became an Insured under this policy;
 - (c) resulting in no loss or damage to the Insured Claimant;
 - (d) attaching or created subsequent to Date of Policy (however, this does not modify or limit the coverage provided under Covered Risk 9 and 10); or
 - (e) resulting in loss or damage that would not have been sustained if the Insured Claimant had paid value for the Title.
4. Any claim, by reason of the operation of federal bankruptcy, state insolvency, or similar creditors' rights laws, that the transaction vesting the Title as shown in Schedule A, is
 - (a) a fraudulent conveyance or fraudulent transfer; or
 - (b) a preferential transfer for any reason not stated in Covered Risk 9 of this policy.
5. Any lien on the Title for real estate taxes or assessments imposed by governmental authority and created or attaching between Date of Policy and the date of recording of the deed or other instrument of transfer in the Public Records that vests Title as shown in Schedule A.

The above policy form may be issued to afford either Standard Coverage or Extended Coverage. In addition to the above Exclusions from Coverage, the Exceptions from Coverage in a Standard Coverage policy will also include the following Exceptions from Coverage:

EXCEPTIONS FROM COVERAGE

This policy does not insure against loss or damage (and the Company will not pay costs, attorneys' fees or expenses) that arise by reason of:

1. (a) Taxes or assessments that are not shown as existing liens by the records of any taxing authority that levies taxes or assessments on real property or by the Public Records; (b) proceedings by a public agency that may result in taxes or assessments, or notices of such proceedings, whether or not shown by the records of such agency or by the Public Records.
2. Any facts, rights, interests, or claims that are not shown in the Public Records but that could be ascertained by an inspection of the Land or that may be asserted by persons in possession of the Land.
3. Easements, liens or encumbrances, or claims thereof, not shown by the Public Records.
4. Any encroachment, encumbrance, violation, variation, or adverse circumstance affecting the Title that would be disclosed by an accurate and complete land survey of the Land and that are not shown by the Public Records.
5. (a) Unpatented mining claims; (b) reservations or exceptions in patents or in Acts authorizing the issuance thereof; (c) water rights, claims or title to water, whether or not the matters excepted under (a), (b), or (c) are shown by the Public Records.

Privacy Statement

July 1, 2001

We recognize and respect the privacy expectations of today's consumers and the requirements of applicable federal and state privacy laws. We believe that making you aware of how we use your non-public personal information ("Personal Information"), and to whom it is disclosed, will form the basis for a relationship of trust between us and the public we serve. This Privacy Statement provides that explanation. We reserve the right to change this Privacy Statement from time to time consistent with applicable privacy laws.

In the course of our business, we may collect Personal Information about you from the following sources:

- From applications or other forms we receive from you or your authorized representative;
- From your transactions with, or from the services being performed by us, our affiliates, or others;
- From our Internet web sites;
- From the public records maintained by governmental entities that we either obtain directly from those entities, or from our affiliates or others; and
- From consumer or other reporting agencies.

Our Policies Regarding the Protection of the Confidentiality and Security of Your Personal Information

We maintain physical, electronic and procedural safeguards to protect your Personal Information from unauthorized access or intrusion. We limit access to the Personal Information only to those employees who need such access in connection with providing products or services to you or for other legitimate business purposes.

Our Policies and Practices Regarding the Sharing of Your Personal Information

We may share your Personal Information with our affiliates, such as insurance companies, agents, and other real estate settlement providers. We may also disclose your Personal Information:

- to agents, brokers or representatives to provide you with services you have requested.
- to third-party contractors or service providers who provide services or perform marketing or other functions on our behalf; and
- to others with whom we enter into joint marketing agreements for products or services that we believe you may find of interest.

In addition, we will disclose your Personal Information when you direct or give us permission, when we are required by law to do so, or when we suspect fraudulent or criminal activities. We may also disclose your Personal Information when otherwise permitted by applicable privacy laws such as, for example, when disclosure is needed to enforce our rights arising out of any agreement, transaction or relationship with you.

One of the important responsibilities of some of our affiliated companies is to record documents in the public domain. Such documents may contain your Personal Information.

Right to Access Your Personal Information and Ability to Correct Errors or Request Changes or Deletion

Certain states afford you the right to access your Personal Information and, under certain circumstances, to find out to whom your Personal Information has been disclosed. Also, certain states afford you the right to request correction, amendment or deletion of your Personal Information. We reserve the right, where permitted by law, to charge a reasonable fee to cover the costs incurred in responding to such requests.

All requests must be made in writing to the following address:

Privacy Compliance Officer
Redwood Empire Title Company
P.O. Box 238
Ukiah, CA 95482

Multiple Products or Services

If we provide you with more than one financial product or service, you may receive more than one privacy notice from us. We apologize for any inconvenience this may cause you.

Post 2015 BLA

Exhibit A

West Ranch

All that certain real property situated in Sections 21, 26, 27, 28, 33, 34, 35, Township 13 North, Range 14 West, Sections 1, 2, 3, 10, 11, 12, 13, Township 12 North, Range 14 West and Sections 6, 7, 18, Township 12 North, Range 13 West, Mount Diablo Base and Meridian, County of Mendocino, State of California, more particularly described as follows:

Parcel 1:

The Southeast quarter of the Southwest quarter and the Southwest quarter of the Southeast quarter of Section 21 and the West half of the Northeast quarter of Section 28, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 250, Mendocino County Records.

APN: 029-190-23 and 029-230-45

Parcel 2:

The West half of the Northwest quarter of Section 27 and the East half of the Northeast quarter of Section 28, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 254, Mendocino County Records.

APN: 029-230-46 and 029-240-38

Parcel 3:

The South half of the Northwest quarter and the Northwest quarter of the Northwest quarter of Section 26 and the Southeast quarter of the Northeast quarter of Section 27, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 258, Mendocino County Records.

APN: 029-240-39

Parcel 4:

The East half of the Southeast quarter, the Northwest quarter of the Southeast quarter and all that portion of the Southwest quarter of Section 28, Township 13 North, Range 14 West, Mount Diablo Meridian lying East of Camp Creek. Also all that portion of the East half of the Northwest quarter of Section 33, Township 13 North, Range 14 West, Mount Diablo Meridian, lying East of Camp Creek.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 262, Mendocino County Records.

APN: 029-230-47

Parcel 5:

The North half of the Southwest quarter, the Southeast quarter of the Northwest quarter, and the Northwest quarter of the Southeast quarter of Section 27, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 266, Mendocino County Records.

APN: 029-240-40

Parcel 6:

The West half of the Southwest quarter of Section 26 and the Northeast quarter of the Southeast quarter and the Southwest quarter of the Southeast quarter of Section 27, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 269, Mendocino County Records.

APN: 029-240-41 and 029-240-42

Parcel 7:

The Northwest quarter of the Southeast quarter, the South half of the Southeast quarter and the East half of the Southwest quarter of Section 26 and the Northeast quarter of the Northwest quarter of Section 35, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 272, Mendocino County Records.

APN: 029-240-43 and 029-240-44

Parcel 8:

The Southwest quarter of the Southeast quarter of Section 28, Township 13 North, Range 14 West, Mount Diablo Meridian. Also all those portions of the West half of the Northeast quarter, the Southwest quarter and the Southeast quarter of Section 33, Township 13 North, Range 14 West, Mount Diablo Meridian lying easterly of Camp Creek and lying southerly of German Creek.

Excepting therefrom the Southwest quarter of the Southwest quarter of Section 33, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 275, Mendocino County Records.

APN: 029-230-48

Parcel 9:

The South half of the Southwest quarter of Section 27 and the North half of the Northwest quarter of Section 34, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 278, Mendocino County Records.

APN: 029-240-45

Parcel 10:

The East half of the Northeast quarter of Section 33 and the South half of the Northwest quarter of Section 34, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 281, Mendocino County Records.

APN: 029-230-49, 029-240-46 and 029-240-47

Parcel 11:

The Northwest quarter of the Northeast quarter, the South half of the Northeast quarter and the Northeast quarter of the Southeast quarter of Section 34, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 284, Mendocino County Records.

APN: 029-240-48

Parcel 12:

The Southeast quarter of the Southeast quarter of Section 27, the Northeast quarter of the Northeast quarter of Section 34, and the West half of the Northwest quarter of Section 35, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 287, Mendocino County Records.

APN: 029-240-49 and 029-240-50

Parcel 13:

The Northwest quarter of the Northeast quarter, the South half of the Northeast quarter and the Southeast quarter of the Northwest quarter of Section 35, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 290, Mendocino County Records.

APN: 029-240-51

Parcel 14:

The West half of the Southwest quarter, the Northeast quarter of the Southwest quarter and the Northwest quarter of the Southeast quarter of Section 34, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 293, Mendocino County Records.

APN: 029-240-52 and 029-240-53

Parcel 16:

The Southeast quarter of the Southwest quarter of Section 34, Township 13 North, Range 14 West, Mount Diablo Meridian. Also Lots 2, 3, 6 and 7 of Section 2, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 305, Mendocino County Records.

APN: 029-240-58 and 049-010-34

Parcel 17:

The South half of the Southeast quarter of Section 34 and the Southwest quarter of the Southwest quarter of Section 35, Township 13 North, Range 14 West, Mount Diablo Meridian. Also Lots 1 and 8 of Section 2 and Lot 5 of Section 1, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 308, Mendocino County Records.

APN: 029-240-59, 029-240-60 and 049-010-35

Parcel 18:

Lots 4 and 5 of Section 2, and Lots 1, 2 and 8 of Section 3, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 311, Mendocino County Records.

APN: 049-010-36

Parcel 19:

Lots 3, 4, 6 and 7 of Section 1, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 314, Mendocino County Records.

APN: 049-010-37

Parcel 20:

Lots 9, 10 and 11 of Section 3; Lots 9, 10, 11, 12, 14, 15, 16 and 17 of Section 2; and Lot 20 of Section 1, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 320, Mendocino County Records.

APN: 049-010-39

Parcel 21:

Lots 13 and 20 of Section 2 and Lots 15 and 16 of Section 3, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 323, Mendocino County Records.

APN: 049-010-40

Parcel 22:

The Northwest quarter of the Southwest quarter of Section 2, the North half of the Southeast quarter, Lot 18 and Lot 17 of Section 3 and those portions of Lot 19 and the Southwest quarter of Section 3, lying North of the Garcia River all in Township 12 North, Range 14 West, Mount Diablo Meridian.

Excepting therefrom all that portion conveyed to Ward M. Hanes and Ruth F. Hanes by grant deed recorded December 24, 1962 in Book 614 of Official Records, Page 274, Mendocino County Records.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 326, Mendocino County Records.

APN: 049-010-31, 049-010-41 and 049-010-42

Parcel 23:

The Southwest quarter of the Southwest of Section 2, the South half of the Southeast quarter of Section 3, and the Northwest quarter of the Northeast quarter of Section 10, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 329, Mendocino County Records.

APN: 049-010-43 and 049-021-16

Parcel 24:

Lot 19, the East half of the Southwest quarter and the Southwest quarter of the Southeast quarter of Section 2 and the Northeast quarter of the Northeast quarter of Section 11, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 332, Mendocino County Records.

APN: 049-010-44 and 049-021-11

Parcel 25:

The East half of the Southeast quarter, the Northwest quarter of the Southeast quarter and Lot 18 of Section 2, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 335, Mendocino County Records.

APN: 049-010-45

Parcel 26:

Lot 19 and the Southwest quarter of Section 1, the Northeast quarter of the Northwest quarter and the West half of the Northeast quarter of Section 12, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 338, Mendocino County Records.

APN: 049-010-46 and 049-021-12

Parcel 48:

The North half of the Southeast quarter and the Southwest quarter of the Northeast quarter of Section 10 and the Northwest quarter of the Southwest quarter of Section 11, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 443, Mendocino County Records.

APN: 049-021-17

Parcel 49:

The East half of the Northeast quarter of Section 10 and the West half of the Northwest quarter of Section 11, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 446, Mendocino County Records.

APN: 049-021-18

Parcel 50:

The East half of the Northwest quarter, the Northwest quarter of the Northeast quarter and the Northeast quarter of the Southwest quarter of Section 11, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 449, Mendocino County Records.

APN: 049-021-19

Parcel 51:

The South half of the Northeast quarter and the North half of the Southeast quarter of Section 11, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 452, Mendocino County Records.

APN: 049-021-20

Parcel 52:

The Southeast quarter of the Southeast quarter of Section 11, the South half of the Southwest quarter of Section 12, the Northwest quarter of the Northwest quarter of Section 13, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 455, Mendocino County Records.

APN: 049-021-21

Parcel 53:

The Northwest quarter of the Southwest quarter, the West half of the Northwest quarter and the Southeast quarter of the Northwest quarter of Section 12, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 458, Mendocino County Records.

APN: 049-021-14 and 049-021-22

Parcel 54:

The Northeast quarter of the Southwest quarter, the North half of the Southeast quarter and the Southeast quarter of the Southeast quarter of Section 12, Township 12 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 461, Mendocino County Records.

APN: 049-021-23

Parcel 55:

The Southwest quarter of the Southeast quarter of Section 12 and all those fractional portions of the East half of the Northwest quarter and the Northwest quarter of the Northeast quarter of Section 13, Township 12 North, Range 14 West, Mount Diablo Meridian lying Northerly of Signal Ridge Road.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 464, Mendocino County Records.

APN: 049-021-24

Parcel 69:

All that certain real property more particularly described in the Quitclaim Deed for Boundary Line Adjustment B 9-2007 to Mailliard Ranch, a California limited partnership recorded May 4, 2009 as 2009-06283, Mendocino County Records. Excepting from Lot 13 of Section 1, Township 12 North, Range 14 West, Mount Diablo Meridian the oil, gas and other minerals as reserved in the deed executed by James D. Lacey & Co. to J.W. Mailliard recorded June 2, 1937 in Book 116, Page 305, Official Records.

APN: 029-240-63, 029-240-64, 049-010-12, 049-010-53, 049-010-54, 049-021-13 and 049-140-31

Parcel 72:

Tract One: Township 13 North, Range 14 West, Mount Diablo Base and Meridian Section 28;
East 1/2 of the Northwest 1/4.

Excepting therefrom, all the oil and gas subject to disposition under the general mining laws, the general mineral leasing laws, the Materials Act., and the Geothermal Steam Act as reserved in the Patent from the United States of America to Valley Health Care Corporation recorded December 31, 1985 in Book 1539 Official Records, Page 38, Mendocino County Records.

APN: 029-230-07-05

Tract Two: That certain non-exclusive easement for travel, recreation, timber management and transportation of timber and agricultural products contained in the Grant of Easement executed by Mailliard Ranch, a limited partnership, recorded November 19, 2007 as 2007-21036 of Official records.

Matthew T. Herman 5/12/15
Matthew T. Herman, P.L.S. 8335
License Expires 12-31-15
SHN Consulting Engineers and Geologists, Inc.



POST 2015 BLA

Exhibit A

Middle Ranch

All that certain real property situated in Sections 35, 36 Township 13 North, Range 14 West, Section 1 Township 12 North, Range 14 West and Sections 5, 6, 7, 8, 18, Township 12 North, Range 13 West, Mount Diablo Base and Meridian, County of Mendocino, State of California, more particularly described as follows:

Parcel 15:

The West half of the Southwest quarter, the Southeast quarter of the Southwest quarter, and the Southwest quarter of the Southeast quarter of Section 36, Township 13 North, Range 14 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 299, Mendocino County Records.

APN: 029-240-13

Parcel 27:

Lots 4, 27, 28, 29 and 31 of Section 6, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 362, Mendocino County Records.

APN: 049-050-17

Parcel 28:

Lots 3, 7, 16, 18 and 19 of Section 6, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 365, Mendocino County Records.

APN: 049-050-18

Parcel 29:

Lot 4 of Section 5 and Lots 1, 6 and 17 of Section 6, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 368, Mendocino County Records.

APN: 049-050-19 and 049-060-x21

Parcel 30:

Lot 43 of Section 6 and Lots 3, 8 and 13 of Section 7, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 371, Mendocino County Records.

APN: 049-050-20 and 049-140-18

Parcel 31:

Lots 39, 41 and 42, and the Southwest quarter of the Southeast quarter of Section 6, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 377, Mendocino County Records.

APN: 049-050-06 and 049-050-22

Parcel 32:

Lot 40, the North half of the Southeast quarter and the Southeast quarter of the Southeast quarter of Section 6, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 380, Mendocino County Records.

APN: 049-050-23

Parcel 56:

Lots 1, 8, 9 and 10 of Section 18, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 473, Mendocino County Records.

APN: 049-140-22

Parcel 57:

Lots 2, 9, 12 and 19 of Section 7, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 476 Mendocino County Records.

APN: 049-140-23

Parcel 58:

Lots 10, 11 and 20 and the Southwest quarter of the Southeast quarter of Section 7, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 479, Mendocino County Records.

APN: 049-140-24 and 049-140-25

Parcel 59:

Lot 1 and the West half of the Northeast quarter and the Northwest quarter of the Southeast quarter of Section 7, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 482, Mendocino County Records.

APN: 049-140-26 and 049-140-27

Parcel 60:

The East half of the Northeast quarter and the East half of the Southeast quarter of Section 7, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 485 Mendocino County Records.

APN: 049-140-28

Parcel 68:

All that certain real property more particularly described in the Quitclaim Deed for Boundary Line Adjustment B 9-2007 to Mailliard Ranch, a California limited partnership recorded May 4, 2009 as 2009-06282, Mendocino County Records.

APN: 029-240-61, 029-240-62 and 049-050-26

Parcel 70:

All that certain real property more particularly described in the Quitclaim Deed for Boundary Line Adjustment B 9-2007 to Mailliard Ranch, a California limited partnership recorded May 4, 2009 as 2009-06284, Mendocino County Records.

APN: 049-140-32

Parcel 71:

All that certain real property more particularly described in the Quitclaim Deed for Boundary Line Adjustment B 9-2007 to Mailliard Ranch, a California limited partnership recorded May 4, 2009 as 2009-06285, Mendocino County Records.

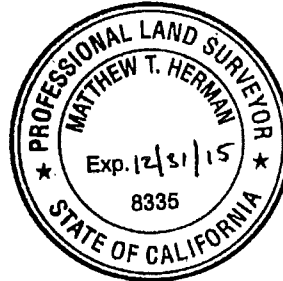
APN: 049-050-16, 049-050-27 and 049-050-28

Parcel 73:

All that certain real property more particularly described in the Quitclaim Deed for Boundary Line Adjustment B 2015-0020 to Mailliard Ranch, a California limited partnership recorded July 9, 2015 as 2015-09313, Mendocino County Records.

APN: 049-050-24, 049-050-25, 049-060-x21 and 049-150-x37

Matthew T. Herman 7/21/15
Matthew T. Herman, P.L.S. 8335
License Expires 12-31-15
SHN Consulting Engineers and Geologists, Inc.



POST 2015 BLA

Exhibit A

East Ranch

All that certain real property situated in Sections 2, 3, 4, 5, 8, 9, 10, 11, 14, 15, 17 Township 12 North, Range 13 West, Mount Diablo Base and Meridian, County of Mendocino, State of California, more particularly described as follows:

Parcel 38:

Lot 7 and East half of Lot 6 of Section 5; Lot 4 and the West half of Lot 5 of Section 4, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 398, Mendocino County Records.

APN: 049-060-x21, 049-070-11

Parcel 39:

Lot 8, the East half of Lot 5 and the East half of Lot 9 of Section 4, Township 12 North, Range 13 West, Mount Diablo Meridian. Also that portion of Lot 10 of Section 4, Township 12 North, Range 13 West, Mount Diablo Meridian, described in the deed executed by Richard L. Elkins to John O. Ornbaun recorded November 27, 1894 in Book 64 of Deeds, Page 302, Mendocino County Records.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 401, Mendocino County Records.

APN: 049-060-x15, 049-060-x22 and 049-070-12

Parcel 40:

The West half of the Southwest quarter of Section 3 and the East half of the Southeast quarter of Section 4, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 413, Mendocino County Records.

APN: 049-060-x25, 049-080-60 and 049-080-61

Parcel 41:

The East half of Lots 10 and 11 of Section 4, Township 12 North, Range 13 West, Mount Diablo Meridian.

Excepting therefrom that portion of the East half of Lot 10 of Section 4, Township 12 North, Range 13 West, Mount Diablo Meridian described in the deed executed by Richard Lee Elkins and Mamie Ella Elkins to Fred George Parker and Linda R. Parker dated October 2, 1936 recorded in Book 109 of Official Records, Page 110, Mendocino County Records, more particularly described as follows:

Beginning at a point 108 feet East of the Northwest corner of the East half of Lot 10 in Section 4, Township 12 North, Range 13 West, Mount Diablo Meridian, and running thence West 108 feet to the corner of said East half of Lot 10, thence South 144 feet from said corner, thence in a direct line 178 feet to the place of beginning, being a triangular piece of land and $\frac{1}{4}$ of an acre more or less.

Also the West half of Lots 9 and 12 of Section 3, Township 12 North, Range 13 West, Mount Diablo Meridian.

Also that portion of the West half of Section 3 and Lot 7 of Section 4, Township 12 North, Range 13 West, Mount Diablo Meridian, described in the deed executed by Hattie Belle Ornbaun to J.W. Mailliard Jr., recorded October 5, 1945 in Book 192 of Official Records, Page 113, Mendocino County Records, more particularly described as follows:

All that portion of the following described land lying South and West of Rancheria Creek: Beginning at a point 20 chains West from the Southeast corner of Lot 5 of Section 3, Township 12 North, Range 13 West, Mount Diablo Meridian, thence West 8.75 chains to a picket fence, thence South 41° West 26.50 chains, thence East 24.14 chains, thence North 20 chains to the point of beginning.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 416, Mendocino County Records.

APN: 049-060-12, 049-060-x25 and 049-080-62

Parcel 42:

The Southeast quarter of the Southwest quarter of Section 3, the North half of the Northeast quarter of Section 9 and the Northwest quarter of the Northwest quarter of Section 10, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 419, Mendocino County Records.

APN: 049-080-63, 049-150-31, 049-150-38 and 049-160-58

Parcel 43:

The Northeast quarter of the Northwest quarter and the West half of the Northeast quarter of Section 10 and the Southwest quarter of the Southeast quarter of Section 3, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 422, Mendocino County Records.

APN: 049-080-10 and 049-160-59

Parcel 44:

The Northeast half of the Northeast quarter of the Southwest quarter and the South half of the Northwest quarter of Section 10, and the South half of the Northeast quarter of Section 9, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 425, Mendocino County Records.

APN: 049-150-39 and 049-160-60

Parcel 45:

The North half of the Southeast quarter, the Northeast half of the Southwest quarter of the Southeast quarter, and the Southeast quarter of the Northeast quarter of Section 10, the Northwest quarter of the Southwest quarter and the Southwest quarter of the Northwest quarter of Section 11, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 428, Mendocino County Records.

APN: 049-160-61 and 049-160-62

Parcel 46:

All of those portions of the Southeast quarter of the Southeast quarter of Section 3, the West half of the Southwest quarter and the Southeast quarter of the Southwest quarter of Section 2, the Northeast quarter of the Northeast quarter of Section 10, the North half of the Northwest quarter and the Southeast quarter of the Northwest quarter of Section 11 lying Southerly of the southerly boundary line of California State Highway 128.

Also the Northeast quarter of the Southwest quarter of Section 11 and all that portion of the Northwest quarter of the Southeast quarter of Section 11 lying North and West of the following described line:

Beginning at a point in the North line of the Northwest quarter of the Southeast quarter of Section 11, which is 35.68 chains East from the Southwest corner of the Southeast quarter of the Northwest quarter of said Section 11, thence along the center of an old traveled road South 13° West, 6.15 chains; South 14° West, 5.55 chains; South 45°30' West, 3.63 chains; South 5°30' West, 3.37 chains; South 20°30' West, 2

chains; South 40° West, 1.50 chains; South 71° West 6.25 chains; South 60°30' West, 3 chains to a point in the center of said old traveled road, 19.64 chains due North from the quarter section corner on the south boundary of said Section 11.

Excepting therefrom that portion conveyed to James A. Sager and Bertha Mae Sager by deed dated July 20, 1935 and recorded in Book 100 of Official Records, Page 449, Mendocino County Records.

Also excepting therefrom that portion conveyed to James A. Sager and Bertha Mae Sager by deed dated September 18, 1941 and recorded in Book 152 of Official Records, Page 301, Mendocino County Records.

Also excepting therefrom any portion granted to the State of California by deed recorded September 26, 1975 in Book 1014 of Official Records, Page 366, Mendocino County Records.

Also excepting therefrom that portion granted to Guido A. Pronsolino and Betty J. Pronsolino by deed recorded December 14, 1983 in Book 1434 of Official Records, Page 529, Mendocino County Records.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 437, Mendocino County Records.

APN: 049-080-64, 049-120-16, 049-160-44 and 049-160-63

Parcel 47:

Those portions of the East half of Lots 8, 9 and 12, the West half of Lot 11, the Northeast quarter of the Southwest quarter and the North half of the Southeast quarter of Section 3, Township 12 North, Range 13 West, Mount Diablo Meridian lying Southerly and Westerly of the southerly boundary line of the California State Highway 128.

Excepting therefrom that portion conveyed by Charles Burton Orchard to Leslie L. C. Hanelt et ux, in deed recorded January 18, 1967 in Book 732 of Official Records, Page 334, Mendocino County Records.

Also excepting therefrom that portion granted to the State of California by deed recorded September 26, 1975 in Book 1014 of Official Records, Page 366, Mendocino County Records.

Also excepting therefrom that portion granted to Guido A. Pronsolino and Betty J. Pronsolino by deed recorded December 14, 1983 in Book 1434 of Official Records, Page 529, Mendocino County Records.

Also excepting therefrom that portion granted to the County of Mendocino in the deed recorded March 17, 1977 in Book 1080 of Official Records, Page 471, Mendocino County Records.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 440, Mendocino County Records.

APN: 049-080-28, 049-080-65 and 049-080-66

Parcel 61:

The Northeast quarter of the Northwest quarter and the Northwest quarter of the Northeast quarter of Section 17, the South half of the Southeast quarter, the Northwest quarter of the Southeast quarter and the East half of the Southwest quarter of Section 8, Township 12 North, Range 13 West, Mount Diablo Meridian.

Excepting therefrom all that portion conveyed to the State of California by deed recorded March 4, 1954 in Book 365 of Official Records, Page 227, Mendocino County Records.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 491, Mendocino County Records.

APN: 049-150-42 and 049-150-43

Parcel 62:

The East half of the Northeast quarter and the Northeast quarter of the Southeast quarter of Section 8, the West half of the Northwest quarter and the Southeast quarter of the Northwest quarter of Section 9, Township 12 North, Range 13 West, Mount Diablo Meridian.

Also that portion of the Northwest quarter of the Southwest quarter of Section 9, Township 12 North, Range 13 West, Mount Diablo Meridian conveyed by Ornbaun Estate, Inc. to J.W. Mailliard and Kate P. Mailliard by deed dated April 16, 1934 recorded in Book 95 of Official Records, Page 77, Mendocino County Records and described as follows:

Beginning at the one quarter section corner between Sections 8 and 9, Township 12 North, Range 13 West, Mount Diablo Meridian, and run first sight South 89°30' East, 5.47 chains to a post marked H.N.O. #12, thence South 41° West, 4.36 chains to a post marked H.N.O.J.S. #10, thence South 79° West 2.50 chains to a point 4.10 chains South of the one quarter section corner, set a redwood post marked H.N.O.J.S.O., from which a tan oak 10 inches in diameter bears South 42°30' East, 25 links distant and marked H.N.O. #11 B.T., a tan oak 4 inches in diameter bears South 68°30' East, 31 links distant, marked on the outside bark H.N.O. #11 B.T., thence North 0°30' East, 4.10 chains to the point of beginning.

Excepting therefrom that portion of the Southwest quarter of the Northwest quarter of Section 9, Township 12 North, Range 13 West, Mount Diablo Meridian, recorded in deed dated April 16, 1934 recorded in Book 95 Official Records, Page 77, Mendocino County Records, and described as follows:

Beginning at a redwood post marked H.N.O.J.S.O. from which a fir 10 inches in diameter bears South 64°45' East, 68 links distant and a maple 12 inches in diameter bears North 85°50' West, 53 links distant, both trees marked H.N.O.H.S.O., this post stands South 89°30' East, 19.87 chains distant from the one quarter section corner between Sections 8 and 9, Township 12 North, Range 13 West, Mount Diablo Meridian, run first sight South 89° East, 3.70 chains to a post marked H.N.O.J.S.O. #1, thence North 57°30' West, 6.83 chains to a post marked #2, thence North 47°15' West, 5.87 chains to a post marked H.N.O.J.S.O. #3, this is a redwood fence post 4 by 4 inches square and stands on the North bank of a creek, thence South 56°30' West, 1.78 chains to a post marked H.N.O.J.S.O. #4, thence South 44°30' West, 1.07 chains to a post marked H.N.O.J.S.O. #5, thence South 56°15' West, 1.90 chains to a post marked H.N.O.J.S.O. #6, thence South 48°15' West, 2.11 chains to a post marked H.N.O.J.S.O. #7, thence South 56° West, 1.70 chains to a post marked H.N.O.J.S.O. #8, thence South 46° West, 2.57

chains, set a redwood fence post 4 by 4 inches square on the East side of a road, marked #9, thence South 41° West, 1.64 chains to a post 5.47 chains East of the one quarter section corner between Sections 8 and 9, Township 12 North, Range 13 West, Mount Diablo Meridian, marked H.N.O.J.S.O. #12, thence South 89°30' East, 18.10 chains to the point of beginning. Magnetic Variation N 17°30'E.

Also excepting therefrom all that portion conveyed to the State of California by deed recorded March 4, 1954 in Book 365 of Official Records, Page 227, Mendocino County Records.

Pursuant to Certificate of Compliance recorded April 8, 1992 in Book 1981, Page 494, Mendocino County Records.

APN: 049-150-44

Parcel 63:

The Southeast quarter of the Southeast quarter of Section 5; the Northeast quarter of the Northwest quarter of Section 9; the South half of the Southwest quarter, and the South 150 feet of the East half of the Northeast quarter of the Southwest quarter of Section 4, all in Township 12 North, Range 13 West, Mount Diablo Meridian.

Excepting therefrom the East 150 feet of the South half of the Southeast quarter of the Southwest quarter of Section 4, Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Boundary Line Adjustment B 11-2004 by deed recorded January 27, 2005 as 2005-01859, Mendocino County Records.

APN: 049-060-26, 049-060-28 and 049-150-30

Parcel 64:

The West half of the Southeast quarter, the East 150 feet of the South half of the Southeast quarter of the Southwest quarter, the Southwest quarter of the Northeast quarter, and the Southeast quarter of the Northwest quarter of Section 4, Township 12 North, Range 13 West, Mount Diablo Meridian.

Excepting therefrom the South 150 feet of the East half of the Southeast quarter of the Northwest quarter of Section 4, all in Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Boundary Line Adjustment B 11-2004 by deed recorded January 27, 2005 as 2005-01860, Mendocino County Records.

Also excepting all of that certain piece or parcel of land known as Ornbaun Graveyard, situated in what is known as the Graveyard Field and consisting of approximately 3 acres of land more or less, and which is enclosed by a metal post and wire fence, as reserved in the deed executed by Ornbaun Estate, Inc. recorded April 24, 1934 in Book 95 of Official Records, Page 77, Mendocino County Records.

APN: 049-060-24

Parcel 66:

The Southwest quarter of the Southwest quarter of Section 11, the Southeast quarter of the Southeast quarter of Section 10, the Northeast quarter of the Northeast quarter of Section 15 and the Northwest quarter of the Northwest quarter of Section 14, all in Township 12 North, Range 13 West, Mount Diablo Meridian.

Pursuant to Boundary Line Adjustment B 74-2005 by deed recorded July 12, 2006 as 2006-13602, Mendocino County Records.

APN: 049-160-52 and 049-160-53

Parcel 67:

The Southeast quarter of the Southwest quarter of Section 11, the East half of the Northwest quarter, the Southwest quarter of the Northwest quarter and those portions of the Northeast quarter of the Southwest quarter and of the Northwest quarter of the Southeast quarter of Section 14 lying Northerly of Yale Creek, all in Township 12 North, Range 13 West, Mount Diablo Meridian.

Together with all that portion of the West half of the Northeast quarter of said Section 14 that lies Westerly of the Easterly edge of the existing ranch road that runs in a generally north/south direction through the West half of the Northeast quarter and the East half of the Northwest quarter of said Section 14.

Pursuant to Boundary Line Adjustment B 74-2005 by deed recorded July 12, 2006 as 2006-13603, Mendocino County Records.

APN: 049-160-54 and 049-160-55

Parcel 74:

All that certain real property more particularly described in the Quitclaim Deed for Boundary Line Adjustment B 2015-0020 to Mailliard Ranch, a California limited partnership recorded July 9, 2015 as 2015-09312, Mendocino County Records.

APN: 049-060-14, 049-060-x21, 049-060-x22, 049-060-x23, 049-060-x27 and 049-150-x37

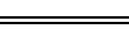
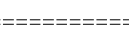
Matthew T. Herman 7/21/15
Matthew T. Herman, P.L.S. 8335
License Expires 12-31-15
SHN Consulting Engineers and Geologists, Inc.



ATTACHMENT E

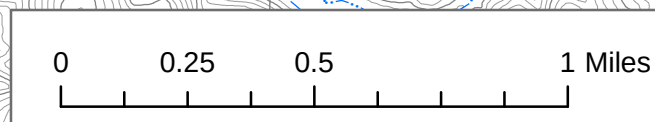
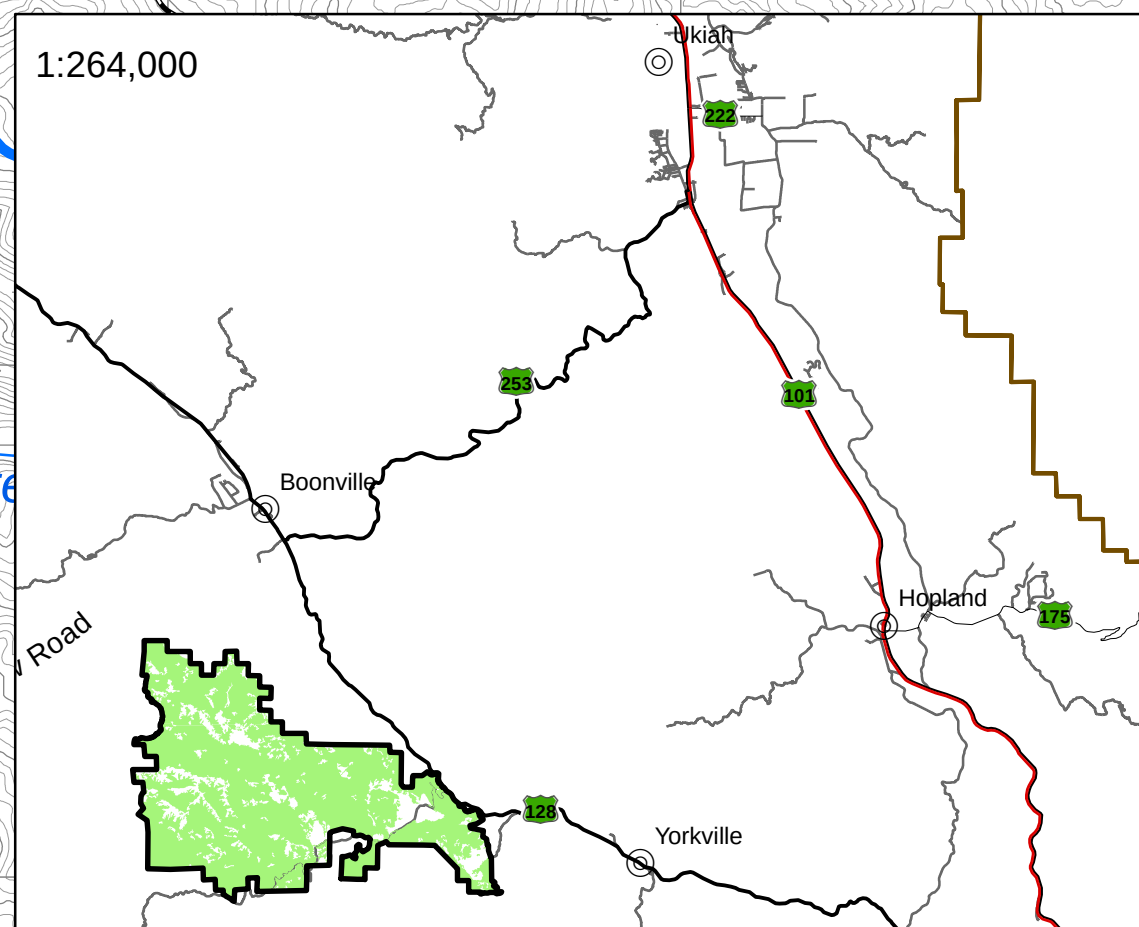
Mailliard Ranch

Project Map

-  Ranch Boundary
-  Project Area
-  Watersheds
-  Public Road
-  Private Permanent Road
-  Private Seasonal Road
-  Private Other Road
-  Class I Watercourse
-  Class II Watercourse



October 13, 2015
Version 1.0A

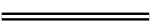
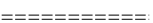


ATTACHMENT F

Mailliard Ranch

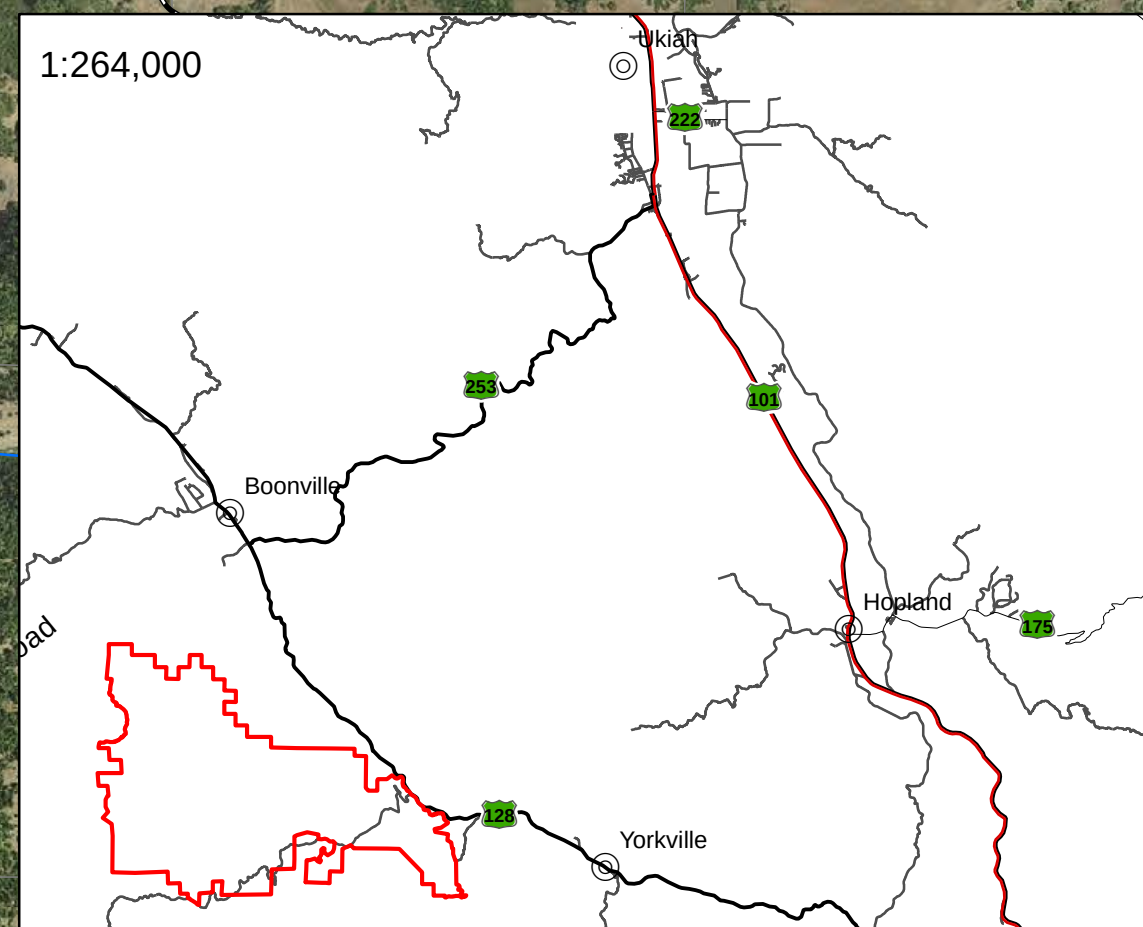
Project Map



-  Ranch Boundary
-  Project Area
-  Public Road
-  Private Permanent Road
-  Private Seasonal Road
-  Private Fire Road
- Class I Watercourse
- Class II Watercourse



October 13, 2015
Version 1.0A

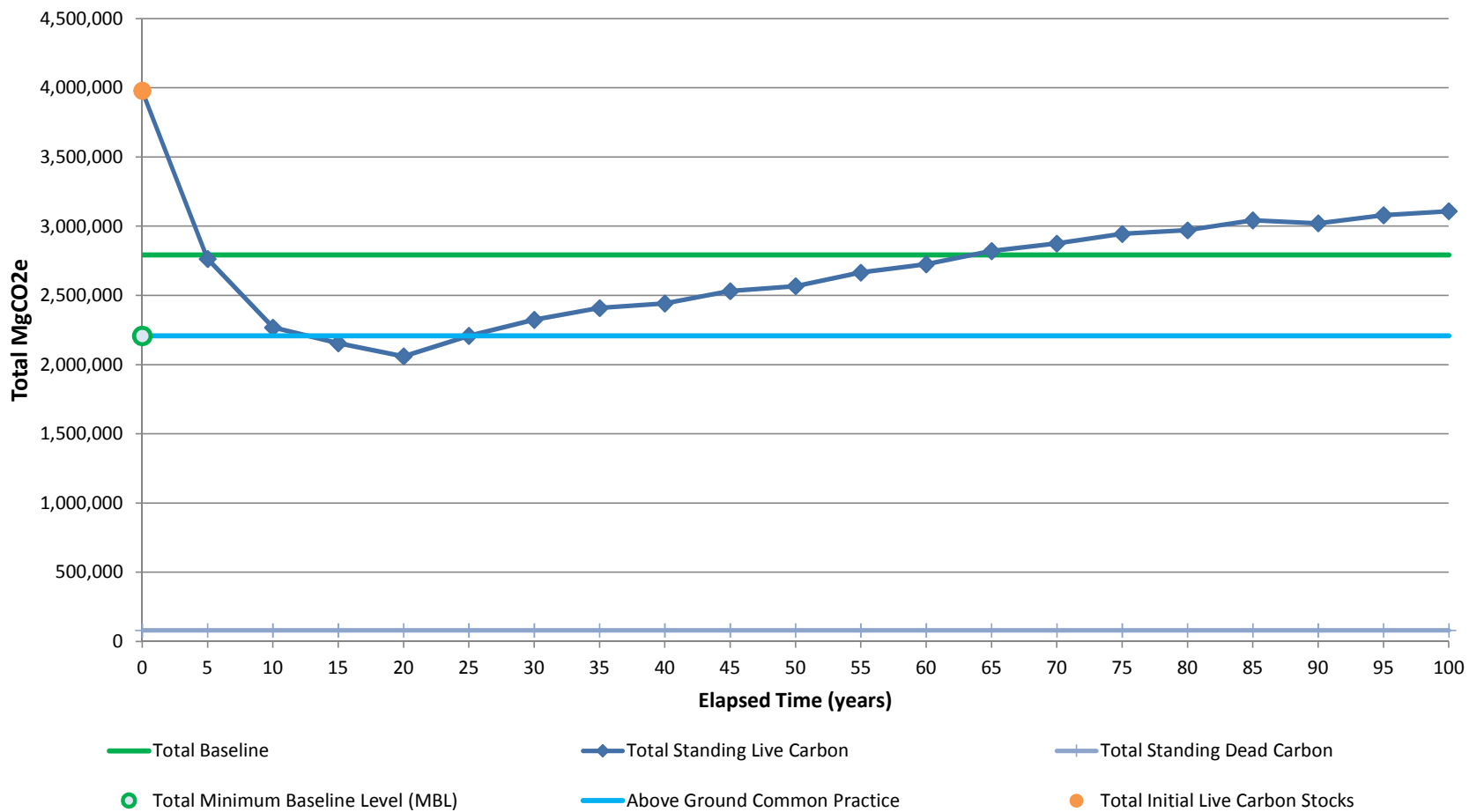


Fish Rock Road

0 0.25 0.5 1 Miles

ATTACHMENT G

Attachment G Baseline Graph



ATTACHMENT H

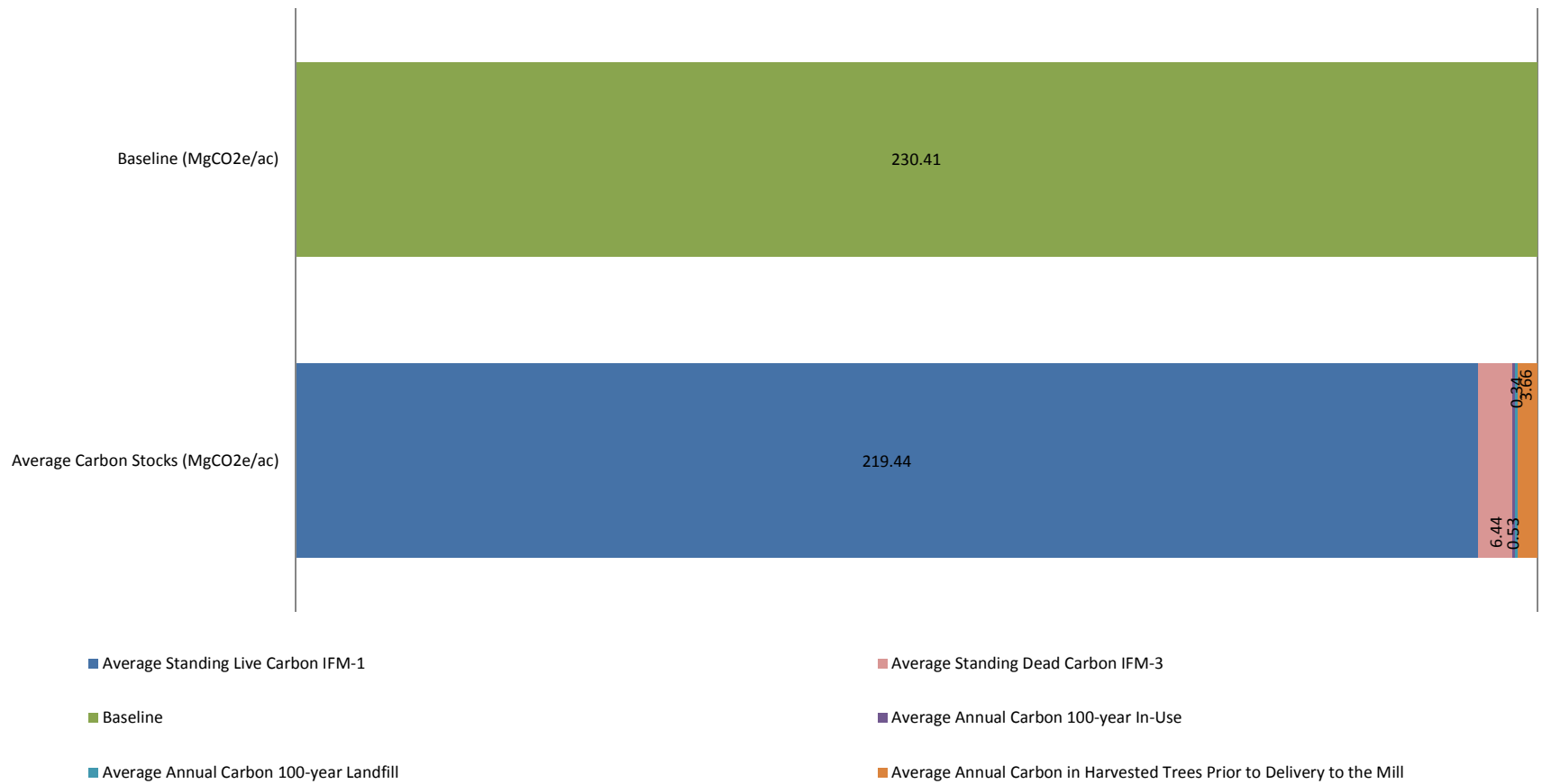
Attachment H

Baseline Carbon Stocks (MgCO₂e per Acre)

Elapsed Time	Standing Live Carbon Pool IFM-1	Standing Dead Carbon Pool IFM-3	Baseline
0	321.99	6.44	225.88
5	223.59	6.44	225.88
10	183.51	6.44	225.88
15	174.31	6.44	225.88
20	166.63	6.44	225.88
25	178.62	6.44	225.88
30	187.98	6.44	225.88
35	194.88	6.44	225.88
40	197.56	6.44	225.88
45	204.74	6.44	225.88
50	207.69	6.44	225.88
55	215.63	6.44	225.88
60	220.47	6.44	225.88
65	228.19	6.44	225.88
70	232.62	6.44	225.88
75	238.23	6.44	225.88
80	240.36	6.44	225.88
85	246.17	6.44	225.88
90	244.37	6.44	225.88
95	249.14	6.44	225.88
100	251.46	6.44	225.88
Average	219.44	6.44	225.88

Carbon Pool	Mg C/ acre	Mg CO ₂ e/acre	Total Mg CO ₂ e
Average Standing Live and Standing Dead Pools	61.647	225.876	2,791,980
Average Annual Carbon 100-year In-Use	0.145	0.531	6,558
Average Annual Carbon 100-year Landfill	0.094	0.343	4,237
Average Annual Carbon in Harvested Trees Prior to Delivery to the Mill	0.998	3.658	45,210

Attachment H - Carbon Stocks and Baseline



ATTACHMENT J

Mailliard Ranch Improved Forest Management Project

Financial Analysis of Baseline Scenario

This analysis is provided per section 6.2.1.3 (1) of Compliance Offset Protocol U.S. Forest Projects, October 20, 2011, and is designed to demonstrate that the baseline growth and harvest regime is financially feasible. This analysis is overly conservative given that the test is simply financial feasibility. If herbicide treatments, tree planting and logging costs were significantly increased, the analysis would still demonstrate that the baseline growth and harvest is financially feasible. Delivered log values are below trended values based on Board of Equalization values, yet still demonstrate financial feasibility.

Model Inputs:

Discount Rate	8.0%
Inflation	0.0%
Real price appreciation for delivered log values	0.0%
Yield Tax	2.9% MBF

Production Costs:

Item	Cost per acre	Quantity	Total Cost	Cost per MBF
THP Preparation	\$100	12,361	\$ 1,236,068	\$9.33
Logging Supervision				\$15.00
Property Management				\$25.00
Logging and Hauling (Derived from BOE Stumpage Values)				\$0.00
Total				\$49.33

Herbicide Treatment of Hardwoods:

Period	Cost per acre	% of Acres Treated	Total Cost	Cost per MBF
1	\$ 230.00	65%	\$1,847,921	\$13.95
2	\$ 230.00	35%	\$995,034	\$23.16
3	\$ 230.00	20%	\$568,591	\$11.94
4	\$ 230.00	20%	\$568,591	\$11.28
5	\$ 230.00	20%	\$568,591	\$11.03
6	\$ 230.00	20%	\$568,591	\$11.21
7	\$ 230.00	20%	\$568,591	\$10.83
8	\$ 230.00	20%	\$568,591	\$10.94
9	\$ 230.00	20%	\$568,591	\$9.95
10	\$ 230.00	20%	\$568,591	\$10.19

Tree Planting: (\$1 per tree cost)

Period	Cost per acre	% of Acres Treated	Total Cost	Cost per MBF
1	\$ 200.00	35%	\$865,247	\$6.53
2	\$ 200.00	25%	\$618,034	\$14.38
3	\$ 200.00	20%	\$494,427	\$10.39
4	\$ 200.00	20%	\$494,427	\$9.81
5	\$ 200.00	20%	\$494,427	\$9.60
6	\$ 200.00	20%	\$494,427	\$9.74
7	\$ 200.00	20%	\$494,427	\$9.41
8	\$ 200.00	20%	\$494,427	\$9.52
9	\$ 200.00	20%	\$494,427	\$8.65
10	\$ 200.00	20%	\$494,427	\$8.86

Financial Analysis of Baseline Scenario

Calculation of Net Present Value of Harvest Stream

Year	Annual Harvest Volume				Stumpage Values per MBF				Production Costs \$ / MBF	Herbicide Treatment \$ / MBF	Tree Planting \$ / MBF	Yield Taxes \$ / MBF	Net Value \$ / MBF	Total Net Value	Present Net Value
	RW MBF	DF MBF	OC MBF	Totals MBF	RW \$ / MBF	DF \$ / MBF	OC \$ / MBF	Camprun \$ / MBF							
2015	4,810	8,413	26	13,248	500.00	75.00	50.00	229.25	49.33	13.95	6.53	6.65	152.79	2,024,167	1,874,228
2016	4,810	8,413	26	13,248	500.00	75.00	50.00	229.25	49.33	13.95	6.53	6.65	152.79	2,024,167	1,735,397
2017	4,810	8,413	26	13,248	500.00	75.00	50.00	229.25	49.33	13.95	6.53	6.65	152.79	2,024,167	1,606,849
2018	4,810	8,413	26	13,248	500.00	75.00	50.00	229.25	49.33	13.95	6.53	6.65	152.79	2,024,167	1,487,823
2019	4,810	8,413	26	13,248	500.00	75.00	50.00	229.25	49.33	13.95	6.53	6.65	152.79	2,024,167	1,377,614
2020	4,810	8,413	26	13,248	500.00	75.00	50.00	229.25	49.33	13.95	6.53	6.65	152.79	2,024,167	1,275,568
2021	4,810	8,413	26	13,248	500.00	75.00	50.00	229.25	49.33	13.95	6.53	6.65	152.79	2,024,167	1,181,081
2022	4,810	8,413	26	13,248	500.00	75.00	50.00	229.25	49.33	13.95	6.53	6.65	152.79	2,024,167	1,093,594
2023	4,810	8,413	26	13,248	500.00	75.00	50.00	229.25	49.33	13.95	6.53	6.65	152.79	2,024,167	1,012,587
2024	4,810	8,413	26	13,248	500.00	75.00	50.00	229.25	49.33	13.95	6.53	6.65	152.79	2,024,167	937,581
2025	1,109	3,168	20	4,297	500.00	75.00	50.00	184.58	49.33	23.16	14.38	5.35	92.36	396,874	170,213
2026	1,109	3,168	20	4,297	500.00	75.00	50.00	184.58	49.33	23.16	14.38	5.35	92.36	396,874	157,604
2027	1,109	3,168	20	4,297	500.00	75.00	50.00	184.58	49.33	23.16	14.38	5.35	92.36	396,874	145,930
2028	1,109	3,168	20	4,297	500.00	75.00	50.00	184.58	49.33	23.16	14.38	5.35	92.36	396,874	135,120
2029	1,109	3,168	20	4,297	500.00	75.00	50.00	184.58	49.33	23.16	14.38	5.35	92.36	396,874	125,111
2030	1,109	3,168	20	4,297	500.00	75.00	50.00	184.58	49.33	23.16	14.38	5.35	92.36	396,874	115,844
2031	1,109	3,168	20	4,297	500.00	75.00	50.00	184.58	49.33	23.16	14.38	5.35	92.36	396,874	107,263
2032	1,109	3,168	20	4,297	500.00	75.00	50.00	184.58	49.33	23.16	14.38	5.35	92.36	396,874	99,317
2033	1,109	3,168	20	4,297	500.00	75.00	50.00	184.58	49.33	23.16	14.38	5.35	92.36	396,874	91,961
2034	1,109	3,168	20	4,297	500.00	75.00	50.00	184.58	49.33	23.16	14.38	5.35	92.36	396,874	85,149
2035	930	3,762	69	4,761	500.00	75.00	50.00	157.67	49.33	11.94	10.39	4.57	81.44	387,683	77,015
2036	930	3,762	69	4,761	500.00	75.00	50.00	157.67	49.33	11.94	10.39	4.57	81.44	387,683	71,311
2037	930	3,762	69	4,761	500.00	75.00	50.00	157.67	49.33	11.94	10.39	4.57	81.44	387,683	66,028
2038	930	3,762	69	4,761	500.00	75.00	50.00	157.67	49.33	11.94	10.39	4.57	81.44	387,683	61,137
2039	930	3,762	69	4,761	500.00	75.00	50.00	157.67	49.33	11.94	10.39	4.57	81.44	387,683	56,609
2040	930	3,762	69	4,761	500.00	75.00	50.00	157.67	49.33	11.94	10.39	4.57	81.44	387,683	52,415
2041	930	3,762	69	4,761	500.00	75.00	50.00	157.67	49.33	11.94	10.39	4.57	81.44	387,683	48,533
2042	930	3,762	69	4,761	500.00	75.00	50.00	157.67	49.33	11.94	10.39	4.57	81.44	387,683	44,938
2043	930	3,762	69	4,761	500.00	75.00	50.00	157.67	49.33	11.94	10.39	4.57	81.44	387,683	41,609
2044	930	3,762	69	4,761	500.00	75.00	50.00	157.67	49.33	11.94	10.39	4.57	81.44	387,683	38,527
2045	839	4,092	109	5,040	500.00	75.00	50.00	145.22	49.33	11.28	9.81	4.21	70.59	355,781	32,738
2046	839	4,092	109	5,040	500.00	75.00	50.00	145.22	49.33	11.28	9.81	4.21	70.59	355,781	30,313
2047	839	4,092	109	5,040	500.00	75.00	50.00	145.22	49.33	11.28	9.81	4.21	70.59	355,781	28,067
2048	839	4,092	109	5,040	500.00	75.00	50.00	145.22	49.33	11.28	9.81	4.21	70.59	355,781	25,988
2049	839	4,092	109	5,040	500.00	75.00	50.00	145.22	49.33	11.28	9.81	4.21	70.59	355,781	24,063
2050	839	4,092	109	5,040	500.00	75.00	50.00	145.22	49.33	11.28	9.81	4.21	70.59	355,781	22,281
2051	839	4,092	109	5,040	500.00	75.00	50.00	145.22	49.33	11.28	9.81	4.21	70.59	355,781	20,630
2052	839	4,092	109	5,040	500.00	75.00	50.00	145.22	49.33	11.28	9.81	4.21	70.59	355,781	19,102
2053	839	4,092	109	5,040	500.00	75.00	50.00	145.22	49.33	11.28	9.81	4.21	70.59	355,781	17,687
2054	839	4,092	109	5,040	500.00	75.00	50.00	145.22	49.33	11.28	9.81	4.21	70.59	355,781	16,377
2055	1,175	3,863	115	5,153	500.00	75.00	50.00	171.34	49.33	11.03	9.60	4.97	96.41	496,761	21,173
2056	1,175	3,863	115	5,153	500.00	75.00	50.00	171.34	49.33	11.03	9.60	4.97	96.41	496,761	19,604
2057	1,175	3,863	115	5,153	500.00	75.00	50.00	171.34	49.33	11.03	9.60	4.97	96.41	496,761	18,152
2058	1,175	3,863	115	5,153	500.00	75.00	50.00	171.34	49.33	11.03	9.60	4.97	96.41	496,761	16,807
2059	1,175	3,863	115	5,153	500.00	75.00	50.00	171.34	49.33	11.03	9.60	4.97	96.41	496,761	15,562
2060	1,175	3,863	115	5,153	500.00	75.00	50.00	171.34	49.33	11.03	9.60	4.97	96.41	496,761	14,410
2061	1,175	3,863	115	5,153	500.00	75.00	50.00	171.34	49.33	11.03	9.60	4.97	96.41	496,761	13,342
2062	1,175	3,863	115	5,153	500.00	75.00	50.00	171.34	49.33	11.03	9.60	4.97	96.41	496,761	12,354
2063	1,175	3,863	115	5,153	500.00	75.00	50.00	171.34	49.33	11.03	9.60	4.97	96.41	496,761	11,439
2064	1,175	3,863	115	5,153	500.00	75.00	50.00	171.34	49.33	11.03	9.60	4.97	96.41	496,761	10,592
2065-2114															177,138
Total															15,941,776

ATTACHMENT K

Mailliard Ranch Modeling Plan

By Jim Clark, RPF #2528

October 15, 2015

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Growth and Yield Modeling:

The growth and yield modeling described in this modeling plan is performed using the FORSEE model and the AllCA_ResLib resource library, and is based on the following:

Plot Data:

The modeling presented in this document is based on cruise plots installed in 2015 across the Mailliard Ranch project area. A new inventory is in the process of being installed. This inventory design is described in Section VII of the Listing Application and in the Inventory Specifications included as Attachment L to the Listing Application. This modeling plan will be updated once the new inventory has been completed.

Updating the Inventory:

The inventory methodology included as Attachment L to the Listing Application provides a detailed description of the method of maintaining an up to date inventory for the Mailliard Ranch project.

Volume Calculations:

Conifer board foot volume calculations presented in Table 5a below utilize the standard FORSEE volume equations. Reported volumes are in board feet Scribner Scale for all conifers 8.5 inches DBH and larger. The FIA volume and biomass equations described in the Listing Application are used for the calculation of all carbon stock values presented below.

Biomass Calculations:

Biomass calculations utilized in the modeling are described in detail in the Listing Application. The Listing Application lists all of the species specific volume and biomass equations utilized which are in compliance with the Forest Project Protocol.

Adjusting the Inventory Data to the Project's Start Date and the end of the Initial Reporting Period:

The Listing Application and Inventory Methodology describe the method by which a stratified inventory was constructed for the purpose of identifying timber strata. The 2015 cruise data will be adjusted to the Project's start date and end of the initial reporting period by adjusting the height and diameter of each tree in the inventory database based on applying a percentage of the average height and diameter increment produced by growing the plot data forward five years in FORSEE.

Calibration:

The FORSEE model allows the assignment of 'calibration' factors to each species for height, DBH, and crown growth and mortality. Calibration factors are applied to certain harvest regimes in order to adjust the model output to local conditions. The harvest regimes described in Table 3b below do not use calibration with the exception of the "No-Harvest" regime (R9). As FORSEE was never designed to perform 100-year no-harvest analyses, a basal area calibration of 0.75 was applied to all species. If the "No-Harvest" regime were allowed to run uncalibrated, the resulting carbon stocking levels at the end of the 100-year baseline analysis period would be unrealistically high.

Missing Volume:

The inventory data upon which the baseline growth and yield analysis is based gathered data on missing volume from trees with broken tops, or from trees that included defects that reduced the tree's net carbon value. FORSEE outputs all growth and yield results in terms of gross volume or biomass. The carbon stock values presented in the Listing Application as of the project commencement date, and the end of the initial reporting period are net of the missing volume recorded in the inventory data. In order to represent this missing volume in the baseline analysis, the average percentage of missing standing live carbon stocks as of the Project start date are used to reduce the baseline growth and yield output from FORSEE.

Ingrowth:

Ingrowth in FORSEE is handled through the sprouting of species such as tanoak, madrone, black oak and white oak, and the addition of regeneration to bring the stand up to a minimum Forest Practice point count. The

sprouting function in FORSEE (FSE.fsprout) was set to sprout 20% of sprouting species, as well as bringing the point count up to specific point count levels per acre using the FORSEE point count regeneration function (FSE.fRegen_PtCount). Redwood was not included in sprouting species because the FORSEE point count regeneration function was used to moderate ingrowth.

Site Index:

In order to conduct growth modeling for the baseline analysis, it will be necessary to develop an estimate of average 50-year base age site index by species for the Project Area. FORSEE calculates 50-year base age site index for all species on the project area based on estimated 50-year site index for Douglas-fir.

Douglas-fir 50-year site index for the project area will be taken from site index data provided by the Soil Survey of Mendocino County Western Part for Douglas-fir and is based on 100-year base age site indices from Technical Bulletin No. 201 (McArdle and Meyer, 1961). The average 100-year site index values from Bulletin 201 are converted to King's 50-year base age site index values using Table 1 from Research Note No 10 (Watson, Krumland, Wensel, 1979).

The average site index values by soil type as developed above are used to calculate an average site index for each stand type found on the Mailliard Ranch Project by calculating the weighted average site index based on the acres of each soil type in a given stand type. Average site index by soil type will be used as a method of capturing the variability of site potential across each stand type. The average Douglas-fir 50-year base age site index for each stand type will be provided in Table 3a in the initial OPDR.

Project Acreage:

The Mailliard Ranch Project is comprised of approximately 12,361 acres of timberland. The topographic map included in Attachment E of the Project Application shows the Project Area boundary. Attachment E also includes GIS data in the form of a KMZ file that includes the Project Area boundary.

Baseline Modeling:

The baseline modeling utilizes the above-described 2015 plot dataset, and an unevenaged management harvesting strategy employing selection, transition and rehabilitation of understocked stands combined with small group openings not exceeding 2.5 acres in size. Portions of Mailliard Ranch timber stands are dominated by hardwoods species, or are in an understocked condition. The baseline modeling assumes an aggressive treatment of hardwood species in order to release existing conifer regeneration, and convert areas dominated by hardwoods to conifer occupation. This reduction is accomplished through rehabilitation and hardwood release treatments.

At the Project's initiation on 3/24/2015 there was one approved Timber Harvest Plans (THPs) on the Project Area.

Baseline Harvest Strategy:

The baseline harvest strategy relies on the application of a series of harvest regimes across the Project Area timber stands. The regimes are modeled at the plot level and the growth and yield data is converted to stand level data. This group-selection harvest strategy results in the eventual harvest in small groups of those areas of the property located outside of WLPZs and no-harvest reserve areas within an 80-year period. Table 3b below describes the harvest regimes applied across the Mailliard Ranch timber stands. The final baseline growth and yield analysis is determined by applying a percentage of each regime to each timber stand type.

The silvicultural prescriptions incorporated into the regimes are designed to best accommodate local timber stand conditions, while complying with the Forest Practice Rules as well as all other legal requirements. To accomplish this, a harvest strategy has been developed that evaluates each plot's stocking status in square feet of basal area per acre and point count stocking. Tables 4a-4c below illustrate the silviculture decision matrix upon which the growth and yield modeling is based. Harvesting under selection-transition, utilizes a BDq harvest strategy.

The "Bdq" formula is commonly used to describe the stand structure of uneven-aged forest stands and has been described extensively in the scientific literature. BDq refers to the stand structure with, in order of relative importance: B, the residual basal area; D, the maximum retained diameter class; and q, the ratio of the number of trees in adjacent (one inch) diameter classes.

Table 3b: Harvest Regime Descriptions

Regime	Harvest Scenario Description
R1	This regime applies the silvicultural parameters outlined in tables 4a through 4c below. Simulates group selection by assigning plots to be group-selected in a given decade.
R9	No-harvest prescription applied to watercourse core zones and NSO activity centers. Assumes a basal area calibration of 0.70 for all species.
R10	WLPZ harvest / NSO Nesting/Roosting prescription. Performs selection harvest every decade while retaining a minimum of 150 square feet of conifer and hardwood basal area per acre, and 60% canopy.
R2	NSO Foraging Habitat prescription. Performs selection harvest every decade while retaining a minimum of 82 square feet of conifer and hardwood basal area per acre and 40%-100% canopy.

General Harvest Constraints:

Harvest on the Mailliard Ranch Project is constrained by several factors. Firstly, the California Forest Practice Rules (FPR) create a minimum set of silvicultural standards below which harvest cannot occur.

Legal requirements include all laws, regulations, and legally-binding commitments applicable to the Project Area at the time of the project's initiation that could affect standing live carbon stocks. Mailliard Ranch is subject to the Z'berg- Nejedly Forest Practice Act of 1973 (FPA) and the corresponding Forest Practice Rules (FPR).

The rules that specifically effect the determination of baseline are those that include limits to silviculture activities. This includes the requirements for minimum basal area retention, rotation ages, harvest adjacency restrictions, watercourse buffer widths and sustained yield requirements.

The pertinent rules include the following:

- 14 CCR 913.11(c): Maximum Sustained Production of High Quality Timber Products;
- 14 CCR 913.2: Minimum basal area retention standards for Unevenaged Regeneration Methods;
- 14 CCR 913.2 (a)(2)(B): Group selection harvest limitations;
- 14 CCR 913.2 (b)(6): Minimum post-harvest residual basal area retention standards for the Transition method;
- 14 CCR 913.4 (b): Standards for rehabilitation of Understocked Areas;
- 14 CCR 913.1 (c): Standards for Seed Tree Seed Step;
- 14 CCR 916.5: Procedure for Determining Watercourse and Lake Protection Zone (WLPZ) Widths and Protective Measures;
- 14 CCR 916.9: Details harvest limitations for Watercourse and Lake Protection Zones around Class 1, 2 and 3 streams;
- 14 CCR 919.9: Northern Spotted Owl
- 14 CCR 912.7(b): Resource Conservation Standards for Minimum Stocking

The methods by which the Forest Practice Rule constraints listed above as well as other legally binding constraints are incorporated into the baseline harvest scenario are described in the following sections.

Constraints Analysis:

Characterization:

Timber harvesting was modeled over 100 years for the baseline scenario, taking legal constraints, financial feasibility, and physical limitations into consideration while maintaining average live above-ground carbon stocks above the minimum baseline level. Forest stand development was projected using a combination of uneven-aged systems to create multi-aged conditions depending on the arrangement of treatment types over space and time. Forest stands were subject to treatment types based primarily on their forest structure and site attributes as it relates to the California Forest Practice Rules, e.g. Timber Site III vs. Timber Site IV or designated northern spotted owl (NSO) habitat vs. non-designated NSO habitat.

Baseline Legal Constraints:

Constraints that affect land-use specific to forest management activities have been incorporated into the carbon modeling. For this project, legal constraints have the greatest effect on timber harvesting levels, as opposed to what is financially feasible or physically possible. These legal constraints dictate what types of silvicultural activities (treatment types) are allowed, and where (spatial) and when (temporal) they are allowed, that is, there are different legal constraints for different locations of the project area.). There are four general constraint types that determine what treatments are operable for any given area: 1) Timber Site; 2) NSO designated habitat; and 3) Water and Lake Protection Zones; and 4) Watercourse core zones. Each constraint, and how it is applied in the modeling, is described below by constraint class.

Northern Spotted Owl:

Two NSO activity centers are associated with the Mailliard Ranch Forest Project Area.

Harvest activity is restricted using the following parameters taken from guidance from the US Fish and Wildlife Service “Northern Spotted Owl Take Avoidance Analysis and Guidance For California Coast Forest District” (“Attachment A”), March 15, 2011.

These restrictions are summarized as follows:

Within the 0.7 mile radius (985 acres) of each Activity Center:

- 1) Retain habitat to maximize attributes desirable for NSO.
- 2) Retain at least 500 acres of suitable (Nesting /Roosting/Foraging) NSO habitat, post-harvest, as follows:
 - a) Retain 200 acres of Nesting/Roosting habitat within a 0.7 mile radius of the Activity Center consisting of:
 - i) 100 acres of the 200 acres of Nesting /Roosting habitat retained should be contiguous, or contiguous as possible with the Activity Center.
 - ii) An Additional 100 acres of Nesting/Roosting habitat within the 0.7 mile radius:
 - 1) If the second 100 acres of Nesting/Roosting habitat is also contiguous with the Activity Center, or within the same drainage, operations should retain a minimum of 66% of the pre-harvest basal area per acre of trees at least 11" DBH.
 - 2) If the remaining 100 acres of Nesting/Roosting habitat is not contiguous with the Activity Center, retain at least Nesting/Roosting habitat.
 - b) Retain at least 300 acres of Suitable NSO habitat, post-harvest, of at least Foraging quality.
- 3) Remove no more than 1/3 of the remaining suitable habitat in excess of 500 acres within 0.7 miles of an Activity Center during the life of timber operations.

NSO Habitat Definitions:

Activity Center (AC): Area of concentrated activity of either a pair of NSO or a single territorial NSO, represented by a mapped location (e.g., usually a nest tree) that occurs within, but not necessarily in the exact center of, the "Core Area," defined below.

Core Area: 100 acres of the 200 acres of Nesting/Roosting habitat retained within a 0.7 mile radius contiguous with the Activity Center. If 100 acres of contiguous Nesting/Roosting is not available, then the highest quality habitat available shall be included.

Foraging Habitat: Habitat that contains $\geq 40\%$ canopy cover of trees that are $\geq 11"$ DBH (diameter at breast height), and have a basal area ≥ 75 square feet per acre of trees $\geq 11"$ DBH. Trees may be conifer or hardwood.

Nesting/Roosting Habitat: Forested habitat that supports successful nesting and associated roosting behavior by NSO. Habitat with $\geq 60\%$ canopy cover of trees that are $\geq 11"$ DBH, and have a basal area ≥ 100 square feet per acre of trees $\geq 11"$ DBH. Trees may be conifer or hardwood.

Regimes R2, R9, and R10 have been designed to retain the required basal area and tree sizes as described in tables 4a-4c below for each respective NSO habitat type description. A buffer analysis around the NSO activity centers was conducted to ensure that the required acreage of each type of NSO habitat was retained in the required quantity.

Within 1000 feet of each AC, no harvest was modeled and stratum acreage within this 1000' buffer distance are assigned to the R9 regime. Within a 0.7 mile radius of the AC, acreage was assigned to either the R2 or R10 regime while considering proximity to the NSO activity center. Areas classified as the R10 regime were selected from stands in proximity to the 1000' AC buffer in order to create a contiguous core zone for each NSO. Stands classified as WLPZ buffer within the 0.7 mile buffer were not included in the assignment of R2/R10 regimes, but were spatially considered in the selection of stands to be retained as either R2 or R10. In general, areas designated as WLPZ were adjacent to stands selected as R2 or R10.

As a means of performing a conservative analysis of NSO habitat retention, 100% of stand acres assigned to the R10 regime within the 0.7 mile AC buffer are modeled as no harvest as a part of the final NSO harvest constraint analysis. This is felt to be conservative given the fact that some level of harvest is allowed within stands designated as NSO Nest/Roost habitat as long as sufficient acreage is retained.

Harvesting WLPZ Areas:

Utilizing the Mailliard Ranch GIS the acreage associated with class I and II WLPZs was determined. These WLPZ acres are harvested using a selection silvicultural prescription R10. Harvest levels within the WLPZ are designed to meet FPR standards for shade canopy retention. FPR requirements for the retention of the largest trees, and restrictions on harvests within the channel zone are addressed by adhering to harvest methods allowed by zone and slope

pursuant to 14 CCR 916.9 as indicated in tables 3d through 3g from the Forest Practice Rules, shown below.

Based on average slope adjacent to Class I and II watercourses, a horizontal buffer distance of 100 feet was applied to either side of Class I watercourses and Class II Large watercourses, and a horizontal buffer distance of 85 feet was applied to either side of Class II Standard watercourses. Across the Mailliard Ranch Project Area, this buffer analysis resulted in 214.27 acres located within class I or II WLPZs not including the class I and II core zones. This represents approximately 12.2% of the unconstrained timbered acreage. Overall, WLPZ areas represent approximately 16.8% of the total timbered acreage

As with Class I and II core zones, in some instances, NSO no-harvest areas are coincident with WLPZ zones.

Additional Assignments to the R10 Regime:

After treating 100% of stand acres assigned to the R10 regime within the 0.7 mile AC buffer as no harvest, average standing live above ground stocks for the next 100 years were still slightly below the minimum baseline level. To compensate, 1.219% of the acreage in each strata was reassigned from the R1 regime to the R10 regime.

Table 3c: Acres by Regime following NSO, Core Zone, WLPZ Buffer Analysis, and MBL Adjustment

[THIS DATA WILL BE PROVIDED IN THE INITIAL OPDR]

Table 3d: Procedure for Determining WLPZ Widths and Protective Measures Class I WLPZs - Confined Channels - Coastal Anadromy Zone

Pursuant to 14 CCR 916.9 (f)(2)						
Zone Designation	Zone width (ft.)	Overstory Canopy Cover		Large Tree Retention	Silviculture Requirements	Operational Requirements
Channel Zone	Variable	Retain all trees except per 916.9 [936.9, 956.9](e)(1) A-F or 916.9 [936.9 956.9] (v)		Retain all trees except per 916.9 [936.9, 956.9](e) (1) A-F or 916.9 [936.9 956.9] (v)	Retain all trees except per 916.9 [936.9, 956.9] (e) (1) A-F or 916.9 [936.9, 956.9](v)	No timber operations except per 916.9 [936.9, 956.9] (e) (1)A-F or 916.9 [936.9, 956.9](v);
Core Zone per 916.9 [936.9 956.9] (f)(2)(A)	30 ft.	Retain all trees except per 916.9 [936.9, 956.9](e) (1)A-F or 916.9 [936.9 956.9] (v)		Retain all trees except per 916.9 [936.9, 956.9](e)(1) A-F or 916.9 [936.9 956.9] (v)	Retain all trees except per 916.9 [936.9, 956.9] (e) (1) A-F or 916.9 [936.9, 956.9](v); no sanitation salvage except 916.9 (s)(t)and (u).	No timber operations except per 916.9 [936.9, 956.9] (e) (1) A-For 916.9 [936.9, 956.9](v);
Inner Zone per 916.9 [936.9 956.9] (f)(2)(B)	70 ft.	80% Coast and Southern Forest District of Coastal Anadromy Zone per 916.9 [936.9 956.9] (f)(2)(B)3.	70% in Northern Forest District of Coastal Anadromy Zone per 916.9 [936.9 956.9] (f)(2)(B)3.	13 largest trees /ac. per 916.9 [936.9 956.9] (f)(2)(B)4.	Increase QMD; No sanitation salvage except 916.9 (s)(t)and (u); commercial thinning or single tree selection only.	Preferred Management Practices in 916.9[936.9, 956.9] (f)(2)(D)
Outer Zone per 916.9 [936.9 956.9] (f)(2)(C) Outer Zone applicable only where even-aged regeneration used adjacent to the WLPZ	50 ft.	50% per 916.9 [936.9 956.9] (f)(2)(C).1.		NA	Commercial thinning or single tree selection only; Retain wind firm trees.	Preferred Management Practices in 916.9[936.9, 956.9] (f)(2)(D)
Special Operating Zone per 916.9 [936.9 956.9] (f)(2)(E)	50 ft.	NA		NA	SOZ applicable only where even-aged regeneration used adjacent to the WLPZ . Retain understory and midstory trees per 916.9 [936.9, 956.9] (f)(2)(E)	All other Forest Practice Rules

Table 3e: Procedure for Determining WLPZ Widths and Protective Measures Class I WLPZs – with flood prone areas or channel migration zones						
Pursuant to 14 CCR 916.9 (f)(3)						
Zone Designation	Zone width (ft.)	Overstory Canopy Cover		Large Tree Retention	Silviculture Requirements	Operational Requirements
Channel Zone or Channel Migration Zone per 916.9 [936.9 956.9] (f)(3)(A)	Variable	Retain all trees except per 916.9 [936.9, 956.9](e) (1)A-F or 916.9 [936.9 956.9] (v)		Retain all trees except per 916.9 [936.9, 956.9](e) (1)A-F or 916.9 [936.9 956.9] (v)	Retain all trees except per 916.9 [936.9, 956.9] (e) (1) A-F or 916.9 [936.9, 956.9](v)	No timber operations except per 916.9 [936.9, 956.9] (e)(1) A-For 916.9 [936.9, 956.9](v);
Core Zone per 916.9 [936.9 956.9] (f)(3)(B)	30 ft.	Retain all trees except per 916.9 [936.9, 956.9](e) (1)A-F or 916.9 [936.9 956.9] (v)		Retain all trees except per 916.9 [936.9, 956.9](e) (1)A-F or 916.9 [936.9 956.9] (v)	Retain all trees except per 916.9 [936.9, 956.9] (e) (1) A-F or 916.9 [936.9, 956.9](v); no sanitation salvage except 916.9 (s)(t)and (u).	No timber operations except per 916.9 [936.9, 956.9] (e) (1)A-For 916.9 [936.9, 956.9](v);
Inner Zone A per 916.9 [936.9 956.9] (f)(3)(C)	Minimum 70 ft. Maximum 120 ft.	80% Coast and Southern Forest District of Coastal Anadromy Zone per 916.9 [936.9 956.9] (f)(3)(C)3.	70% in all other watersheds per 916.9 [936.9 956.9] (f)(3)(C)3.	13 largest trees /ac. per 916.9 [936.9 956.9] (f)(3)(C)4.	Increase QMD; No sanitation salvage except 916.9 (s)(t)and (u); commercial thinning or single tree selection only.	Preferred Management Practices in 916.9 [936.9, 956.9] (f)(3)(E)
Inner Zone B per 916.9 [936.9 956.9] (f)(3)(D)	Variable: distance from Inner Zone A to end of FPA.	50%		13 largest trees /ac. per 916.9 [936.9 956.9] (f)(3)(D)1.	Increase QMD; No sanitation salvage except 916.9 (s)(t)and (u); commercial thinning or single tree selection only.	Preferred Management Practices in 916.9[936.9, 956.9] (f)(3)(E)
Outer Zone per 916.9 [936.9 956.9] (f)(3)(F) Applicable only where even-aged regeneration used adjacent to the WLPZ	50 ft.	50%		NA	Commercial thinning or single tree selection only; Retain wind firm trees.	Preferred Management Practices in 916.9[936.9, 956.9] (f)(3)(E)

Table 3f. Core and Inner Zone widths.				
Water Class	Class II-S (feet)		Class II-L (feet)	
Geographic location	Watersheds in the coastal anadromy zone		Watersheds in the coastal anadromy zone	
Slope class	Core Zone (feet)	Inner Zone (feet)	Core Zone (feet)	Inner Zone (feet)
≤30%	15	35	30	70
30-50%	15	60	30	70
>50%	15	85	30	70

Table 3g: Procedures for Determining Watercourse and Lake Protection Zone Widths and Protective Measures ¹								
Pursuant to 14 CCR 916.5								
Water Class Characteristics or Key Indicator Beneficial Use	1) Domestic supplies, including springs, on site and/or within 100 feet downstream of the operations area and/or 2) Fish always or seasonally present onsite, includes habitat to sustain fish migration and spawning.		1) Fish always or seasonally present offsite within 1000 feet downstream and/or 2) Aquatic habitat for nonfish aquatic species. 3) Excludes Class III waters that are tributary to Class I waters.		No aquatic life present, watercourse showing evidence of being capable of sediment transport to Class I and II waters under normal high water flow conditions after completion of timber operations.		Man-made watercourses, usually downstream, established domestic, agricultural, hydroelectric supply or other beneficial use.	
Water Class	Class I		Class II		Class III		Class IV	
Slope Class (%)	Width Feet	Protection Measure	Width Feet	Protection Measure	Width Feet	Protection Measure	Width Feet	Protection Measure
					[see 916.4(c)] [see 936.4(c)] [see 956.4(c)]		[see 916.4(c)] [see 936.4(c)] [see 956.4(c)]	
<30	75	BDG	50	BEI	See CFH		See CFI	
30-50	100	BDG	75	BEI	See CFH		See CFI	
>50	150 ²	ADG	100 ³	BEI	See CFH		See CFI	
1 - See Section 916.5(e) for letter designations application to this table.								
2 – Subtract 50 feet width for cable yarding operations.								
3 – Subtract 25 feet width for cable yarding operations.								

Unevenaged Silviculture:

All forest stands in the project area are subject to retention standards for uneven-aged silviculture based on their "Timber Site" or site class. Forest stands in the project area of this constraint class must follow these terms at a minimum:

All forest stands where uneven-aged silviculture is applied shall maintain the minimum basal area retention thresholds of 125 square feet per acre for Site I stands and 75 square feet per acre for Site II and III stands and 50 square feet per acre for Site IV and V stands for selection silviculture, and 50 square feet per acre for transition silviculture for Site II and III stands.

Selection:

14 CCR 913.2: Minimum basal area retention standards for Unevenaged Regeneration Methods:

Unevenaged management is utilized to establish and maintain an unevenaged stand structure. Unevenaged management attributes include the establishment and/or maintenance of a multi-aged, balanced stand structure, promotion of growth on leave trees throughout a broad range of diameter classes, and encouragement of natural reproduction.

- a) Selection** Under the selection regeneration method, the trees are removed individually or in small groups sized from .25 acres to 2.5 acres.
- 1) Trees to be harvested or trees to be retained shall be marked by or under the supervision of the RPF prior to felling operations. When openings greater than .25 acres will be created, the boundaries of the small group(s) may be designated in lieu of marking individual trees within the small group areas. A sample area must be marked prior to a preharvest inspection for evaluation. The sample area shall include at least 10% of the harvest area up to a maximum of 20 acres per stand type which is representative of the range of conditions present in the area.
 - 2) Post harvest stand stocking levels shall be stated in the THP. The level of residual stocking shall be consistent with maximum sustained production of high

quality timber products. In no case shall stocking be reduced below the following standards:

A. Selection System.

1. On Site I lands at least 125 square feet per acre of basal area shall be retained.
2. On Site II and III lands at least 75 square feet per acre of basal area shall be retained.
3. On Site IV and V lands at least 50 square feet per acre of basal area shall be retained.
4. Unless the plan submitter demonstrates how the proposed harvest will achieve MSP pursuant to 14 CCR § 913.11 (a) or (b), the residual stand shall contain sufficient trees to meet at least the basal area, size, and phenotypic quality of tree requirement specified under the seed tree method.

B. Group Selection.

1. At least 80% of the stocked plots must meet the Basal Area stocking standards of 14 CCR 913.2(a)(2)(A).
 2. Not more than 20% of the stocked plots may meet stocking standards utilizing the 300 point count standard with trees that are at least 10 (ten) years old.
 3. An RPF or supervised designee may offset up to 8 plots per 40 plots where those plot centers are initially placed within small group clearings created during the current harvest. Unless substantially damaged by fire, the RPF or supervised designee shall not exclude small group clearings created by previous timber harvesting from the stocking survey.
 4. Unless the plan submitter demonstrates how the proposed harvest will achieve MSP pursuant to 14 CCR 913.11 (a) or (b), the residual stand shall contain sufficient trees to meet at least the basal area, size, and phenotypic quality of tree requirements specified under the seed tree method.
- 3) Within any THP, small group clearings under the selection method shall be separated by a logical logging area.

- 4) Following completion of timber operations (including site preparation) not more than 20 percent of the THP area harvested by this method shall be covered by small group clearings.

Transition:

14 CCR 913.2: Minimum basal area retention standards for Unevenaged Regeneration Methods:

- b) Transition.** The transition method may be used to develop an unevenaged stand from a stand that currently has an unbalanced irregular or evenaged structure. The transition method involves the removal of trees individually or in small groups from irregular or evenaged stands to create a balanced stand structure and to obtain natural reproduction.
- 1) Area for determination of preharvest seed tree retention levels shall be no greater than 20 acres in size.
 - 2) This method is to be used to increase stocking and improve the balance of age classes so as to allow the residual stand to be managed by the selection regeneration method. This method shall not be used more than two times for a stand. The RPF shall delineate areas previously treated by the transition method on the plan map.
 - 3) Stands suitable for the transition method contain adequate quantity and quality of seed producing trees to provide adequate regeneration for new age classes. Stands suitable for this method shall have no more than 50 sq. ft. of basal area greater than the selection basal area standards.
 - 4) Trees to be harvested or trees to be retained shall be marked by or under the supervision of a RPF before felling operations. A sample area must be marked before the preharvest inspection for evaluation. The sample area shall include at least 10% of the harvest area up to a maximum of 20 acres per stand type which is representative of the range of conditions present.
 - 5) Immediately following the completion of timber operations, the minimum basal area standards in 14 CCR 912.7(b)(2) shall be met.
 - 6) The post harvested residual stand shall contain at least 15 square feet of basal area per acre of seed

trees at least 12 inches dbh or greater for timber sites I, II or III; or 12 square feet of basal area per acre of seed trees 12 inches dbh or greater for timber sites IV or V. Unless obviously stocked, these basal area requirements will be determined from sampling averaged across each harvested area required in 14 CCR § 913.2(b)(1). Unless the plan submitter demonstrates how the proposed harvest will achieve MSP pursuant to 14 CCR § 913.11(a) or (b) [953.11(a) or (b)], where present in the preharvest stand, disease free, undamaged seed trees 18 inches dbh or greater shall be retained post harvest until the stand exceeds the minimum seed tree requirements of 14 CCR § 913.1(c)(1)(A). The seed trees shall be full crown, capable of seed production and representative of the best phenotypes available in the present stand.

- 7) Following completion of timber operations (including site preparation) not more than 20 percent of the Plan area harvested by this method shall be occupied by small group clearings.

14 CCR 912.7: Resource Conservation Standards for Minimum Stocking:

The following resource conservation standards constitute minimum acceptable stocking in the Coast Forest District after timber operations have been completed.

- b) An area on which timber operations have taken place shall be classified as acceptably stocked if either of the standards set forth in (1) or (2) below are met within five (5) years after completion of timber operations unless otherwise specified in the rules.
 - 2) The average residual basal area measured in stems 1 inch or larger in diameter, is at least 85 square ft. per acre on Site I lands, and 50 square ft. per acre on lands of Site II classification or lower. Site classification shall be determined by the RPF who prepared the plan.

Commercial Thinning:

14 CCR 913.3: Intermediate Treatments:

- a) **Commercial thinning.** Commercial thinning is the removal of trees in a young-growth stand to maintain or increase average stand diameter of the residual crop trees, promote timber growth, and/or improve forest health. The residual stand shall consist primarily of healthy and vigorous dominant and codominant trees from the preharvest stand.
- 1) Post harvest stand stocking levels shall be stated in the THP. The level of residual stocking shall be consistent with maximum sustained production of high quality timber products. Generally stands will develop stand structures with considerably higher levels of basal area than provided in these minimum standards as stand age increases. In no case shall stocking be reduced below the following standards:
 - A. Where the preharvest dominant and codominant crown canopy is occupied primarily by trees greater than 14 in. DBH:
 1. On Site I lands, at least 125 sq. ft. per acre of basal area shall be left.
 2. On Site II and III lands, at least 100 sq. ft. per acre of basal area shall be left.
 3. On Site IV lands, at least 75 sq. ft. per acre of basal area shall be left.
 4. On Site V lands, at least 50 sq. ft. per acre of basal area shall be left.
 - B. Where the preharvest dominant and codominant crown canopy is occupied primarily by trees less than 14 in. DBH, a minimum of 100 trees per acre over 4 in. DBH shall be retained for site I, II and III. For site IV and V - 75 trees per acre over 4 in. dbh shall be retained.

Rehabilitation of Understocked Areas:

14 CCR 913.3: Special Prescriptions:

The following special harvesting methods are appropriate under certain conditions:.

- b) **Rehabilitation of Understocked Area Prescription.** For the purposes of restoring and enhancing the productivity of commercial timberlands which do not meet the stocking standards defined in 14 CCR 912.7 prior to any timber operations on such lands, an area may be harvested provided it

is restocked in accordance with Subsections (1) or (2). To facilitate restocking, a regeneration plan must be included in the THP. The regeneration plan shall include site preparation, method of regeneration, and other information appropriate to evaluate the plan.

- 1) If the area meets the standards of 14 CCR 912.7 within five years of completion of timber operations, the area shall be considered acceptably stocked, or shall be considered acceptably stocked if it contains at least 10 planted countable trees for each tree harvested on sites I, II, and III, and 5 planted countable trees for each tree harvested on site IV and V.
- 2) On understocked timberlands where no countable conifer trees are to be harvested and the broadleaf species are not designated for management, the area shall be planted to equal or exceed the stocking standards of 14 CCR 912.7(b)(1) [932.7(b)(1), 952.7(b)(1)] and shall be considered acceptably stocked if within five years of completion of timber operations it contains at least an average point count of 150 of Group A species on all site classifications.

This overall constraint is emulated in the baseline by setting a minimum basal area target for uneven-aged stands when they are treated. Approximately 6% of the Project Area is harvested as small groups each decade of the 100-year baseline analysis period during the second period on.

MSP:

All forest stands and baseline activities in the project area are subject to the Maximum Sustained Production (MSP) of High Quality Timber Products section of the California Forest Practice Rules. It is assumed in the baseline model that MSP is achieved pursuant to 14 CCR 913.11(c)(2) and (3), paraphrased below:

- 2) For uneven-aged management, complying with the seed tree retention standards, meeting minimum stocking and basal area standards for the selected silvicultural methods as contained in the Forest Practice Rules only with group A species, and protecting the soil, air, fish and wildlife, water resources and

other public trust resources through the application of these rules.

- 3) For intermediate treatments and special prescriptions, complying with the stocking requirements of the individual treatment or prescription.

This overall constraint is emulated in the baseline by requiring that selection and transition harvest retain at least 15 square feet of conifer basal area in trees 18" DBH or larger for site class III areas, and 12 square feet of conifer basal area in trees 18" DBH or larger and that rehabilitation and commercial thinning harvests meet the minimum stocking standards of the Forest Practice Rules.

Hardwood Harvest:

The Mailliard Ranch's hardwood reduction program calls for the manipulation of hardwood stocking levels through, manual or mechanical treatments or commercial harvest, or basal herbicide treatments as appropriate. Understocked portions of the Project Area were modeled as a rehabilitation harvest per 14 CCR 913.4(b).

Baseline Harvest Summary:

Treatment types, or silviculture systems, were applied to forest stands in the baseline model such that they followed the silvicultural method objectives in Article 3 of the Forest Practice Rules and as additionally described in this section. Specifically, these treatments included selection, transition, commercial thinning, and rehabilitation of understocked stands. Treatments were selected and scheduled in the baseline based on legal constraint(s) and stocking.

Non-Commercial Treatments:

Portions of the Mailliard Ranch's timberlands exist in a condition that does not permit current commercial timber harvest. These stands are composed of advanced conifer regeneration with varying levels of hardwood competition. The stands with the heaviest hardwood component are targeted for a "Release" treatment during the first decade of the planning period. For stands with lesser amounts of hardwood competition, or those stands where the hardwood component is too small to treat economically, no treatment is modeled in the baseline growth and yield analysis; however, Mailliard Ranch

may, at its discretion, undertake stand improvement treatments in these non-commercial stands. Non-commercial treatments may include hardwood reduction treatments and pre-commercial thinning of conifers.

The arrangement of these treatments over time and space create timber product value in both yields and appreciation and provide NSO habitat that is in line with the baseline scenario characterization and legal constraints. By the end of the baseline model, 292.67 acres remain un-treated as a result of being protected NSO habitat or restricted WLPZ areas. The application of the silvicultural regimes described below at the landscape level, yield an acceptable return on investment for the forest owner while maintaining compliance with the California Forest Practice Rules and NSO Take Avoidance protection measures. Overall, the baseline regime reflects maximum sustained productivity and a harvest and growth pattern that indefinitely serves multiple management objectives.

Standing Dead

The standing dead carbon pool represents approximately 1.6% of the total carbon found on the Project Area; however, standing dead levels are below the one metric ton test in the structural elements evaluation criteria under section 3.8.2 (Table 3.2) of the protocol. The standing dead carbon pool is treated as a static pool as a part of the baseline analysis. The level of the standing dead carbon pool on the Mailliard Ranch meets the minimum standards for Standing Dead per the Natural Forest Management requirements of the protocol; furthermore, as the baseline analysis involves ongoing forest management and maintenance of young and vigorous stands, standing dead levels are expected to be maintained at the current levels. It could be argued that the baseline harvesting scenario would remove poorly formed and suppressed trees, thus capturing mortality that would have otherwise occurred under a harvest scenario that removed fewer trees and less volume over time.

Silvicultural Prescriptions

The following tables show the silvicultural constraints designed to demonstrate conformance with the requirements of the Forest Practice Rules. Table 4b contains the parameters used to assign first period (decade) silviculture. Harvests in following decades is guided by the minimum retention values shown in table 4c.

Table 4a: Silvicultural Prescriptions used by the Mailliard Ranch Project

Regime	Prescription	Description
R1	Selection	The goal of this prescription is to create and maintain, multistoried, uneven-aged stands with varied diameter classes. Trees are harvested individually, or in small groups up to 2.5 acres in size.
	Transition	The goal of this prescription is to develop uneven-aged stands from stands that have an even-aged or irregular stand structure. Trees are harvested individually, or in small groups up to 2.5 acres in size.
	Rehabilitation	The goal of this prescription is to regenerate stands that are primarily experiencing excessive hardwood competition, and that also do not meet minimum stocking standards. Successive harvests will utilize uneven-aged silviculture.
	Hardwood Release	The goal of this prescription is to improve growth in stands that are primarily experiencing excessive hardwood competition, and that are also well stocked with conifer seedlings. Successive harvests will utilize uneven-aged silviculture.
	Commercial Thinning	To promote timber growth and improve forest health through the harvest of trees in a manner that results in a stand capable of being managed using single tree or group selection.
R9	No Harvest	This prescription is used to account for those portions of the Project Area where harvesting is prohibited.
R10	Single Tree Selection (WLPZ/NSO Nest Roost Habitat)	The goal of this prescription is to create and maintain dense, multistoried, uneven-aged stands with varied diameter classes while meeting the retention standards for NSO Nesting/Roosting Habitat.
R2	Single Tree Selection (NSO Foraging Habitat)	The goal of this prescription is to create and maintain dense, multistoried, uneven-aged stands with varied diameter classes while meeting the retention standards for NSO Foraging Habitat.

Table 4b: Pre-harvest Stand Conditions by Silvicultural Prescription

Regime	Prescription	Pre-Harvest Conifer Basal Area (Square Feet per Acre)		Other Pre-Harvest Considerations
		Lower Limit	Upper Limit	
R1	Selection Site Class II and III	125	None	Retain at least 15 square feet of basal area in trees 18” or larger.
	Selection Site Class IV	70	None	Retain at least 12 square feet of basal area in trees 18” or larger.
	Transition Site Class II and III	70	125	Retain at least 15 square feet of basal area in trees 18” or larger.
	Rehabilitation Site Class II and III	0	50	Less than 300 point count, at least 35 square feet of hardwood basal area.
	Rehabilitation Site Class IV	0	50	Less than 150 point count, at least 35 square feet of hardwood basal area.
	Hardwood Release	0	70	At least 300 point count, at least 100 square feet of hardwood basal area.
	Commercial Thinning Site Class II and III	100	None	At least 300 point count.
	Commercial Thinning Site Class IV	75	None	Less than 150 point count.
R9	No Harvest	None	None	
R10	Single Tree Selection (WLPZ/NSO Nest Roost Habitat)	None	None	At least 130 square feet of basal area in trees 11” or larger.
R2	Single Tree Selection (NSO Foraging Habitat)	None	None	At least 75 square feet of basal area in trees 11” or larger.

Table 4c: Post-harvest Stocking by Silvicultural Prescription

Regime	Prescription	Stocking Considerations	Conifer Basal Area Retention (sq. ft. per acre)	Hardwood Basal Area Retention (sq. ft. per acre)	Regeneration Assumptions	Time to Next Treatment
R1	Selection Site Class II and III	Less than 20% of stand in group openings, at least 15 sq. ft. >18" DBH	≥75	7	300 Point Count, Sprout 20%	At Least 10 Years
	Selection Site Class IV	Less than 20% of stand in group openings, at least 12 sq. ft. >18" DBH	≥50	7	150 Point Count, Sprout 20%	At Least 10 Years
	Transition Site Class II and III	Less than 20% of stand in group openings, at least 15 sq. ft. >18" DBH	≥50	7	300 Point Count, Sprout 20%	Selection within 10-20 Years
	Rehabilitation Site Class II and III		≥10 where conifer ≥10 pre-harvest	7	300 Point Count, Sprout 20%	Selection within 30-40 Years
	Rehabilitation Site Class IV		≥10 where conifer ≥10 pre-harvest	7	150 Point Count, Sprout 20%	Selection within 30-40 Years
	Hardwood Release	No Commercial Conifer Harvest	No Commercial Conifer Harvest	7	None	Selection within 20-40 Years
	Commercial Thinning Site Class II and III	≥ average stand diameter than pre-harvest stand	>100 if QMD >14" and 100 4"+ trees if QMD <14"	7	300 Point Count, Sprout 20%	Selection within 10-20 Years
	Commercial Thinning Site Class IV	≥ average stand diameter than pre-harvest stand	>75 if QMD >14" and 75 4"+ trees if QMD <14"	7	150 Point Count, Sprout 20%	Selection within 10-20 Years
R9	No Harvest	None	None		None	
R10	Single Tree Selection (WLPZ/NSO Nest Roost Habitat)	Retain at least 130 square feet of basal area in trees 11" or larger.	130	20	300 Point Count, Sprout 20% Hardwoods	At Least 10 Years
R2	Single Tree Selection (NSO Foraging Habitat)	Retain at least 75 square feet of basal area in trees 11" or larger.	75	7	300 Point Count, Sprout 20% Hardwoods	At Least 10 Years

Growth and Yield Analysis:

The baseline growth and yield analysis was modeled using the FORSEE model utilizing the above described harvest strategy. Table 5a shows the results of the growth and yield analysis in terms of conifer yields, while table 5b shows the results in terms of tonnes of live carbon for all species. Table 6 shows the results in terms of average basal area per acre over the 100 year planning horizon.

Table 5a: Average Annual per Acre Conifer Growth and Yield through the Planning Horizon (Scribner Board Feet per Acre)

[THIS DATA WILL BE PROVIDED IN THE INITIAL OPDR]

Table 5b: Average Annual per Acre Total Live Carbon Growth and Yield through the Planning Horizon (Mg C per Acre)

[THIS DATA WILL BE PROVIDED IN THE INITIAL OPDR]

Table 6: Average Basal Area per Acre through the Planning Horizon

[THIS DATA WILL BE PROVIDED IN THE INITIAL OPDR]

Table 7 presents the percentage of each silvicultural regime applied to the various timber stands for the entire baseline modeling analysis.

Table 7: Application of Silvicultural Regimes through the 100-year Planning Horizon

[THIS DATA WILL BE PROVIDED IN THE INITIAL OPDR]

Table 8 below shows the modeled standing live carbon stocks over the 100-year baseline analysis period, the projected standing dead carbon pool, and the resulting average baseline carbon stocks on a per acre basis. These figures are plotted in Figure 1 as well.

Baseline Carbon Stocks

The baseline modeling scenario defined in this document follows the guidelines presented in section 6.2 of the Compliance Offset Protocol U.S. Forest Projects, April 25, 2014.

Key components of the calculated baseline are as follows:

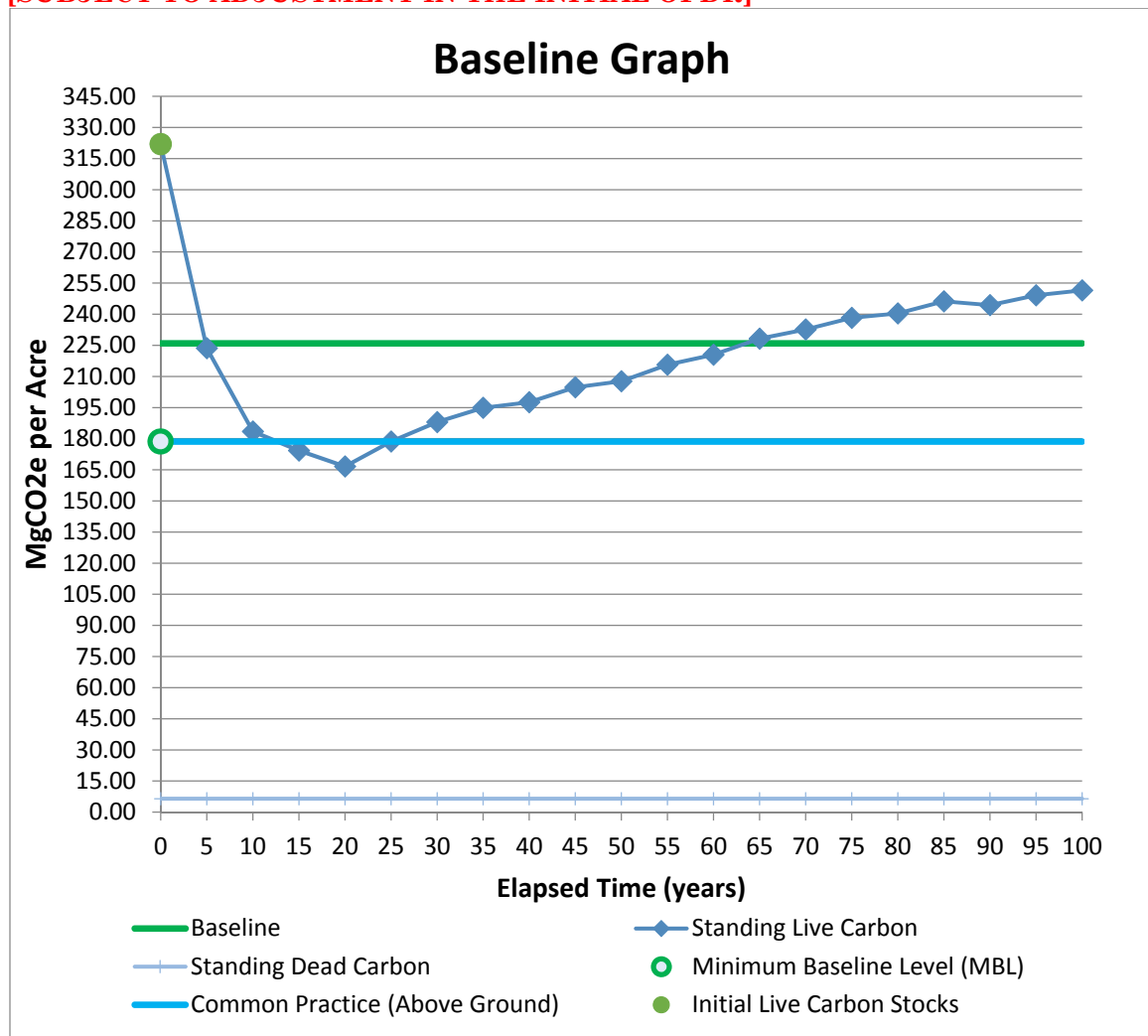
1. Initial Project live carbon stocks are above Common Practice.
2. The Project is not subject to the High Stocking Reference calculation.
3. Initial live carbon stocks have been modeled subject to all legal and financial constraints for a 100-year period.
4. The average carbon stocks of the 100-year baseline growth and yield modeling scenario have been calculated.
5. The average stocks of standing dead carbon over the 100-year period have been calculated.
6. The average production of In-Use carbon, landfill carbon, and harvested carbon prior to delivery to a mill have been calculated from the 100-year baseline growth and yield scenario.

Table 8: Average Baseline Carbon Stocks per acre Generated by the Baseline Harvest Scenario (Mg CO₂e per Acre).

[SUBJECT TO ADJUSTMENT IN THE INITIAL OPDR]

Elapsed Time	Standing Live Carbon Pool IFM-1	Standing Live Above Ground	Standing Live Below Ground	Standing Dead Carbon Pool IFM-3	Baseline
0	321.99	262.08	59.91	6.44	225.88
5	223.59	182.00	41.59	6.44	225.88
10	183.51	149.38	34.13	6.44	225.88
15	174.31	141.89	32.42	6.44	225.88
20	166.63	135.64	30.99	6.44	225.88
25	178.62	145.40	33.22	6.44	225.88
30	187.98	153.02	34.96	6.44	225.88
35	194.88	158.63	36.25	6.44	225.88
40	197.56	160.82	36.75	6.44	225.88
45	204.74	166.66	38.08	6.44	225.88
50	207.69	169.06	38.63	6.44	225.88
55	215.63	175.52	40.11	6.44	225.88
60	220.47	179.46	41.01	6.44	225.88
65	228.19	185.75	42.44	6.44	225.88
70	232.62	189.35	43.27	6.44	225.88
75	238.23	193.92	44.31	6.44	225.88
80	240.36	195.66	44.71	6.44	225.88
85	246.17	200.38	45.79	6.44	225.88
90	244.37	198.92	45.45	6.44	225.88
95	249.14	202.80	46.34	6.44	225.88
100	251.46	204.69	46.77	6.44	225.88
Average	219.44	178.62	40.82	6.44	225.88

Figure 1: Baseline Carbon Stocks
[SUBJECT TO ADJUSTMENT IN THE INITIAL OPDR]



Wood Products

The baseline growth and yield modeling produces a flow of wood products over the 100-year planning period. Table 9 below shows the average wood products generated over the 100-year period. Three average wood products numbers are presented: average wood products In-use, average wood products stored in landfills, and the average amount of carbon in standing live carbon stocks prior to delivery to a mill.

Table 9: Average Wood Products Carbon per acre Generated by the Baseline Harvest Scenario.

[SUBJECT TO ADJUSTMENT IN THE INITIAL OPDR]

Woods Products	Mg C/ acre	Total Mg CO2e
Average Annual Carbon 100-year In-Use	0.145	6,558.13
Average Annual Carbon 100-year Landfill	0.094	4,236.98
Average Annual Carbon in Harvested Trees Prior to Delivery to the Mill	0.998	45,209.53

ATTACHMENT L

MAILLIARD RANCH CARBON PROJECT INVENTORY METHODOLOGY

This document contains specifications for the collection of data in the field for the Mailliard Ranch Inventory, as well as the data to be collected and the standards for data collection and processing. The Mailliard Ranch Project includes approximately 12,360 acres of timberland characterized by Coastal Redwood, Douglas-fir, Tanoak, Pacific Madrone, true oak, and associated conifer and hardwood species. The Project Boundary includes the following GHG emission sources, GHG sinks, and GHG reservoirs (SSRs or Carbon Pools) as defined in table 5.1 of the Compliance Offset Protocol U.S. Forest Projects, November 14, 2014:

- IFM-1 Standing live carbon (carbon in all portions of living trees)
- IFM-3 Standing dead carbon (carbon in all portions of standing dead trees)
- IFM-7 Carbon in in-use forest products
- IFM-8 Forest product carbon in landfills
- IFM-14 Biological emissions/removals from changes in harvesting on forestlands outside the Project Area
- IFM-17 Biological emissions from decomposition of forest products

This Forest Carbon Inventory at its core consists of a systematic sampling of the timber stands found on the Mailliard Ranch Project. Sampling will be conducted utilizing a random selection of plots located across eight timber stratum. Plot locations were determined from a random selection of plots from a 5 chain by 5 chain grid that uniformly covers the entire Project Area. The final inventory design is expected to result in the installation of 357 plots across the Project Area.

The standard procedures for collecting field measurements are detailed below and are generally aimed at the collection of tree data pertaining to the quantification of the IFM-1 and IFM-3 carbon pools. Carbon in carbon pools IFM7, IFM-8, IFM-14, and IFM-17 are calculated as described in the calculation methodologies section below.

Inventory Methodologies

A description of the inventory methodology for each of the carbon pools listed above is included in the Application under section VII (A) and is included herein by reference. The data collection procedures for IFM-1 and IFM-3 SSRs are described in detail in the attached Mailliard Ranch Carbon Project Inventory Specification included as Appendix B.

Calculation Methodologies

A description of the calculation methodologies used to determine metric tons per acre of each of the carbon pools listed above is included in the Application under section VII (B) and is included herein by reference. Included are the analytic methods and biomass equation references used to translate field measurements into volume and biomass carbon estimates.

Data Management Systems and Data Processing

The inventory data gathered by this inventory methodology is entered into an Access database as described in the attached Mailliard Ranch Inventory Plot Data Entry Procedures (Appendix C). Plot data within the database was extensively sorted and queried to look for data entry errors. This process result in a final data set for cruise processing. The Access database serves as the repository for inventory data and is accessed by the growth and yield model during growth and yield simulations.

The inventory database is utilized to process the inventory data through the growth and yield model FORSEE. The calculation of volume, biomass and the ultimate conversion to carbon utilizes the inventory data and growth and yield output data and applies the volume formulas and biomass conversion factors described in section VII (B) of the Application as referenced above.

Management of inventory data over the life of the Project will include archiving of retired inventory data as the data exceeds the maximum plot life requirements prescribed by the Protocol. Archived inventory data will also include a copy of each inventory database used to develop those carbon stock estimates reported in each OPDR submitted for the Project. This series of archived inventory database files will serve as the repository of inventory data as it existed for each reporting period.

Stratification Methodology

The Mailliard Ranch Project Area was stratified based on species composition and relative stocking. The Project Area is dominated by Coastal redwood and Douglas-fir with varying levels of hardwood species, and other conifer species. Stratification was performed pre-sampling utilizing aerial photos with GIS system polygon overlays. Vegetation strata were verified utilizing historic and current field verification. Boundaries were established utilizing GIS overlays with sample stratification based on plot location within identified vegetation strata polygons. The strata boundaries were digitized into the Mailliard Ranch Geographical Information System utilizing orthophoto imagery as a guide. A map of the timber stand boundaries and inventory plot locations is included as Appendix D.

The stratification resulted in the following project acreages:

Table 1: Strata and Plot Summary

Stratum	Plots	Acres
C1	16	137.76
C2	36	975.89
C3	97	3,399.21
C4	21	923.55
C5	6	62.34
H1	51	1,219.99
H2	94	3,895.67
H3	36	1,746.26
Total	357	12,360.68

Quality Assurance/Quality Control (QA/QC)

Procedures for ensuring quality control are explained in the attached Mailliard Ranch Carbon Project Inventory Specifications document under the “Check Cruising” heading. Procedures in verifying the integrity of inventory data are described above.

Inventory Monitoring

Updating the Inventory

As timber management activities take place on the Mailliard Ranch Project Area or disturbance such as fire or mortality resulting from pathogens or other factors occurs, cruise plots installed in 2015 will be relocated and remeasured within areas that have been harvested, treated for hardwood reduction, or subject to disturbance. By 2027, all of the plots installed in 2015 will have been remeasured regardless of whether or not the plot had been harvested, treated for hardwood reduction, or subject to disturbance. On this basis, Mailliard Ranch will maintain a forest inventory system that will meet the inventory specifications and requirements contained in Appendix A of the Compliance Offset Protocol U.S. Forest Projects, with plots which are no more than 12 years old.

Updating the Project’s carbon stocks from the end of the last reporting period to the end of the current reporting period will involve the following steps:

1. Any newly installed inventory plots will be incorporated into the inventory estimate. Newly installed plots will be grown forward to the end of the reporting period utilizing FORSEE as described in the modeling plan.
2. Existing inventory plots that are less than 12 years old will be updated using FORSEE as described in the modeling plan. This update process will involve adjusting the plot data one year forward either by using FORSEE’s “Inventory Update” tool, or through the application of average annual increment based on diameter and height increment predicted by FORSEE over the next-five year period.
3. Plots older than 12-years will be replaced in the database by new plot data collected at the same plot location. Retired plot data will be archived as described in the Data Management Systems section above.
4. Updating the forest inventory for harvests or disturbances will involve either the installation of new plots, or adjustments to previous plot data.
 - a. If new inventory plots are installed, they will be installed at randomly selected plot locations taken from the 5x5 chain grid within the harvested or disturbed portion of the Project Area. The number of randomly selected plots will be determined based on the size of the area harvested or disturbed, and estimated carbon stock variability within the harvested or disturbed area.
 - i. Existing inventory plot data within the harvested or disturbed area will be removed from the inventory database.
 - ii. Harvested or disturbed areas will be stratified based on the current inventory stratification, or may be placed into a new stratum representing the harvested or disturbed area.

- b. At the discretion of the OPO, inventory updates may involve adjustments to existing plot data (depletions) that will involve the following steps:
 - i. The carbon in harvested wood products delivered to the mill will be calculated using the “Harvested Wood Products Worksheet” provided by CAR, and included as Appendix E herein.
 - ii. Using the ratio of harvested wood carbon to harvested tree carbon calculated in Table 8 of the CAR worksheet. The carbon in harvested wood products will be multiplied by this ratio to determine the total amount of carbon subject to harvest. This carbon will be subtracted from the carbon stock estimate derived through the inventory stock estimate generated by updating the existing inventory data as described above.
5. Disturbances related to fire, insect or disease, and unauthorized harvest will be monitored through annual inspections of the Project Area by the OPO. Portions of the Project Area affected by fire, insect or disease, or unauthorized harvest will be mapped and reported in the OPDR. If the mapped disturbed portion of the Project Area is less than 5 acres in cumulative size, no adjustment to the carbon stock inventory will be performed. For mapped disturbances between 5 and 40 acres of cumulative size, a depletion of the inventory based on the average stocking and acreage of each stratum disturbed will be calculated, or at the discretion of the OPO, new inventory plots may be installed following the procedures described in step 4(a) above. For mapped disturbances larger than 40 acres in cumulative size, new inventory plots will be installed following the procedures described in step 4(a) above.
6. The field collection of updated inventory data following harvest, hardwood reduction or disturbance will be conducted prior to the next field verification, and at a minimum within 36 months of the harvest or disturbance.
7. A revised inventory confidence deduction will be calculated each year following the update process.

Appendices:

- A. Inventory Change Log
- B. Mailliard Ranch Carbon Project Inventory Specification
- C. Mailliard Ranch Inventory Plot Data Entry Procedures
- D. Plot and Strata Map
- E. CAR Harvested Wood Products Worksheet

Appendix A

Inventory Change Log

[illegible]

Appendix B

Mailliard Ranch Carbon Project Inventory Specification

Mailliard Ranch Carbon Project Inventory Specification

September 4 2015

The cruise shall include the Mailliard property for a total of approximately 12,000 acres. The emphasis of the cruise is to develop timber stand and stock tables at the ownership level, calculate live carbon and standing dead carbon pools, and allow for growth and yield projections to be performed.

The cruise is based on a systematic sample of the ownership, and will include post-cruising stratification. The cruise design will install approximately 350 plots that were randomly selected from a systematic 5 chain by 5 chain grid that covers the entire project area.

Plot Documentation and Location: Cruisers will be supplied with maps that show the locations of the plots and plot numbers, air photo maps, and an electronic list of coordinates for plot centers (UTM).

It is the cruiser's responsibility to accurately locate plots within the accuracy tolerances specified (one chain). Plots will be located via a systematic list of GPS coordinates as supplied by NCRM and if necessary, due to lack of adequate GPS satellite reception, take-off points established by NCRM, and field measurement (hip chain, or electronic device). Handheld GPS equipment will be used to establish plot centers. As needed, plot take-off points will be monumented with black and red striped flagging hung with glo-orange, and a metal tag listing the plot number, and the distance and direction to the plot. The timber cruiser will navigate from the closest and easiest access point to the plot in question using the handheld GPS units. As needed and where it is not possible or practical to establish a road take-off point for a given plot, the plot shall be located based on the last plot cruised on the cruise line.

When navigating to a given plot with the handheld GPS unit, the cruiser will set a "proximity" alarm on the GPS unit. The first time that the GPS unit triggers the proximity alarm, the cruiser shall stop and note the best achievable distance and direction to the plot as indicated by the GPS unit. The cruiser shall then measure the distance to the plot center using a hand compass and steel tape, hip chain or electronic device.

Plots shall be measured where they fall regardless of roads, watercourses, or unmapped non-timbered areas. The cruise will be based on all acres within the timbered strata including roads and small non-timbered areas. Where plots are located adjacent to mapped non-timber areas or on boundaries between different timber types, cruise plot locations should be relocated in half-chain increments such that the plot is entirely within the timbered type. The plot center shall be moved in the cardinal direction most close to perpendicular to the type boundary. For such plots, a GPS coordinate of the actual plot center shall be recorded.

Mailliard Ranch Carbon Project Inventory Specification

Plot centers will be documented with a rebar stake (provided by NCRM) and flagging (tied to the stake) with the plot number written in rain proof ink. Rebar must be driven down deep enough to leave 2-3 inches above ground. If the plot center falls on an access road, the rebar must be driven completely in so the tip is just below the road surface and a hole must be dug just around it for access. A second long vinyl flag (at least 24" in length) with the plot number, date, and cruiser initials written in rain proof ink shall be hung on trees stems or branches over, or nearly over the plot center. The plot number shall be painted on the nearest tree to plot center of sufficient size. Certain "aesthetic plots" will not be painted; trees on such plots will be identified with tree tags nailed at breast height (BH). Flagging to establish plot center shall be glow lime green and provided by NCRM.

At each plot center, two plot reference trees at least 3.5" in diameter will be established near the cardinal directions for the purpose of relocating the plot center. These reference trees shall be established after performing all other measurements on the plot; a reference tree tag shall be placed on each reference tree within 1' of the ground line on the face of the tree which is facing plot center. The plot number shall be scribed on each reference tree tag. Species, azimuth and slope distance (rounded down to nearest 1/10th inch) from the nail hole on the reference tree to the plot center shall be recorded with the plot data. A ring shall be painted around the circumference of the reference tree at DBH to identify these trees and the plot in the future (excluding aesthetic plots). Paint color shall be glo-orange. Prior to leaving each plot, trees should be tallied and correlated to each tree recorded as a check.

Plot Card Format: Paper field data forms will follow the format of the attached sample cruise card. Cruiser shall fill out all appropriate information on cruise cards while in the field; including plot number, date, cruiser initials. All cruise cards produced within any day shall be completed and "proofed" by the cruiser the same day.

Sampling Method: All plots will be circular fixed plots; plot radius distances will be horizontal distances.

The cruise will consist of three nested circular plots:

1. 1/10th acre (37.24' limiting distance)– Conifers and hardwoods 10.6" and larger.
2. 1/50th acre (16.66' limiting distance)– Conifers and hardwoods 3.6" to 10.5" DBH.
3. 1/100th acre (11.77' limiting distance)– Conifers and hardwoods 1.0" to 3.5" DBH.

Data to be collected:

1. Tree number shall be recorded clockwise from north and painted on the tree above DBH with orange paint (only paint tree numbers on trees in two largest plots as trees smaller than 3.6" DBH are difficult to paint). Record all the trees in the largest plot first then the middle plot and finally the smallest plot.
2. Species Code
3. DBH to the nearest 1/10th inch (paint a horizontal line at DBH location on the uphill side of the tree).

Mailliard Ranch Carbon Project Inventory Specification

4. Live crown ratio (LCR) to the nearest 10%
5. Total height to the nearest foot (and the lean in degrees if lean > 15° from a vertical line above the base of the stem)
6. Status Code
7. Conifer and hardwood snag trees if they are at least 5" DBH and 15.0' in height prior to rounding. Above 15' height will be recorded to the nearest foot (height to the break, if snag is broken), including decay class.
8. Missing volume by 1/3rd segment of the tree as described below.

Blank Plots

If there are no trees located on any of nested plots, the plot is considered a Blank Plot. Blank Plots are noted on the plot card by including "XX" in the Species column.

Species Codes:

DF	Douglas-fir	TO	Tanoak
SP	Sugar pine	PM	Madrone
PP	Ponderosa pine	BO	Black oak
WF	White fir	WO	Oregon white oak
IC	Incense cedar	LO	Interior live oak
WH	Western hemlock	CLO	Coast live oak
CX	Other conifer	CNO	Canyon live oak
NM	California nutmeg	BM	Bigleaf maple
GP	Gray pine	CL	California laurel
RW	Coast Redwood	RA	Red alder
XX	Blank Plot	CB	California buckeye
		GC	Golden chinkapin
		HX	Other hardwood*

*Include the species of each "Other hardwood" in the note field.

Diameter at Breast Height:

Measure DBH at 4.5 feet above ground on the uphill side of tree perpendicular to angle of the tree. On leaning or pistol butt trees, measure 4.5 feet along the stem, not vertical distance. Ground level (duff layer or mineral soil) is beneath any branches or forest litter that may be accumulated on the uphill side. For trees where there is no good ground level to measure from, figure where a faller would cut the tree, and measure DBH 3.5 feet above that stump height.

Diameter is recorded to the nearest 0.1". If the diameter reading is not exactly on a tenth, record the DBH to the next lower one-tenth inch. Paint a horizontal line at the DBH location on the uphill side of the tree. Do not remove moss from trees prior to measuring DBH. Where trees have moss at DBH, pull the Spencer's tape sufficiently tight to be pressed against the bole, but not so tight as to compress the bark. Please see Appendix A for special instructions regarding DBH measurements. If, for any reason, DBH is estimated, make note on the plot card.

Live Crown Ratio:

Estimate live crown ratio, in percent, on all trees on the plot. Visually estimate the percentage of the total length of the tree bole that is covered by live crown, to the nearest 10 percent. In trees with uneven crown length, average the two most different sides of the tree.

Missing Volume:

Record missing gross volume for each 1/3rd portion of the tree, bottom, middle, and top. If a tree has a broken top, record missing volume by thirds of the height to the break. DO NOT record missing volume for the portion of the tree missing above the break. For example, if the broken top is the only missing portion of the tree, record nothing for missing volume for this missing portion of the tree as the cruise compiler will estimate the missing portions based on a regressed total tree height. Record missing volume to the nearest 10 percent by segment for any tree with missing volume. If any portion of the tree is missing, record the missing volume for each 1/3rd segment of the tree. For example if 20% of the bottom 1/3rd, and 60% of the middle 1/3rd is missing, record 20-60-0 for the tree.

Total Height:

Total height to the nearest foot will be measured for all trees on each plot (Measure total height from the ground (uphill side of the tree) to the highest point on top of the tree (highest branch) unless it is broken then measure to the top of the break in the stem. Trees with previously broken tops are considered recovered when a new leader (dead or alive) is 1/3 the diameter of the broken top at the point where the top was broken (not where the new leader originates from the trunk). If a tree has recovered from a broken top, then measure to the height of the new leader. Trees with broken tops will have the condition of the top noted in the Status Code column (broken [BT], broken and recovered [RL], dead [DT]). DO NOT record BT for a tree having a broken top if it has recovered as defined above.

Status Codes:

BT	Broken top
FT	Forked top (significantly forked conifers only)
RL	Recovered leader
DT	Dead top
SN	Snag

Snag Decay Class:

Each snag recorded on a given plot shall have its decay class recorded. These decay classes are generally described as follows:

- Class 1 Leaves mostly still attached, intact bark, fine twigs, and branches.
- Class 2 Leaves mostly gone, fine branches mostly gone, bark loose and starting to fall off.
- Class 3 A few large branches or stubs remain, bark falling off in large patches, softwood sloughing is evident.
- Class 4 Highly decomposed, no branches, little bark, broken off top.
- Class 5 Mostly decomposed, no branches, very little bark, broken off close to the ground.

Check Cruising: A minimum of five percent of plots will be check cruised. Each plot check cruised will receive either a pass or fail grade. The basis for pass or fail will be individual plot measurements for a given plot as compared to the check cruiser. Plot data shall be proofed daily and provided to NCRM for check cruising within 3 days of cruising. NCRM will randomly select plots to be checked as plot data is received from cruiser. All check cruise reports should be provided to cruiser in a timely manner and no later than 3 days from receipt of plot data from cruiser.

The following tolerances will be used to determine if a cruiser passes or fails the quality control check on any one plot:

Measurement	Tolerance, + / - of check measurement
Tree count on 1/10 th , and 1/50 th acre plot only including snags	None.
Species	None.
Total height	±10% or 10' whichever is less, on each tree.
DBH 1/10 th acre plot	±0.3" for trees less than 24" DBH ±0.5" for conifer trees and ±1" for hardwood trees 24" DBH or greater
DBH 1/50 th and 1/100 th acre plots	±0.3" for all trees
Live crown ratio	20%.
Plot location	Within one chain of mapped location
Tree count on 1/100 th – acre plot	±20% within each species class

The cruiser's work will be considered acceptable if the following is met:

1. The cruise design was followed.
2. The plot card is correctly filled out
3. A minimum score of 86% is achieved using the Check Cruise Worksheet (the worksheet generates a score by evaluating all data on a plot and considers data that misses the cruise tolerances)

If 2 or more plots measured by the same cruiser on the same day fail the check cruising criteria, then in addition to the failed plots, all plots measured on the day of measurement of the last failed plot by the same cruiser will have to be re-measured in their entirety.

Remarks:

Record descriptive information for a particular tree, notes about measurements, or other observations.

Special Circumstances:

DBH: See Appendix A.

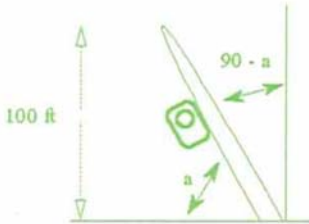
As the plots are fixed area plots, trees are considered on the plot if the center of the tree at ground level is within the fixed plot radius. If it is not possible to get a DBH it can be estimated by the cruiser and noted in the remarks section that the tree (use the tree "line number on the cruise card," to identify the tree) was estimated. If possible, a half diameter measurement can be taken and doubled to estimate DBH with nails marking the zero and estimated half diameter points. If necessary, a nail can be placed at breast height on one side of the tree and a compass reading taken from several steps back where the nail is in line with the center of the tree. Then a second nail can be placed on the opposite tree face in line with the center of the tree using the reversed compass reading.

The reference for determining if a tree is off or on the plot is the point where the tree meets the ground. On slopes, ground level is along the general slope around the stem; thus, the point along the general sloped-ground level at which the center of the tree intersects is the point of measurement for borderline limiting distance calls. Trees leaning away from plot center are on the plot in question if the center of the base of the tree, not the tree's DBH, is within the plot radius.

Leaning Trees: Total height on slightly leaning trees ($<16^\circ$) shall be measured perpendicular to the lean of the tree. Height of significantly leaning trees (16° - 75°) shall be taken from a point as perpendicular to the lean as possible and measured along the vertical distance from the ground to the highest main stem of the tree; from the same ground, the angle of the tree lean (along a straight line between base and top height measurement) shall be measured to the nearest 5° . The cruiser may additionally estimate the trees height using the heights of similar diameter trees that are standing upright. Severely leaning trees (80° +) must be measured horizontally with steel tape and noted as such in the notes column; such heights are not subject to penalties by check cruisers.

A) Slope Correction Factor Method:

1. Measure vertical height to tree tip from a point perpendicular to tree lean.
2. Measure angle of tree lean, reading from the side of clinometer (in Degrees).
3. Subtract the degree reading from 90° .
4. Find slope correction factor for step 3 angle.
5. Multiply vertical height by slope correction factor.



EXAMPLE:

Vertical height = 100 ft. Clinometer reading = 61° ($a = 61$)
 $90^\circ - 61^\circ = 29^\circ$ Slope Correction Factor for $29^\circ = 1.14$
Corrected height = $100 \times 1.14 = \underline{114 \text{ ft}}$

Measurement Tools:

Tree heights shall be measured using laser hypsometers, DBH shall be measured with steel diameter tapes, plot diameters shall be determined utilizing steel tapes while correcting for slope. Slope shall be determined with a Relaskop or clinometer.

Borderline Calls:

DBH: Extra care should be taken when measuring DBH on trees near the cutoff between the 10th and 50th acre plots. Trees with DBHs between 10.4" and 10.8" must be remeasured at the breast height mark confirmed at 4.5' (or BH). Make notes regarding any decisions pertaining to the measurements that may be controversial, such as irregularities at BH, diameter height, and/or alternative diameter measurements. **If a tree's DBH is within five hundredths below 10.6, record it as a 10.6.**

Plot Boundary: Any tree on the 10th acre or 50th acre plot within **3** feet of the plot boundary should have its slope distance from plot center to the center of the tree remeasured with the steel tape and its horizontal distance calculated on the notes section of the plot card to verify if it's within the limiting distance.

Review of Plot card Prior to Leaving the Plot:

Prior to leaving the plot, a review of trees recorded on the plot card shall be performed. The cruiser should be looking for data entry errors such as a DBH recorded less than 10.6" for a tree on the 1/10th acre plot, a missing tree or visual errors such as under recorded or over recorded diameters or heights.

APPENDIX A – SPECIAL INSTRUCTIONS FOR DBH MEASUREMENTS

The attached special instructions for DBH measurement are taken from the FIA National Core Field Guide, Version 6.1 dated October, 2014 section 5.9.2. Not all instructions apply to Mailliard Carbon Project Inventory. For example, where the special instructions refer to multi-stemmed woodland species, no such species as defined in Appendix 3 of the Core Field Guide are found on the Mailliard Project Area, and as such, references to multi-stemmed woodland species can be ignored. Also, forked trees may be considered branches. For this cruise, when a tree fork, below DBH and above one-foot from the ground, has an angle greater than 45° from the main stem, that fork shall be treated as a branch and not an individual tree.

5.9.2 DIAMETER AT BREAST HEIGHT (DBH)

Unless one of the following special situations is encountered, measure DBH at 4.5 feet above the ground line on the uphill side of the tree. Round each measurement down to the last 0.1 inch. For example, a reading of 3.68 inches is recorded as 3.6 inches.

Special DBH situations:

1. **Forked tree:** In order to qualify as a fork, the stem in question must be at least 1/3 the diameter of the main stem and must branch out from the main stem at an angle of 45 degrees or less. Forks originate at the point on the bole where the piths intersect. Forked trees are handled differently depending on whether the fork originates below 1.0 foot, between 1.0 and 4.5 feet, or above 4.5 feet.

- **Trees forked below 1.0 foot.** Trees forked below 1.0 foot are treated as distinctly separate trees (fig. 23). Distances and azimuths are measured individually to the center of each stem where it splits from the stump (fig. 26 A-C). DBH is measured for each stem at 4.5 feet above the ground. When stems originate from pith intersections below 1 foot, it is possible for some stems to be within the limiting distance of the microplot or subplot, and others to be beyond the limiting distance. If stems originating from forks that occur below 1.0 foot fork again between 1.0 and 4.5 feet (fig. 26-E), the rules in the next paragraph apply.

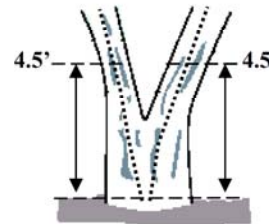


Figure 23. Forked below 1.0 ft.

- **Trees forked between 1.0 foot and 4.5 feet.** Trees forked between 1.0 foot and 4.5 feet are also counted as separate trees (fig. 24), but only one distance and azimuth (to the central stump) is recorded for each stem (fig. 26 D-F). Although a single azimuth and distance applies to all, multiple stems should be recorded as they occur in clockwise order (from front to back when one stem is directly in front of another). The DBH of each fork is measured at a point 3.5 feet above the pith intersection. When forks originate from pith intersections between 1.0 and 4.5 feet, the limiting distance is the same for all forks—they are either all on, or all off the plot.

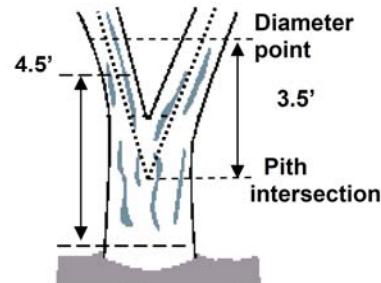


Figure 24. Forked between 1.0-4.5 ft.

Multiple forks are possible if they all originate from approximately the same point on the main stem. In such cases, measure DBH on all stems at 3.5 feet above the common pith intersection (fig. 26-F).

Once a stem is tallied as a fork that originated from a pith intersection between 1.0 and 4.5 feet, do not recognize any additional forks that may occur on that stem. Measure the diameter of such stems just below the base of stem separation as shown in figure 26-E (i.e., do not move the point of diameter the entire 3.5 feet above the first fork).

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- Trees forked at or above 4.5 feet. Trees forked at or above 4.5 feet count as one single tree (fig. 25). If a fork occurs at or immediately above 4.5 feet, measure diameter below the fork just beneath any swelling that would inflate DBH.

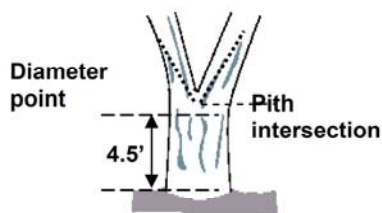


Figure 25. One tree.

2. Stump sprouts: Stump sprouts originate between ground level and 4.5 feet on the boles of trees that have died or been cut. Stump sprouts are handled the same as forked trees, with the exception that stump sprouts are not required to be 1/3 the diameter of the dead bole. Stump sprouts originating below 1.0 foot are measured at 4.5 feet from ground line. Stump sprouts originating between 1.0 foot and 4.5 feet are measured at 3.5 feet above their point of occurrence. As with forks, rules for measuring distance and azimuth depend on whether the sprouts originate above or below 1.0 foot. For multi-stemmed woodland species, treat all new sprouts as part of the same new tree.

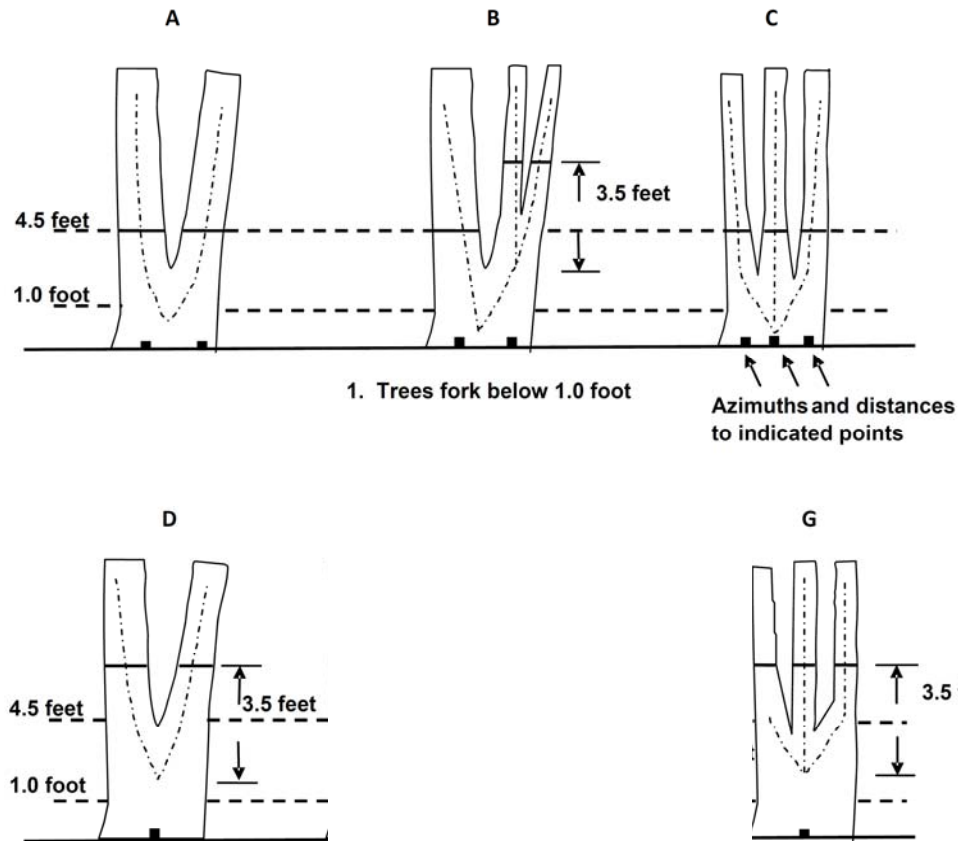


Figure 26. Summary of where to measure DBH, distance, and azimuth on forked trees.

3. Tree with butt-swell or bottleneck: Measure these trees 1.5 feet above the end of the swell or bottleneck if the swell or bottleneck extends 3.0 feet or more above the ground (fig. 27).

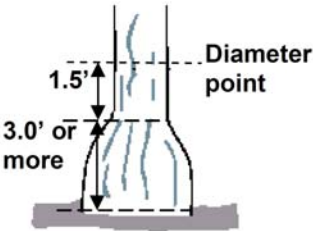


Figure 27. Bottleneck tree.

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4. Tree with irregularities at DBH: On trees with swellings (fig. 28), bumps, depressions, and branches (fig. 29) at DBH, diameter will be measured immediately above the irregularity at the place it ceases to affect normal stem form.

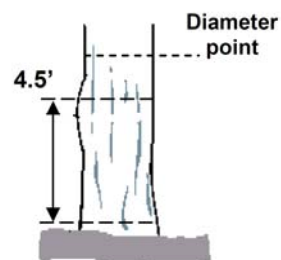


Figure 28. Tree with swelling.

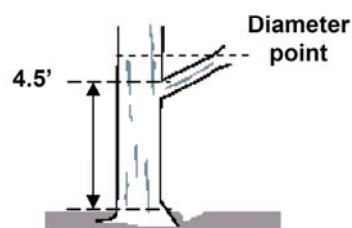


Figure 29. Tree with branch.

5. Tree on slope: Measure diameter at 4.5 feet from the ground along the bole on the uphill side of the tree (fig. 30).

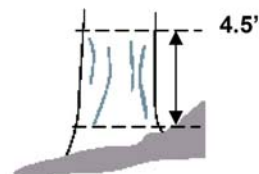


Figure 30. Tree on a slope.

6. Leaning tree: Measure diameter at 4.5 feet from the ground along the bole. The 4.5-foot distance is measured along the underside face of the bole (fig. 31).

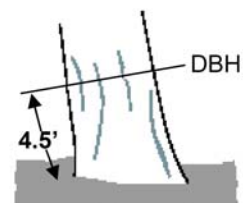


Figure 31. Leaning tree.

Mailliard Ranch Carbon Project Inventory Specification

8. Independent trees that grow together: If two or more independent stems have grown together at or above the point of DBH, continue to treat them as separate trees. Estimate the diameter of each, set the "DIAMETER CHECK" code to 1, and explain the situation in the notes.

In this situation use the "half-DBH" method. Take a half tree diameter by estimating two point opposite each other on the stem at the DBH point. Measure the distance between the two marks and double the measurement to determine DBH. Either paint the location of the two marks, or set an aluminum nail at each point. Make a note that the DBH was measured using the "half-DBH" method.

9. Missing wood or bark: Do not reconstruct the DBH of a tree that is missing wood or bark at the point of measurement. Record the diameter, to the nearest 0.1 inch, of the wood and bark that is still attached to the tree (fig. 32). If a tree has a localized abnormality (gouge, depression, etc.) at the point of DBH, apply the procedure described for trees with irregularities at DBH (figs. 28 and 29).

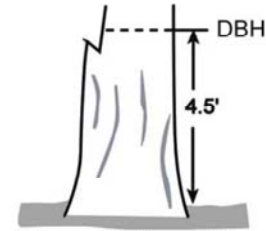


Figure 32. Tree with part of stem missing.

10. Live windthrown tree: Measure from the top of the root collar along the length to 4.5 feet (fig. 33).

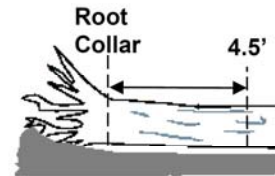


Figure 33. Tree on the ground.

11. Down live tree with tree-form branches growing vertical from main bole: When a down live tree, touching the ground, has vertical (less than 45 degrees from vertical) tree-like branches coming off the main bole, first determine whether or not the pith of the main bole (averaged along the first log of the tree) is above or below the duff layer.
- If the pith of the main bole is above the duff layer, use the same forking rules specified for a forked tree, and take all measurements accordingly (fig. 34).
 - If the pith intersection of the main down bole and vertical tree-like branch occurs below 4.5 feet from the stump along the main bole, treat that branch as a separate tree, and measure DBH 3.5 feet above the pith intersection for both the main bole and the tree-like branch.

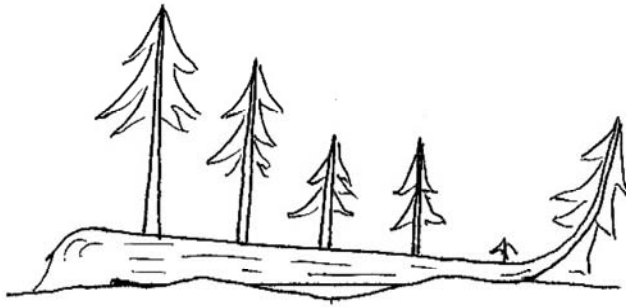


Figure 34. Down tree above duff.

- If the intersection between the main down bole and the tree-like branch occurs beyond the 4.5 feet point from the stump along the main bole, treat that branch as part of the main down bole.
- If the pith of main tree bole is below the duff layer, ignore the main bole, and treat each tree-like branch as a separate tree; take DBH and length measurements from the ground, not necessarily from the top of the down bole (fig. 35). However, if the top of the main tree bole curves out of the ground towards a vertical angle, treat that portion of that top as an individual tree originating where the pith leaves the duff layer.

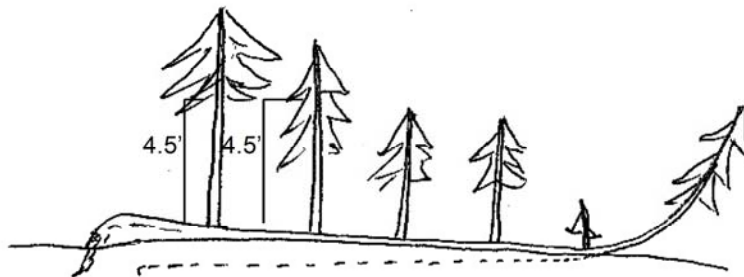


Figure 35. Down tree below duff.

12. Tree with curved bole (pistol butt tree): Measure along the bole on the uphill side (upper surface) of the tree (fig. 36).

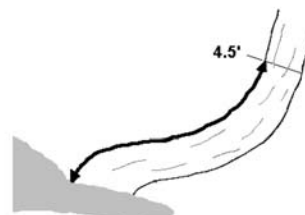


Figure 36. Tree with curved bole (pistol butt tree).

REFERENCES

¹ Harmon, Mark E.; Woodall, Christopher W.; Fasth, Becky; Sexton, Jay; Yatkov, Misha. 2011. Differences between standing and downed dead tree wood density reduction factors: A comparison across decay classes and tree species. Res. Pap. NRS-15. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 40 p.

Appendix C

Mailliard Ranch Inventory
Plot Data Entry Procedures

Mailliard Ranch Inventory

Plot Data Entry Procedures

The following data entry procedures indicate the steps taken for the current Project inventory, as well as the steps that will be taken as additional inventory data is collected across the Project Area.

1. Cruise cards are ordered as they are received from the cruisers. A page number is added to the lower left corner of each card. A copy of the cards with this page number is made and used for the basis of data entry. Data entry cards are stored in a binder with a copy of the completed data entry form.
2. Open the "Select Plot to View" form in the "Mailliard_Carbon_Project_2015.mdb" Access database found at L:\Projects\Mailliard\Carbon\Inventory.
3. Type the plot number ("Plot" on the field card) in the StandId field and hit the enter key to move through the other data in the plot header.
4. Irregularities in the header data should be noted in the Data Entry Note field.
5. To begin entering the tree data, click in the upper left most cell in the TREE DATA portion of the form and type the Tree No.s from 1 to the total number of trees on the plot in the Tree# column. Then enter the remaining data by column from left to right. It is more efficient to enter data by moving up and down the columns, rather than across columns for each tree.
6. Snags are recorded with "SN" in the status column followed by the decay class. SN1 is a snag with decay class 1. Record SN in the Status column, and 1 in the DC (Decay Class) column. Record zero for LCR for all snags.
7. Enter Log Ht and defect by log position data as recorded on the field card. This data is not used for the carbon inventory, but must be entered properly. WTS cruisers include a line through log position columns if the data is the same as the cell to the left of the line. Record the value in the cell to the left of the line for all columns through which the line passes up to the recorded log Ht.
8. Leaning trees have the lean in degrees recorded in the Remarks column. Enter the lean from the Remarks column to the nearest 5 degrees in the Lean column.
9. Missing volume is recorded in the Remarks column on the field card, and in the B1/3, M1/3, and T1/3 columns in the database. Missing volume is recorded to the nearest 10 percent by segment for any tree with missing volume. If any portion of the tree is missing, the missing volume for each 1/3rd segment of the tree is recorded. For example if 20% of the bottom 1/3rd, and 100% of the middle 1/3rd is missing, 20-100-0

is recorded for the tree. The B1/3, M1/3, and T1/3 columns default to zero, separate the recorded data into the respective columns.

10. Record all of the data in the Remarks column of the card into the Note column in the form, even if the data is recorded elsewhere on the form with the exception of 0-0-0 data included for trees without missing volume.
11. If there is a problem reading the data for a tree, or if the data entered differs from the data on the cruise card, describe the issue in the Entry Note column for the tree in question.
12. When data entry is complete, the person entering the card shall write the word "Entered", the date entered, and their initials in the upper right corner of the card in the box where the word "Remarks" is found.

Data Review

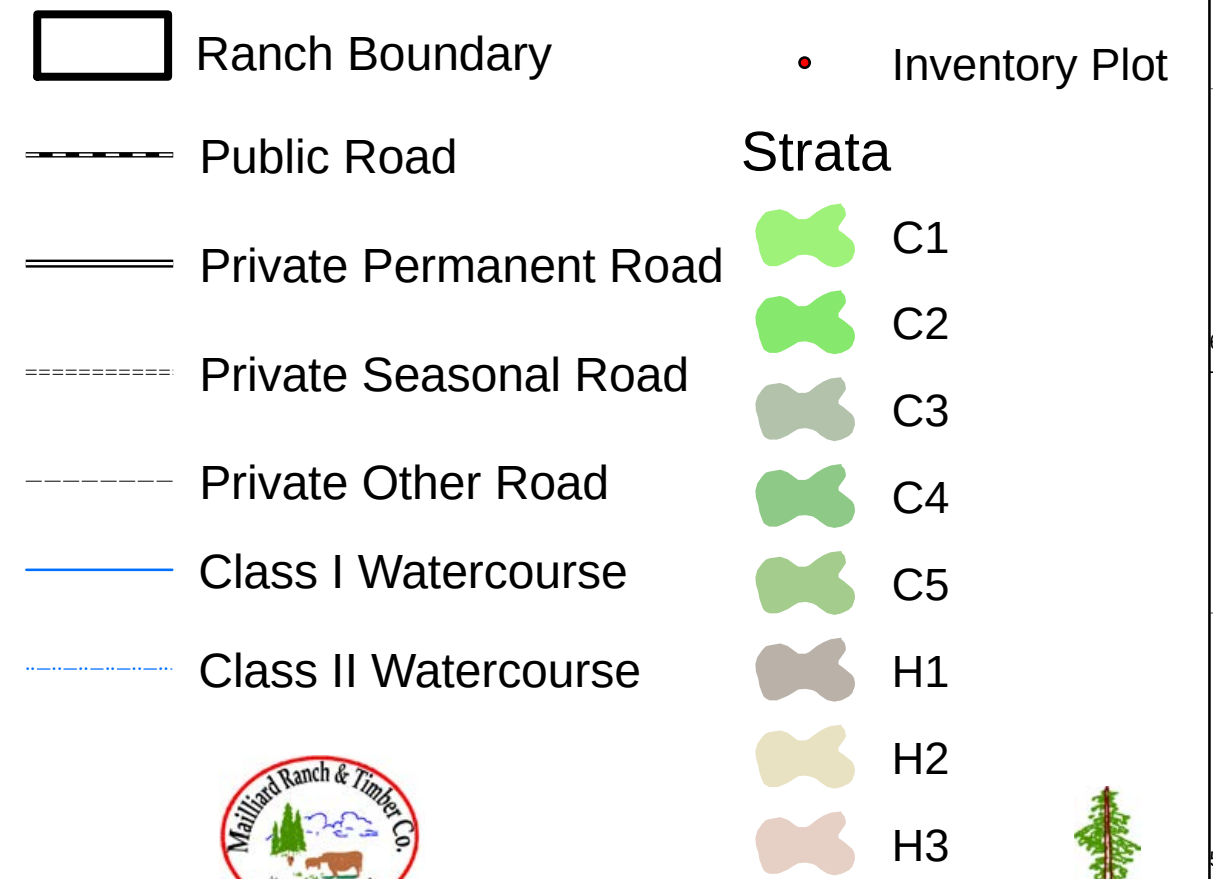
1. Data review begins with a visual review of the plot card and the data entered. Check that data is entered in the appropriate column, and in the appropriate order.
2. Save a PDF of the completed plot card with the StandId as the file name into the following directory on the server:
L:\Projects\Mailliard\Carbon\Inventory\Plotcards\Final_Plot_Cards
3. Print a hard copy of the PDF and place it in the Data Entry binder opposite the field card.
4. Review the printed card against the field card. Make any corrections, then reprint the completed card.
5. Scan a copy of the field card with the StandId and "_field" as the file name and save it as a PDF into the following directory on the server:
L:\Projects\Mailliard\Carbon\Inventory\Plotcards\Field_Cards

Appendix D

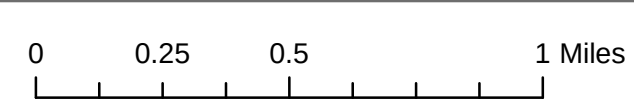
Plot Map

Mailliard Ranch

Plot and Strata Map



October 13, 2015
Version 1.0A



Appendix E

CAR Harvested Wood Products Worksheet

Harvested Wood Products Worksheet

The Harvested Wood Products (HWP) Worksheet is designed to standardize and facilitate the reporting of harvested wood products for each Reporting Period in the Calculation Worksheet. The HWP worksheet produces standardized outputs that Project Developers must insert into the Calculation Worksheet for the following areas:

- 1) Actual Project Carbon in Harvested Wood Delivered to Mill (tCO₂e)
- 2) Actual Project Carbon in Trees Harvested for Wood Products (tCO₂e)
- 3) Actual Project Carbon Stored Long-term in Wood Products (tCO₂e) - Excl Landfill
- 4) Actual Project Carbon Stored Long-term in Wood Products (tCO₂e) - Incl Landfill
- 5) Baseline Carbon Stored Long-term in Wood Products (tCO₂e) - Excl Landfill
- 6) Baseline Carbon Stored Long-term in Wood Products (tCO₂e) - Incl Landfill

The default values (conversions, mill efficiencies, etc) must be used unless the Project Developer can provide verifiable alternatives. The HWP worksheet is divided into 3 sections (Data Inputs, Estimates of Carbon Storage in Wood Products and Emissions associated with Harvested Trees, and Conversion Assumptions). Project Developers must make a separate copy of the HWP worksheet for each Reporting Period and submit it as part of the Annual Monitoring Report.

Section 1. Data Inputs

Table 1. Key to worksheet inputs			Table 2. Project Characteristics			Table 3. Default Wood Products Classes; Volume Totals								
The key below provides a color-coded reference to cells in this worksheet. User action is required wherever a 'Step' is mentioned.			Step 1. Using the pull-down menus where provided, enter the current reporting period project data into Table 2. If multiple hardwood and/or softwood harvest units were recorded, consolidate into one hardwood and one softwood harvest unit using the values in Table 9.			Step 2. If the default wood products classes are being used, enter the appropriate values from the Assessment Area data file and proceed to Step 3 if harvesting occurred or Step 5 if there was no harvest. If the actual distribution of wood products generated from the reporting period harvest is known, skip this step and proceed to Step 4.								
Step Guidance			Region*:	Pacific Southwest (PSW)	Softwood Lumber	Hardwood Lumber	Plywood	Oriented Strandboard	Non Structural Panels	Miscellaenous	Paper			
Project data entered by Project Developer			Reporting Period:		0%	0%	0%	0%	0%	0%	0%			
Assumptions and/or data populated automatically			Hardwood Harvest Units:	Cubic Feet	Step 3. If the default wood products classes are being used, enter the total amount of wood delivered to the mill(s) and proceed to Step 5.				Hardwood		Softwood			
Default Values			Softwood Harvest Units:	MBF-Scribner ("Large" or "Long")					Total		0	Total		
Data calculated automatically for input into the Calculation Worksheet			*From the Reserve's Assessment Area Data File.						%		#DIV/0!	%		#DIV/0!

Table 4. Volume in Logs Delivered to Mill

Step 4. Enter the name of the mill(s) and the volume of harvested wood sent to the mill(s) during the current reporting period in Table 4. Both the hardwood and softwood volumes must be categorized based on the wood product classes shown below. If wood products class data is only partially available, categorize the unknown wood products as "miscellaneous". If wood products class data is unavailable or no wood products were harvested in the current reporting period, refer to Steps 2 and 3. Default mill efficiencies are listed in Table 12. These default values may be overwritten if mill-specific data is available and verifiable.

	Hardwood							Softwood							
	Wood Product Classes							Wood Product Classes							
	Mill Efficiency	Lumber	Oriented Strandboard	Non Structural Panels	Misc Products	Mill Efficiency	Paper	Mill Efficiency	Lumber	Plywood	Oriented Strandboard	Non Structural Panels	Misc Products	Mill Efficiency	Paper
	56.8%	N/A	N/A	N/A	N/A	56.8%	N/A	67.5%	N/A	N/A	N/A	N/A	N/A	67.5%	N/A
	56.8%	N/A	N/A	N/A	N/A	56.8%	N/A	67.5%	N/A	N/A	N/A	N/A	N/A	67.5%	N/A
	56.8%	N/A	N/A	N/A	N/A	56.8%	N/A	67.5%	N/A	N/A	N/A	N/A	N/A	67.5%	N/A
	56.8%	N/A	N/A	N/A	N/A	56.8%	N/A	67.5%	N/A	N/A	N/A	N/A	N/A	67.5%	N/A
	56.8%	N/A	N/A	N/A	N/A	56.8%	N/A	67.5%	N/A	N/A	N/A	N/A	N/A	67.5%	N/A
	56.8%	N/A	N/A	N/A	N/A	56.8%	N/A	67.5%	N/A	N/A	N/A	N/A	N/A	67.5%	N/A
	56.8%	N/A	N/A	N/A	N/A	56.8%	N/A	67.5%	N/A	N/A	N/A	N/A	N/A	67.5%	N/A
Gross Total:		-	-	-	-		-		-	-	-	-	-		-
Net Total:		-	-	-	-		-		-	-	-	-	-		-

Section 2. Estimates of Carbon Storage in Wood Products and Emissions Associated with Harvested Trees

Table 5. Estimates of CO₂-equivalent (CO₂-e) in Harvested Wood Products associated with Project Activities

Units	Hardwood					Softwood						Sum
	Lumber	Oriented Strandboard	Non Structural Panels	Misc Products	Paper	Lumber	Plywood	Oriented Strandboard	Non Structural Panels	Misc Products	Paper	
Project carbon in harvested wood delivered to mills (Cubic Feet)	-	-	-	-	-	-	-	-	-	-	-	-
Project carbon in harvested wood delivered to mills (tCO ₂ e)	-	-	-	-	-	-	-	-	-	-	-	-
Project carbon transferred to wood products (Cubic Feet)	-	-	-	-	-	-	-	-	-	-	-	-
Project carbon transferred to wood products (tCO ₂ e)	-	-	-	-	-	-	-	-	-	-	-	-
% Product												0%
Long-term storage in in-use wood products (tCO ₂ e)	-	-	-	-	-	-	-	-	-	-	-	-
Long-term storage in wood products in landfills (tCO ₂ e)	-	-	-	-	-	-	-	-	-	-	-	-

Table 6. Estimates of CO₂-equivalent (CO₂-e) in Harvested Wood Products associated with Baseline Activities

Units	Hardwood					Softwood						Sum
	Lumber	Oriented Strandboard	Non Structural Panels	Misc Products	Paper	Lumber	Plywood	Oriented Strandboard	Non Structural Panels	Misc Products	Paper	
tCO2e	-	-	-	-	-	-	-	-	-	-	-	-
% Product	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Long-term storage in in-use wood products (tCO2e)	-	-	-	-	-	-	-	-	-	-	-	-
Long-term storage in wood products in landfills (tCO2e)	-	-	-	-	-	-	-	-	-	-	-	-

Table 7. Calculation Worksheet Information

Table 7. Calculation Worksheet Information			Table 8. Ratio of Harvested Wood Carbon to Harvested Tree Carbon		
Calculation Sheet Inputs (for Current Reporting Period)		Row Location in Calculation Worksheet	Step 5. Enter the 100-year baseline data to calculate a ratio of carbon in trees harvested for wood products to carbon in harvested wood delivered to the mill.		
Actual Project Carbon in Harvested Wood Delivered to Mill (tCO ₂ e)	-	11 (Excel 22)	Baseline Carbon in Trees Harvested for Wood Products (tCO ₂ e) (from Excel Row 21 of the Monitoring Calculation Worksheet)		
Actual Project Carbon in Trees Harvested for Wood Products (tCO ₂ e)	-	9 (Excel 20)	Baseline Carbon in Harvested Wood Delivered to Mill (tCO ₂ e) (from Row 23 of the Monitoring Calculation Worksheet)		
Actual Project Carbon Stored Long-term in Wood Products (tCO ₂ e) - Excl Landfill	-	13 (Excel 24)	Multiplier of Carbon in Wood Delivered to Mill to Carbon in Trees Harvested for Wood Products		
Actual Project Carbon Stored Long-term in Wood Products (tCO ₂ e) - Incl Landfill	-	14 (Excel 25)			
Baseline Carbon Stored Long-term in Wood Products (tCO ₂ e) - Excl Landfill	-	15 (Excel 26)			
Baseline Carbon Stored Long-term in Wood Products (tCO ₂ e) - Incl Landfill	-	16 (Excel 27)			

Section 3. Conversion Assumptions

Table 9. Volume multipliers for converting timber and chip units to Cubic Feet		Table 10. Conversion Factors: to convert volume estimates to CO2-e		Source	Table 11. 100-year average storage factors		
		Cubic Feet / Hardwood Harvest Unit	1		Table 9.	Wood Product Class	In-Use
Unit	Factor	Cubic Feet / Softwood Harvest Unit	145	Table 9.	Softwood Lumber	0.463	0.298
Bone Dry Tons	71.3	SG of Softwoods by Region	0.399	Table 12.	Hardwood Lumber	0.250	0.414
Bone Dry Units	82.5	SG of Hardwoods by Region	0.51	Table 12.	Softwood Plywood	0.484	0.287
Cords	75	Tree Carbon:Wood Carbon	0.00	Table 8.	Oriented Strandboard	0.582	0.233
Cubic Feet	1	Pounds to Metric Tons	0.0004535970	-	Non Structural Panels	0.380	0.344
Cubic Meters	35.3	Portion of Carbon in Biomass	0.5	-	Miscellaneous Products	0.176	0.454
Cunits-Chips (CCF)	100	Carbon to CO2-e	3.67	Reserve FPP	Paper	0.058	0.178
Cunits-Roundwood	100	Density of water (lbs/cf)	62.43	-	Source: Reserve Forest Project Protocol, Appendix C.3 & C.4		
Cunits-Whole tree chip	126	Table 12. Average regional factors: specific gravity (SG) and mill efficiencies (ME)					
Green tons	31.5						
MBF-Doyle	222	Hardwoods			Softwoods		
MBF-International 1/4"	146	Region	SG	Saw Log ME	Pulp ME	SG	Saw Log ME
MBF-Scribner ("C" or "Small")	165	Northeast (NE)	0.518	0.614	0.650	0.371	0.569
MBF-Scribner ("Large" or "Long")	145	Northern Lake States (NLS)	0.473	0.585	0.685	0.360	0.630
MCF-Thousand Cubic Feet	1000	Northern Prairie States (NPS)	0.537	0.585	0.685	0.434	0.630
Oven Dried Tonnes	75.8	Pacific Northwest, East (PWE)	0.424	0.568	0.568	0.396	0.637
Source: American Forest & Paper Association, Sustainable Forestry Initiative Program Annual Progress Reporting Form		Pacific Northwest, West (PWW)	0.415	0.531	0.531	0.426	0.740
		Pacific Southwest (PSW)	0.510	0.568	0.568	0.399	0.675
		Rocky Mountain, North (RMN)	0.389	0.568	0.568	0.394	0.704
		Rocky Mountain, South (RMS)	0.353	0.568	0.568	0.369	0.704
		Southeast (SE)	0.508	0.609	0.591	0.462	0.636
		South Central (SC)	0.529	0.587	0.581	0.463	0.629
		Sources: USDA Forest Service, Forest Inventory and Analysis Program database of forest surveys (SG) andTechnical Guidelines for Voluntary Reporting of Greenhouse Gas Program (ME). Average wood specific gravity is the density of wood divided by the density of water based on wood dry mass associated with green tree volume.					

ATTACHMENT M

FIA Volume Equation documentation updated on 9-19-2014

Contacts: Karen Waddell, Kurt Campbell, Olaf Kuegler, Glenn Christensen

Volume estimation for PNW- Databases -- NIMS and FIADB

Cubic and board foot volumes (in Scribner and International 1/4" log rules) are calculated for softwood and hardwood trees measured on forest land. A variety of volumes are estimated including gross and net volume of the merchantable stem, gross and net volume of both the sawlog portion and the upper stem portion of the bole, gross total stem volume of the entire bole from ground to tip.

All total stem volumes are calculated on all live trees in the inventory that are ≥ 1 " DIA, and on dead trees that are ≥ 5 " DIA.

All other volumes (gross and net growing stock and sawtimber volumes) are calculated on the merchantable stem, originally for the purpose of providing timber information. This is the most common volume most users will see in published reports. Gross volume from these equations has not been adjusted for the presence of cull (rot and defect). Net volume is gross volume minus an estimate of volume lost due to rot, physical defect, and/or other damage.

Growing stock volume is the volume of a tree, from a 1-foot stump to a 4" top, calculated on all trees ≥ 5 " DIA. Board foot volume (sawtimber volume); for softwoods it is the volume of a tree from a 1-foot stump to a 6" top, calculated for softwood species ≥ 9 " DIA; and for hardwoods, it is the volume of a tree from a 1-foot stump to an 8" top, calculated for hardwood species ≥ 11 " DIA.

Note, that the sawlog and upper stem volumes are the cubic volume of sawtimber-sized trees, not to be confused with sawtimber (boardfoot) volume.

The log length for the log rule used in sawtimber (board-foot) calculations differs by species group and location, as follows:

On the west side of Oregon and Washington--

Scribner volume uses a 32-foot log rule for softwoods, and
a 16-foot log rule for hardwoods;

International 1/4" volume uses a 16-foot log rule for softwoods, and
an 8-foot log rule for hardwoods.

On the east side of Oregon and Washington, and all of California--

Scribner volume uses a 16-foot log rule for softwoods, and
a 16-foot log rule for hardwoods;

International 1/4" volume uses a 16-foot log rule for softwoods, and
an 8-foot log rule for hardwoods.

Board foot equations estimate volume of the fractional log up to the specified top diameter. The fractional log is the last log of the tree, which is less than the log rule specification.

The following volume names are used throughout the equations and are defined below:

CUBIC VOLUME (in cubic feet)

<u>Type of Volume</u>	<u>Calculated on trees with a DIA of:</u>	<u>Volume name in equations</u>
<u>All softwoods and hardwoods:</u>		
Volume of the total stem, ground to tip	$\geq 1"$	CVTS
Volume from a 1-foot stump to the tip	$\geq 1"$	CVT
Volume from a 1-foot stump to a 4-inch top	$\geq 5"$	CV4
<u>Softwood sawlog volume:</u>		
Volume from a 1-foot stump to a 6-inch top	$\geq 9"$	CV6
<u>Hardwood sawlog volume:</u>		
Volume from a 1-foot stump to an 8-inch top	$\geq 11"$	CV8

BOARD FOOT VOLUME (square feet)

<u>Type of Volume</u>	<u>Calculated on trees with a DIA of:</u>	<u>Volume name in equations</u>
<u>Softwoods:</u>		
Scribner volume, 16-foot log rule, 1-foot stump to a 6-inch top (Eastern OR; Eastern WA; CA)	$\geq 9"$	SV616
Scribner volume, 32-foot log rule, 1-foot stump to a 6-inch top (Western OR; Western WA)	$\geq 9"$	SV632
International 1/4" volume, 16-foot log rule, 1-foot stump to a 6-inch top (all states)	$\geq 9"$	XINT6
<u>Hardwoods:</u>		
Scribner volume, 16-foot log rule 1-foot stump to an 8-inch top (all states)	$\geq 11"$	SV816
International 1/4" volume, 8-foot log rule, 1-foot stump to an 8-inch top (all states)	$\geq 11"$	XINT8

PROCEDURES

The general procedure used to calculate volume is as follows:

- a.) estimate cubic volume first to produce CVTS, CVT, CV4, and the TARIF number;
- b.) estimate RATIO's from equations that use DBH and TARIF as inputs;
- c.) use the RATIO's to convert cubic volume to Scribner and International 1/4" board-foot volumes;
- d.) use the RATIO's to convert the Scribner 16-foot log rule to the Scribner 32-foot log rule.

There are three methods to calculate cubic volume, depending on the equation. Each method produces an estimate for CVTS, CVT, CV4, and TARIF. In cases where volume equations do not exist for a given species, a suitable equation has been chosen and assigned to each species.

After cubic volume is calculated, all species use the same set of equations to develop the RATIO's needed to produce the remaining volumes.

CUBIC VOLUME Method 1: The TARIF number is based on CVTS.

Softwood equations 1, 2, 4, 6-15, 17, 21, 22, 24

Hardwood equations 25-31

1. Calculate CVTS from published or documented volume equations for the species.
 2. Calculate the TARIF number from CVTS, using the equation in DNR report #24.
 3. Calculate CV4 from the TARIF number and tree basal area.
 4. Calculate CVT from the TARIF number and DIA.
-

CUBIC VOLUME Method 2: The TARIF number is based on CV4.

Softwood equations 3, 5, 16, 18, 19, 20, 23

5. Calculate CV4 directly from published equations, using a form factor, DIA and height.
 6. Calculate the TARIF number from CV4 and tree basal area.
 7. If the tree ≥ 6 " DIA then Calculate CVTS from CV4.
 8. If the tree < 6 " DIA then adjust the TARIF before calculating CVTS.
 9. Calculate CVT from the TARIF number and DIA.
-

CUBIC VOLUME Method 3: The TARIF number is based on CV8.

Hardwood equations 32 to 44

10. Calculate CVTS, CV4, and CV8 directly from published equations;
 11. Calculate TARIF from CV8.
 12. Calculate CVT from CV8.
-

13. CALCULATE CONVERSION RATIOS:

For all trees:

After CVTS and CV4 have been estimated, use equations to calculate the ratios. These ratios are used to convert cubic to board foot volume, and 16 to 32-foot log rules as follows:

<u>RATIO</u>	<u>Used to convert:</u>
RC6	CV4 to CV6
RC8	CV4 to CV8 (if needed)
RS616	CV6 to SV616
RS816	SV616 to SV816
RS632	SV616 to SV632
RI6	CV6 to XINT6
RI8	XINT6 to XINT8

SOFTWOOD CUBIC VOLUME EQUATIONS

Volume equation numbers

Species Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
11	Pacific silver fir	11	11	10	10	11
14	Bristlecone fir	--	--	--	--	18
15	White fir	23	11	10	10	23
17	Grand fir	11	11	10	10	23
19	Subalpine fir	11	11	10	10	18
20	California red fir	18	--	10	--	18
21	Shasta red fir	18	--	18	--	18
22	Noble fir	11	11	10	10	18
41	Port-Orford-cedar	19	19	19	19	8
42	Alaska-cedar	9	9	8	8	8
50	Cypress	--	--	--	--	19
51	Arizona cypress	--	--	--	--	19
52	Baker cypress	--	--	--	--	19
54	Monterey cypress	--	--	--	--	19
55	Sargent's cypress	--	--	--	--	19
56	McNabb cypress	--	--	--	--	19
62	California juniper	--	--	--	--	14
64	Western juniper	21	21	21	21	21
65	Utah juniper	--	--	--	--	14
66	Rocky mountain juniper	--	--	14.2	--	14.2
72	Subalpine larch	--	22	22	22	--
73	Western larch	22	22	22	22	22
81	Incense cedar	19	19	19	19	19
92	Brewer spruce	13	--	13	13	12
93	Engelmann spruce	13	13	12	12	12
98	Sitka spruce	13	13	13	13	12
101	Whitebark pine	15	15	15	15	20
102	Bristlecone pine	--	--	--	--	16
103	Knobcone pine	15	15	15	--	16
104	Foxtail pine	--	--	--	--	16
108	Lodgepole pine	15	15	15	15	16
109	Coulter pine	--	--	--	--	5
113	Limber pine	--	--	16	--	16
116	Jeffrey pine	5	--	4	--	5
117	Sugar pine	20	--	20	--	20
119	Western white pine	15	15	15	15	20
120	Bishop pine	16	--	16	--	16
122	Ponderosa pine	5	4	4	4	5
124	Monterey pine	--	--	--	--	16
127	Gray pine	--	--	--	--	5
130	Scotch pine	15	--	--	--	--
133	Singleleaf pinyon pine	--	--	--	--	14.1

SOFTWOOD CUBIC VOLUME EQUATIONS

Volume equation numbers (continued)

		Halfstate				
Species Code	Species	WOR	WWA	EOR	EWA	CA
137	Washoe pine	--	--	--	--	5
142	Great Basin bristlecone pine	--	--	--	--	16
201	Bigcone Douglas-fir	--	--	--	--	3
202	Douglas-fir	1	1	2	2	3
211	Redwood	24	24	24	--	24
212	Giant Sequoia	24	--	24	--	24
231	Pacific yew	9	9	8	8	8
242	Western redcedar	9	9	8	8	8
251	California nutmeg	--	--	--	--	8
263	Western hemlock	6	6	6	6	6
264	Mountain hemlock	17	17	17	17	17
298/299	Unknown Conifer	17	17	17	17	17

There are many equations used to estimate softwood cubic-foot volume. Each equation below has been cross-walked to a particular tree species in the table above.

Click on an equation number to view the actual equation and procedure used to estimate volume.

SOFTWOOD VOLUME EQUATION SOURCES

<u>EQUATION 1</u>	<u>DOUGLAS-FIR</u>	(Brackett, 1973; DNR RPT # 24,1977)
<u>EQUATION 2</u>	<u>DOUGLAS-FIR</u>	(DNR MEMO--SUMMERFIELD,11/7/80)
<u>EQUATION 3</u>	<u>DOUGLAS-FIR</u>	(USDA-FS RES NOTE PNW-266)
<u>EQUATION 4</u>	<u>PONDEROSA PINE</u>	(DNR MEMO--SUMMERFIELD,11/7/80)
<u>EQUATION 5</u>	<u>PONDEROSA PINE</u>	(USDA-FS RES NOTE PNW-266)
<u>EQUATION 6</u>	<u>W.HEMLOCK</u>	(DNR NOTE 27,4/79)
<u>EQUATION 7</u>	<u>W.HEMLOCK</u>	(BROWNE (1962) BC FOREST SERV,P33)
<u>EQUATION 8</u>	<u>REDCEDAR</u>	(REDCEDAR INTERIOR--DNR RPT # 24,1977)
<u>EQUATION 9</u>	<u>REDCEDAR</u>	(REDCEDAR COAST--DNR RPT # 24,1977)
<u>EQUATION 10</u>	<u>TRUE FIRS</u>	(INTERIOR BALSAM--DNR RPT # 24,1977)
<u>EQUATION 11</u>	<u>TRUE FIRS</u>	(COAST BALSAM--DNR RPT # 24,1977)
<u>EQUATION 12</u>	<u>SPRUCE</u>	(SITKA SPRUCE INTERIOR--DNR RPT # 24,1977)
<u>EQUATION 13</u>	<u>SPRUCE</u>	(SITKA SPRUCE MATURE--DNR RPT # 24,1977)
<u>EQUATION 14</u>	<u>Other junipers</u>	(Chojnacky, 1985)
<u>EQUATION 14.1</u>	<u>Singleleaf pinyon</u>	(Chojnacky, 1985)
<u>EQUATION 14.2</u>	<u>Rocky mountain juniper</u>	(Chojnacky, 1985)
<u>EQUATION 15</u>	<u>LODGEPOLE PINE</u>	(LODGEPOLE PINE--DNR RPT # 24,1977)
<u>EQUATION 16</u>	<u>LODGEPOLE PINE</u>	(USDA-FS RES NOTE PNW-266)
<u>EQUATION 17</u>	<u>MTN.HEMLOCK</u>	(BELL, OSU RES.BULL 35)
<u>EQUATION 18</u>	<u>SHASTA RED FIR</u>	(USDA-FS RES NOTE PNW-266)
<u>EQUATION 19</u>	<u>INCENSE CEDAR</u>	(USDA-FS RES NOTE PNW-266)
<u>EQUATION 20</u>	<u>SUGAR PINE</u>	(USDA-FS RES NOTE PNW-266)
<u>EQUATION 21</u>	<u>W.JUNIPER</u>	(CHITTESTER,1984)
<u>EQUATION 22</u>	<u>W.LARCH</u>	(LARCH--DNR RPT # 24,1977)
<u>EQUATION 23</u>	<u>WHITE FIR</u>	(USDA-FS RES NOTE PNW-266)
<u>EQUATION 24</u>	<u>REDWOOD</u>	(Krumland and Wensel 1975; DNR RPT # 24,1977)

Equation 7

Browne, J.E. 1962. Standard cubic-foot volume tables for the commercial tree species of British Columbia. B.C. Forest Service, Victoria. 107 p.

Equations 1, 8, 9, 10, 11, 12, 13, 15

Brackett, M. 1973. Notes on TARIF tree volume computation. Res. Management Report 24. WA Dept. of Nat. Resources. Olympia. 26p.

Brackett, Michael. 1977. Notes on TARIF tree-volume computation. DNR report # 24. State of Washington, Department of Natural Resources, Olympia, WA. 132p.
(see Weyerhaeuser Eqn. #4, page 6)

Equations 2, 4

Summerfield, Edward. 1980. In-house memo describing equations for Douglas-fir and ponderosa pine. State of Washington, Department of Natural Resources. On file with the PNW Research Station.

Equations 3, 5, 16, 18, 19, 20, 23

MacLean, Colin and John M. Berger. 1976. Softwood tree-volume equations for major California species. PNW Research Note, PNW-266. Pacific Northwest Forest and Range Experiment Station, Portland Oregon. 34p. (see page 4)

Equation 6

Chambers, C.J. and Foltz, B. 1979. The TARIF system -- revisions and additions., Resource Management Report # 27. WA Dept. of Nat. Resources. Olympia. (see page 2)

Equations 14, 14.1, 14.2

Chojnacky D.C., 1985. Pinyon-Juniper Volume Equations for the Central Rocky Mountain States. Res. Note INT-339, USDA, Forest Service, Intermountain Res. Station, Ogden, UT 84401.

Equation 17

Bell, J.F., Marshall, D.D. and Johnson G.P. 1981. Tarif tables for mountain hemlock: developed from an equation of total stem cubic-foot volume. Research Bulletin #35. OSU Forest Research Lab, School of Forestry, Oregon State University, Corvallis, OR. (see page 6)

Equation 21

Chittester, Judith and Colin MacLean. 1984. Cubic-foot tree-volume equations and tables for western juniper. Research Note, PNW-420. Pacific Northwest Forest and Range Experiment Station. Portland, Oregon. 8p. (see page 4)

Equation 24

Krumland, B.E. and L.E. Wensel. 1975. Preliminary young growth volume tables for coastal California conifers. Research Note #1. In-house memo. Co-op Redwood Yield Research Project. Department of Forestry and Conservation, College of Natural Resources, U of Cal, Berkeley. On file with the PNW Research Station. (see Table 1, page 4)

Softwood cubic volume equations

Equation 1

$$\begin{aligned} \text{CVTSL} \cong & 0.321809 + 0.04948 \log HT + 0.15664 \log DBH + 0.015664 \log^2 DBH, \\ & + 2.02132 \log DBH + 1.63408 \log HT + 0.16185 \log^2 HT, \end{aligned} \quad (1)$$

$$\text{CVTS} = 10^{**} \text{CVTSL} \quad (2)$$

$$\text{TARIF} \cong \frac{\text{CVTS} + 0.912733}{\left[1.033 + 1.0 + 1.382937 \exp \left(0.4015292 \log \frac{DBH}{10.0} \right) \right] + BA + 0.087266 + 0.174533} \quad (3)$$

$$\text{CV4} \cong \frac{\text{TARIF} + BA + 0.087266}{0.912733} \quad (4)$$

$$\text{CVT} \cong \frac{\text{TARIF} + 0.9679 + 0.1051 \log DBH + 0.5523 \log^2 DBH + \left[1.033 + 1.0 + 1.382937 \exp \left(0.4015292 \log \frac{DBH}{10.0} \right) \right] + BA + 0.087266 + 0.174533}{0.912733} \quad (5)$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA = .005454154 x DBH²

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 2

$$CVTSL \cong 06.110493 + 1.81306 \ln DBH + 1.083884 \ln HT, \quad (1)$$

$$CVTS \cong \exp CVTSL, \quad (2)$$

$$TARIF \cong \frac{CVTS^{0.912733}}{\left[1.033 + 1.0 + 1.382937 \exp \left(4.015292 + \frac{DBH}{10.0} \right) \right]^{0.087266} + 0.174533} \quad (3)$$

$$CV4 \cong \frac{TARIF^{0.087266}}{0.912733}, \quad (4)$$

$$CVT \cong \frac{\left[TARIF^{0.9679 + 0.1051 + 0.5523 DBH^{1.5}} \right]^{0.087266} + 0.174533}{0.912733} \quad (5)$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA = .005454154 x DBH²

CVTSL = Natural Log, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 3– (uses PNW 266 formulas from MacLean and Berger)

‘FOR THIS SET OF EQUATIONS CREATE A TEMPORARY DBH AND BA for trees less than 6”DBH

IF DBH < 6.0 THEN **TMP_DBH** = 6.0

‘CALCULATE BASAL AREA PER TREE USING DBH AND DBH_TEMP

BA = DBH**2 * 0.005454154

BA_TMP = TMP_DBH **2 * 0.005454154

‘CALCULATE A **CUBIC FORM FACTOR** (CF4) USING TMP_DBH and DBH

‘CF4 EQUATIONS VARY BY VOLUME EQUATION

CF4 = 0.248569 + 0.0253524*(HT/DBH) - 0.0000560175*(HT**2/ DBH)

IF(CF4 < 0.3) CF4 =0.3

IF(CF4 > 0.4) CF4 =0.4

CF4_TMP = 0.248569 + 0.0253524*(HT/TMP_DBH) - 0.0000560175*(HT**2/ TMP_DBH)

IF(CF4_TMP < 0.3) CF4_TMP=0.3

IF(CF4_TMP > 0.4) CF4_TMP=0.4

‘-----

‘For ease of use and to improve readability of equations, calculate the following term and use it

‘in the equations that follow. Note that actual DBH and BA are used for all trees.

‘Do not use TMP_DBH or BA_TMP here.

TERM = ((1.033 * (1.0 + 1.382937 * EXP(-4.015292 * (DBH/10.0)))) * (BA + 0.087266) - 0.174533)

‘-----

IF DBH >= 6.0 THEN

CV4 = CF4 * BA * HT

TARIF = (CV4 * 0.912733) / (BA - 0.087266)

IF (TARIF <= 0.0) TARIF=0.01

CVTS = (CV4 * TERM) / (BA - 0.087266)

CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733

ELSEIF

DBH < 6.0 THEN

CV4_TMP = CF4_TMP *BA_TMP * HT

TARIF_TMP = (CV4_TMP * 0.912733) / (BA_TMP - 0.087266)

IF (TARIF_TMP <= 0.0) TARIF_TMP = 0.01

‘CALCULATE An **ADJUSTED TARIF** FOR SMALL TREES (Both DBH and TMP_DBH are used)

TARIF = TARIF_TMP * (0.5 * (TMP_DBH - DBH)**2 + (1.0 + 0.063 * (TMP_DBH - DBH)**2))

IF (TARIF <= .0.0) TARIF = 0.01

CVTS = TARIF * TERM

CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733

CV4 = CF4 * BA * HT (calculated with actual DBH and BA)

END IF

IF DBH < 5.0 THEN CV4 = NULL

IF DBH >= 5.0 THEN KEEP CV4 (i.e. don't keep CV4_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 4

$$CVTSL \cong 08.521558 + 1.977243 \ln DBH + 0.105288 \ln HT + \frac{136.0489}{2} \ln HT, \quad (1)$$

$$CVTS \cong \exp CVTSL, \quad (2)$$

$$TARIF \cong \frac{CVTS + 0.912733}{1.033 + 1.0 + 1.382937 \exp 4.015292 DBH + BA + 0.087266 + 0.174533}, \quad (3)$$

$$CV4 \cong \frac{TARIF + BA + 0.087266}{0.912733}, \quad (4)$$

$$CVT \cong \frac{TARIF + 0.9679 + 0.1051 + 0.5523 DBH^{1.5} + \left[1.033 + 1.0 + 1.382937 \exp 4.015292 \left(\frac{DBH}{10.0} \right) \right] + BA + 0.087266 + 0.174533}{0.912733} \quad (5)$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA = .005454154 x DBH²

CVTSL = Natural Log (ln), CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 5 (uses PNW 266 formulas from MacLean and Berger)

‘FOR THIS SET OF EQUATIONS CREATE A TEMPORARY DBH AND BA for trees less than 6”DBH

IF DBH < 6.0 THEN **TMP_DBH** = 6.0

‘CALCULATE BASAL AREA PER TREE USING DBH AND DBH_TEMP

BA = DBH**2 * 0.005454154

BA_TMP = TMP_DBH **2 * 0.005454154

‘CALCULATE A **CUBIC FORM FACTOR** (CF4) USING TMP_DBH and DBH

‘CF4 EQUATIONS VARY BY VOLUME EQUATION

CF4 = 0.402060 - 0.899914 * (1/DBH)

IF(CF4 < 0.3) CF4=0.3

IF(CF4 > 0.4) CF4=0.4

CF4_TMP = 0.402060 - 0.899914 * (1/TMP_DBH)

IF(CF4_TMP < 0.3) CF4_TMP=0.3

IF(CF4_TMP > 0.4) CF4_TMP=0.4

‘-----

‘For ease of use and to improve readability of equations, calculate the following term and use it

‘in the equations that follow. Note that actual DBH and BA are used for all trees.

‘Do not use TMP_DBH or BA_TMP here.

TERM = ((1.033 * (1.0 + 1.382937 * EXP(-4.015292 * (DBH/10.0)))) * (BA + 0.087266) - 0.174533)

‘-----

IF DBH >= 6.0 THEN

CV4 = CF4 * BA * HT

TARIF = (CV4 * 0.912733) / (BA - 0.087266)

IF (TARIF <= 0.0) TARIF=0.01

CVTS = (CV4 * TERM) / (BA - 0.087266)

CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733

ELSEIF

DBH < 6.0 THEN

CV4_TMP = CF4_TMP * BA_TMP * HT

TARIF_TMP = (CV4_TMP * 0.912733) / (BA_TMP - 0.087266)

IF (TARIF_TMP <= 0.0) TARIF_TMP = 0.01

‘CALCULATE An **ADJUSTED TARIF** FOR SMALL TREES (Both DBH and TMP_DBH are used)

TARIF = TARIF_TMP * (0.5 * (TMP_DBH - DBH)**2 + (1.0 + 0.063 * (TMP_DBH - DBH)**2))

IF (TARIF <= .0.0) TARIF = 0.01

CVTS = TARIF * TERM

CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733

CV4 = CF4 * BA * HT (calculated with actual DBH and BA)

END IF

IF DBH < 5.0 THEN CV4 = NULL

IF DBH >= 5.0 THEN KEEP CV4 (i.e. don't keep CV4_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 6

$$CVTSL \cong 0.272170 + 2.00857 \log DBH + 1.08620 \log HT + 0.00568 DBH, \quad (1)$$

$$CVTS = 10^{CVTSL} \quad (2)$$

$$TARIF \cong \frac{CVTS^{0.912733}}{\left[\left(\left(1.033 - 1.0 + 1.382937 \exp \left(-0.4015292 \left(\frac{DBH}{10.0} \right) \right) \right) \right) \right]^{0.087266} BA^{0.174533}} \quad (3)$$

$$CV4 \cong \frac{TARIF^{0.087266} BA^{0.174533}}{0.912733} \quad (4)$$

$$CVT \cong \frac{TARIF^{0.9679 + 0.1051 \exp(0.5523 DBH^{1.5})} \left[\left(\left(1.033 - 1.0 + 1.382937 \exp \left(-0.4015292 \left(\frac{DBH}{10.0} \right) \right) \right) \right) \right]^{0.087266} BA^{0.174533}}{0.912733} \quad (5)$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) $BA = .005454154 \times DBH^2$

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 7

$$\text{CVTSL} \cong 0.2663834 + 1.79023 \partial \log \text{DBH} + 1.124873 \partial \log \text{HT}, \quad (1)$$

$$CVTS=10^{**}CVTSL \quad (2)$$

$$\text{TARIF} \equiv \frac{\overline{CVTS} \cdot 0.912733}{\left[\begin{array}{c} \sqrt[1.033]{\delta} \cdot \sqrt[1.0]{1.382937 \cdot \exp\left(0.4015292 \cdot \sqrt[\frac{DBH}{10.0}]{} \right)} \end{array} \right] \cdot BA \cdot 0.087266 + 0.174533} \quad (3)$$

$$CV4 \cong \frac{TARIF \partial BA 0.087266}{0.912733}, \quad (4)$$

$$CVT \cong \frac{TARIF \partial \left[0.9679 \quad 0 \quad 0.1051 \quad 0.5523^{DBH} \quad 0.1.5 \right] \partial \left[\left[\left[\left[1.033 \quad \partial \left[1.0 \cdot 1.382937 \quad \partial \exp \left(0.4015292 \quad \partial \left[\frac{DBH}{10.0} \right] \right) \right] \right] \right] \right] \partial BA \cdot 0.087266 , 0.174533}{0.912733} \quad (5)$$

WHERE:

$$\text{DBH (inches)} = \text{DBH (CM) CONVERTED TO INCHES (DBH/2.54)}$$
$$\text{HT (feet)} = \text{HT (M)} \text{ CONVERTED TO FEET (HT/0.3048)}$$

BA = BASAL AREA (DBH IN INCHES) $BA = .005454154 \times DBH^2$

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 8

$$CVTSL \cong 0.2464614 + 1.701993 \log DBH + 1.067038 \log HT, \quad (1)$$

$$CVTS = 10^{CVTSL} \quad (2)$$

$$TARIF \cong \frac{CVTS \cdot 0.912733}{\left[\left(\left(1.033 + 1.0 + 1.382937 \exp \left(0.4015292 + \frac{DBH}{10.0} \right) \right) \right) \cdot BA \cdot 0.087266 + 0.174533 \right]} \quad (3)$$

$$CV4 \cong \frac{TARIF \cdot BA \cdot 0.087266}{0.912733}, \quad (4)$$

$$CVT \cong \frac{TARIF \cdot \left(0.9679 + 0.1051 + 0.5523 DBH^{0.15} \right) \cdot \left(\left(1.033 + 1.0 + 1.382937 \exp \left(0.4015292 + \frac{DBH}{10.0} \right) \right) \right) \cdot BA \cdot 0.087266 + 0.174533}{0.912733} \quad (5)$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA = .005454154 x DBH²

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 9

$$\text{CVTSL} \cong 0.2379642 \cdot 1.682300 \partial \log DBH + 1.039712 \partial \log HT, \quad (1)$$

$$CVTS=10^{**}CVTSL \quad (2)$$

[illegible]

$$CV4 \cong \frac{TARIF \partial BA 0.087266}{0.912733}, \quad (4)$$

[illegible]

WHERE:

$$\text{DBH (inches)} = \text{DBH (CM) CONVERTED TO INCHES (DBH/2.54)}$$
$$\text{HT (feet)} = \text{HT (M)} \text{ CONVERTED TO FEET (HT/0.3048)}$$

BA = BASAL AREA (DBH IN INCHES) $BA = .005454154 \times DBH^2$

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 10

$$\text{CVTSL} \cong 0.2502332 + 1.864963 \partial \log DBH + 1.004903 \partial \log HT, \quad (1)$$

$$CVTS=10^{**}CVTSL \quad (2)$$

[illegible]

$$CV4 \cong \frac{TARIF \partial BA 0.087266}{0.912733}, \quad (4)$$

[illegible]

WHERE:

$$\text{DBH (inches)} = \text{DBH (CM) CONVERTED TO INCHES (DBH/2.54)}$$
$$\text{HT (feet)} = \text{HT (M) CONVERTED TO FEET (HT/0.3048)}$$

BA = BASAL AREA (DBH IN INCHES) $BA = .005454154 \times DBH^2$

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 11

$$\text{CVTSL} \cong 0.2575642 \cdot 1.806775 \partial \log \text{DBH} + 1.094665 \partial \log \text{HT}, \quad (1)$$

$$CVTS=10^{**}CVTSL \quad (2)$$

$$\text{TARIF} \equiv \frac{\overline{CVTS} \cdot 0.912733}{\left[\begin{array}{c} \sqrt[1.033]{\delta} \\ \sqrt[1.0 \cdot 1.382937]{\delta \exp} \\ \sqrt[0.4015292]{\delta} \end{array} \cdot \frac{DBH}{10.0} \right]^{BA \cdot 0.087266 + 0.174533}} \quad (3)$$

$$CV4 \cong \frac{TARIF \partial BA 0.087266}{0.912733}, \quad (4)$$

[illegible]

WHERE:

$$\text{DBH (inches)} = \text{DBH (CM) CONVERTED TO INCHES (DBH/2.54)}$$
$$\text{HT (feet)} = \text{HT (M)} \text{ CONVERTED TO FEET (HT/0.3048)}$$

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH²

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 12

$$\text{CVTSL} \cong 0.2539944 + 1.841226 \partial \log \frac{1}{DBH} + 1.034051 \partial \log \frac{1}{HT}, \quad (1)$$

$$CVTS=10^{**}CVTSL$$

[illegible]

$$CV4 \cong \frac{TARIF \partial BA 0.087266}{0.912733}, \quad (4)$$

[illegible]

WHERE:

$$\text{DBH (inches)} = \text{DBH (CM) CONVERTED TO INCHES (DBH/2.54)}$$
$$\text{HT (feet)} = \text{HT (M)} \text{ CONVERTED TO FEET (HT/0.3048)}$$

BA = BASAL AREA (DBH IN INCHES) $BA = .005454154 \times DBH^2$

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 13

$$CVTSL \cong 0.2700574 + 1.754171 \log DBH + 1.164531 \log HT, \quad (1)$$

$$CVTS = 10^{CVTSL} \quad (2)$$

$$TARIF \cong \frac{CVTS + 0.912733}{\left[\left(1.033 + 1.0 + 1.382937 \exp \left(0.4015292 + \frac{DBH}{10.0} \right) \right) + BA + 0.087266 + 0.174533 \right]} \quad (3)$$

$$CV4 \cong \frac{TARIF + BA + 0.087266}{0.912733} \quad (4)$$

$$CVT \cong \frac{TARIF + 0.9679 + 0.1051 + 0.5523 DBH^{0.15} + \left(1.033 + 1.0 + 1.382937 \exp \left(0.4015292 + \frac{DBH}{10.0} \right) \right) + BA + 0.087266 + 0.174533}{0.912733} \quad (5)$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) $BA = .005454154 \times DBH^2$

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 14

IF (DRC >= 3 AND HT > 0) then Factor = DRC x DRC x HT;

IF STEMS=1 THEN S = 1

IF STEMS>1 THEN S = 0

VOLUME = (-.13386 + (.133726 x (Factor^{1/3})) + (.036329 x S))³

IF VOLUME <=0 then VOLUME = 0.1

WHERE:

VOLUME = cubic foot volume from ground level to a 1.5-inch minimum branch diameter
(includes live wood, dead wood, and bark)

STEMS = number of stems 3 inches and larger within the first foot above DRC. When STEMS=1 it is a single stemmed tree

DRC (inches) = Diameter at the root collar

HT (feet) = Total height of the tree

No boardfoot equation is available

Equation 14.1

IF (DRC >= 3 AND HT > 0) then Factor = DRC x DRC x HT;

IF STEMS = 1 THEN S = 1

IF STEMS > 1 THEN S = 0

VOLUME = (-0.14240 + (.148190 x (Factor^{1/3})) - (.016712 x S))³

IF VOLUME <=0 then VOLUME = 0.1

WHERE:

VOLUME = cubic foot volume from ground level to a 1.5-inch minimum branch diameter
(includes live wood, dead wood, and bark)

STEMS = number of stems 3 inches and larger within the first foot above DRC. When STEMS=1 it is a single stemmed tree

DRC (inches) = Diameter at the root collar

HT (feet) = Total height of the tree

No boardfoot equation is available

Equation 14.2

IF (DRC >= 3 AND HT > 0) then Factor = DRC x DRC x HT;

$$\text{VOLUME} = (0.02434 + (0.119106 \times (\text{Factor}^{1/3}))^3$$

IF VOLUME <= 0 then VOLUME = 0.1

WHERE:

VOLUME = cubic foot volume from ground level to a 1.5-inch minimum branch diameter (includes live wood, dead wood, and bark)

DRC (inches) = Diameter at the root collar

HT (feet) = Total height of the tree

No boardfoot equation is available

Equation 15

$$\text{CVTSL} \cong 0.2615591 + 1.847504 \log_{10} \text{DBH} + 1.085772 \log_{10} \text{HT}, \quad (1)$$

$$\text{CVTS} = 10^{**} \text{CVTSL}$$

$$\text{TARIF} \cong \frac{\text{CVTS} \cdot 0.912733}{\left[\left(1.033 + 1.0 \cdot 1.382937 \exp \left(-0.4015292 \left(\frac{\text{DBH}}{10.0} \right) \right) \right) \cdot \left(\text{BA} \cdot 0.087266 + 0.174533 \right) \right]} \quad (3)$$

$$\text{CV4} \cong \frac{\text{TARIF} \cdot \left(\text{BA} \cdot 0.087266 + 0.174533 \right)}{0.912733} \quad (4)$$

$$\text{CVT} \cong \frac{\text{TARIF} \cdot \left(0.9679 + 0.1051 \cdot 0.5523^{\text{DBH} \cdot 0.15} \right) \cdot \left(1.033 + 1.0 \cdot 1.382937 \exp \left(-0.4015292 \left(\frac{\text{DBH}}{10.0} \right) \right) \right) \cdot \left(\text{BA} \cdot 0.087266 + 0.174533 \right)}{0.912733} \quad (5)$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA = .005454154 x DBH²

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 16 (uses PNW 266 formulas from MacLean and Berger)

'FOR THIS SET OF EQUATIONS CREATE A TEMPORARY DBH AND BA for trees less than 6"DBH

IF DBH < 6.0 THEN **TMP_DBH** = 6.0

'CALCULATE BASAL AREA PER TREE USING DBH AND DBH_TEMP

BA = DBH**2 * 0.005454154

BA_TMP = TMP_DBH **2 * 0.005454154

'CALCULATE A **CUBIC FORM FACTOR** (CF4) USING TMP_DBH and DBH

'CF4 EQUATIONS VARY BY VOLUME EQUATION

CF4 = 0.422709 - 0.0000612236 * (HT**2/DBH)

IF(CF4 < 0.3) CF4=0.3

IF(CF4 > 0.4) CF4=0.4

CF4_TMP = 0.422709 - 0.0000612236 * (HT**2/TMP_DBH)

IF(CF4_TMP < 0.3) CF4_TMP=0.3

IF(CF4_TMP > 0.4) CF4_TMP=0.4

'-----

'For ease of use and to improve readability of equations, calculate the following term and use it

'in the equations that follow. Note that actual DBH and BA are used for all trees.

'Do not use TMP_DBH or BA_TMP here.

TERM = ((1.033 * (1.0 + 1.382937 * EXP(-4.015292 * (DBH/10.0)))) * (BA + 0.087266) - 0.174533)

'-----

IF DBH >= 6.0 THEN

CV4 = CF4 * BA * HT

TARIF = (CV4 * 0.912733) / (BA - 0.087266)

IF (TARIF <= 0.0) TARIF=0.01

CVTS = (CV4 * TERM) / (BA - 0.087266)

CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733

ELSEIF

DBH < 6.0 THEN

CV4_TMP = CF4_TMP * BA_TMP * HT

TARIF_TMP = (CV4_TMP * 0.912733) / (BA_TMP - 0.087266)

IF (TARIF_TMP <= 0.0) TARIF_TMP = 0.01

'CALCULATE An **ADJUSTED TARIF** FOR SMALL TREES (Both DBH and TMP_DBH are used)

TARIF = TARIF_TMP * (0.5 * (TMP_DBH - DBH)**2 + (1.0 + 0.063 * (TMP_DBH - DBH)**2))

IF (TARIF <= .0.0) TARIF = 0.01

CVTS = TARIF * TERM

CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733

CV4 = CF4 * BA * HT (calculated with actual DBH and BA)

END IF

IF DBH < 5.0 THEN CV4 = NULL

IF DBH >= 5.0 THEN KEEP CV4 (i.e. don't keep CV4_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 17

$$CVTS \cong 0.001106485 \partial DBH^{1.8140497} \partial HT^{1.2744923} \quad (1)$$

$$TARIF \cong \frac{CVTS \partial 0.912733}{\left[\left[\left[\left[\left[1.033 \partial 1.0 \cdot 1.382937 \partial \exp \left(0.4015292 \partial \left(\frac{DBH}{10.0} \right) \right) \right] \right] \right] \right] \partial BA \cdot 0.087266 \partial 0.174533 \right]} \quad (2)$$

$$CV4 \cong \frac{TARIF \partial BA \partial 0.087266}{0.912733} \quad (3)$$

$$CVT \cong \frac{TARIF \partial \left[0.9679 \partial 0.1051 \partial 0.5523 DBH^{0.15} \right] \partial \left[\left[\left[\left[\left[1.033 \partial 1.0 \cdot 1.382937 \partial \exp \left(0.4015292 \partial \left(\frac{DBH}{10.0} \right) \right) \right] \right] \right] \right] \right] \partial BA \cdot 0.087266 \partial 0.174533}{0.912733} \quad (5)$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA = .005454154 x DBH²

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 18 (uses PNW 266 formulas from MacLean and Berger)

'FOR THIS SET OF EQUATIONS CREATE A TEMPORARY DBH AND BA for trees less than 6"DBH

IF DBH < 6.0 THEN **TMP_DBH** = 6.0

'CALCULATE BASAL AREA PER TREE USING DBH AND DBH_TEMP

BA = DBH**2 * 0.005454154

BA_TMP = TMP_DBH **2 * 0.005454154

'CALCULATE A **CUBIC FORM FACTOR** (CF4) USING TMP_DBH and DBH

'CF4 EQUATIONS VARY BY VOLUME EQUATION

CF4 = 0.231237 + 0.028176 * (HT/DBH)

IF(CF4 < 0.3) CF4=0.3

IF(CF4 > 0.4) CF4=0.4

CF4_TMP = 0.231237 + 0.028176 * (HT/TMP_DBH)

IF(CF4_TMP < 0.3) CF4_TMP=0.3

IF(CF4_TMP > 0.4) CF4_TMP=0.4

'-----

'For ease of use and to improve readability of equations, calculate the following term and use it
'in the equations that follow. Note that actual DBH and BA are used for all trees.

'Do not use TMP_DBH or BA_TMP here.

TERM = ((1.033 * (1.0 + 1.382937 * EXP(-4.015292 * (DBH/10.0)))) * (BA + 0.087266) - 0.174533)

'-----

IF DBH >= 6.0 THEN

CV4 = CF4 * BA * HT

TARIF = (CV4 * 0.912733) / (BA - 0.087266)

IF (TARIF <= 0.0) TARIF=0.01

CVTS = (CV4 * TERM) / (BA - 0.087266)

CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733

ELSEIF

DBH < 6.0 THEN

CV4_TMP = CF4_TMP * BA_TMP * HT

TARIF_TMP = (CV4_TMP * 0.912733) / (BA_TMP - 0.087266)

IF (TARIF_TMP <= 0.0) TARIF_TMP = 0.01

'CALCULATE An **ADJUSTED TARIF** FOR SMALL TREES (Both DBH and TMP_DBH are used)

TARIF = TARIF_TMP * (0.5 * (TMP_DBH - DBH)**2 + (1.0 + 0.063 * (TMP_DBH - DBH)**2))

IF (TARIF <= .0.0) TARIF = 0.01

CVTS = TARIF * TERM

CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733

CV4 = CF4 * BA * HT (calculated with actual DBH and BA)

END IF

IF DBH < 5.0 THEN CV4 = NULL

IF DBH >= 5.0 THEN KEEP CV4 (i.e. don't keep CV4_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 19 (uses PNW 266 formulas from MacLean and Berger)

‘FOR THIS SET OF EQUATIONS CREATE A TEMPORARY DBH AND BA for trees less than 6”DBH

IF DBH < 6.0 THEN **TMP_DBH** = 6.0

‘CALCULATE BASAL AREA PER TREE USING DBH AND DBH_TEMP

BA = DBH**2 * 0.005454154

BA_TMP = TMP_DBH **2 * 0.005454154

‘CALCULATE A **CUBIC FORM FACTOR** (CF4) USING TMP_DBH and DBH

‘CF4 EQUATIONS VARY BY VOLUME EQUATION

CF4 = 0.225786 + 4.44236 * (1/HT)

IF(CF4 < .27) CF4=.27

CF4_TMP = 0.225786 + 4.44236 * (1/HT)

IF(CF4_TMP < .27) CF4_TMP=.27

‘-----

‘For ease of use and to improve readability of equations, calculate the following term and use it
‘in the equations that follow. Note that actual DBH and BA are used for all trees.

‘Do not use TMP_DBH or BA_TMP here.

TERM = ((1.033 * (1.0 + 1.382937 * EXP(-4.015292 * (DBH/10.0)))) * (BA + 0.087266) - 0.174533)

‘-----

IF DBH >= 6.0 THEN

CV4 = CF4 * BA * HT

TARIF = (CV4 * 0.912733) / (BA - 0.087266)

IF (TARIF <= 0.0) TARIF=0.01

CVTS = (CV4 * TERM) / (BA - 0.087266)

CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733

ELSEIF

DBH < 6.0 THEN

CV4_TMP = CF4_TMP * BA_TMP * HT

TARIF_TMP = (CV4_TMP * 0.912733) / (BA_TMP - 0.087266)

IF (TARIF_TMP <= 0.0) TARIF_TMP = 0.01

‘CALCULATE An **ADJUSTED TARIF** FOR SMALL TREES (Both DBH and TMP_DBH are used)

TARIF = TARIF_TMP * (0.5 * (TMP_DBH - DBH)**2 + (1.0 + 0.063 * (TMP_DBH - DBH)**2))

IF (TARIF <= .0.0) TARIF = 0.01

CVTS = TARIF * TERM

CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733

CV4 = CF4 * BA * HT (calculated with actual DBH and BA)

END IF

IF DBH < 5.0 THEN CV4 = NULL

IF DBH >= 5.0 THEN KEEP CV4 (i.e. don't keep CV4_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # .27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 20 – (uses PNW 266 formulas from MacLean and Berger)

‘FOR THIS SET OF EQUATIONS CREATE A TEMPORARY DBH AND BA for trees less than 6”DBH

IF DBH < 6.0 THEN **TMP_DBH** = 6.0

‘CALCULATE BASAL AREA PER TREE USING DBH AND DBH_TEMP

BA = DBH**2 * 0.005454154

BA_TMP = TMP_DBH **2 * 0.005454154

‘CALCULATE A **CUBIC FORM FACTOR** (CF4) USING TMP_DBH and DBH

‘CF4 EQUATIONS VARY BY VOLUME EQUATION

CF4 = 0.358550 - 0.488134 * (1/DBH)

IF(CF4 < 0.3) CF4=0.3

IF(CF4 > 0.4) CF4=0.4

CF4_TMP = 0.358550 - 0.488134 * (1/ TMP_DBH)

IF(CF4_TMP < 0.3) CF4_TMP=0.3

IF(CF4_TMP > 0.4) CF4_TMP=0.4

‘-----

‘For ease of use and to improve readability of equations, calculate the following term and use it

‘in the equations that follow. Note that actual DBH and BA are used for all trees.

‘Do not use TMP_DBH or BA_TMP here.

TERM = ((1.033 * (1.0 + 1.382937 * EXP(-4.015292 * (DBH/10.0)))) * (BA + 0.087266) - 0.174533)

‘-----

IF DBH >= 6.0 THEN

CV4 = CF4 * BA * HT

TARIF = (CV4 * 0.912733) / (BA - 0.087266)

IF (TARIF <= 0.0) TARIF=0.01

CVTS = (CV4 * TERM) / (BA - 0.087266)

CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733

ELSEIF

DBH < 6.0 THEN

CV4_TMP = CF4_TMP *BA_TMP * HT

TARIF_TMP = (CV4_TMP * 0.912733) / (BA_TMP - 0.087266)

IF (TARIF_TMP <= 0.0) TARIF_TMP = 0.01

‘CALCULATE An **ADJUSTED TARIF** FOR SMALL TREES (Both DBH and TMP_DBH are used)

TARIF = TARIF_TMP * (0.5 * (TMP_DBH - DBH)**2 + (1.0 + 0.063 * (TMP_DBH - DBH)**2))

IF (TARIF <= .0.0) TARIF = 0.01

CVTS = TARIF * TERM

CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733

CV4 = CF4 * BA * HT (calculated with actual DBH and BA)

END IF

IF DBH < 5.0 THEN CV4 = NULL

IF DBH >= 5.0 THEN KEEP CV4 (i.e. don't keep CV4_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # .27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 21

$$CVTS \cong 0.005454154 \left[0.30708901 + 0.0008615762 \cdot HT - 0.0037255243 \cdot DBH + \frac{HT}{HT + 4.5} \right] \cdot DBH^2 \cdot HT \cdot \left[\frac{HT}{HT + 4.5} \right]^2 \quad (1)$$

$$TARIF \cong \frac{CVTS + 0.912733}{\left[\left[\left[\left[1.033 + 1.0 \cdot 1.382937 \cdot \exp\left(-4.015292 \cdot \frac{DBH}{10.0}\right) \right] \cdot BA + 0.087266 + 0.174533 \right] \right] \right]} \quad (2)$$

$$CV4 \cong \frac{CVTS \cdot 3.48}{1.18052 + 0.32736 \cdot \exp(-0.1 \cdot DBH)} + 2.948 \quad (3)$$

$$CVT \cong \frac{TARIF \cdot \left[0.9679 + 0.1051 \cdot 0.5523^{DBH + 1.5} \right] \cdot \left[\left[\left[\left[1.033 + 1.0 \cdot 1.382937 \cdot \exp\left(-4.015292 \cdot \frac{DBH}{10.0}\right) \right] \cdot BA + 0.087266 + 0.174533 \right] \right] \right]}{0.912733} \quad (5)$$

If CVTS < 0 then CVTS = 2

If CV4 < 0 then CV4 = 1

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) $BA = .005454154 \times DBH^2$

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 22

Use for dbh>2

$$CVTSL \cong 0.2624325 + 1.847123 \log DBH + 1.044007 \log HT, \quad (1)$$

$$CVTS \cong \frac{CVTSL}{10.0} \quad (2)$$

$$TARIF \cong \frac{CVTS^{0.912733}}{\left[1.033 + 1.0 + 1.382937 \exp \left(-0.4015292 \left(\frac{DBH}{10.0} \right) \right) \right]^{0.087266} + 0.174533} \quad (3)$$

$$CV4 \cong \frac{TARIF + 0.087266}{0.912733} \quad (4)$$

$$CVT \cong \frac{TARIF^{0.9679} + 0.1051 + 0.5523 DBH^{0.15} \left[1.033 + 1.0 + 1.382937 \exp \left(-0.4015292 \left(\frac{DBH}{10.0} \right) \right) \right]^{0.087266} + 0.174533}{0.912733} \quad (5)$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA = .005454154 x DBH²

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 23 (uses PNW 266 formulas from MacLean and Berger)

'FOR THIS SET OF EQUATIONS CREATE A TEMPORARY DBH AND BA for trees less than 6"DBH

IF DBH < 6.0 THEN **TMP_DBH** = 6.0

'CALCULATE BASAL AREA PER TREE USING DBH AND DBH_TEMP

BA = DBH**2 * 0.005454154

BA_TMP = TMP_DBH **2 * 0.005454154

'CALCULATE A **CUBIC FORM FACTOR** (CF4) USING TMP_DBH and DBH

'CF4 EQUATIONS VARY BY VOLUME EQUATION

CF4 = 0.299039 + 1.91272 * (1/HT) + 0.0000367217 * (HT**2/DBH)

IF(CF4 < 0.3) CF4=0.3

IF(CF4 > 0.4) CF4=0.4

CF4_TMP = 0.299039 + 1.91272 * (1/HT) + 0.0000367217 * (HT**2/TMP_DBH)

IF(CF4_TMP < 0.3) CF4_TMP=0.3

IF(CF4_TMP > 0.4) CF4_TMP=0.4

'-----

'For ease of use and to improve readability of equations, calculate the following term and use it

'in the equations that follow. Note that actual DBH and BA are used for all trees.

'Do not use TMP_DBH or BA_TMP here.

TERM = ((1.033 * (1.0 + 1.382937 * EXP(-4.015292 * (DBH/10.0)))) * (BA + 0.087266) - 0.174533)

'-----

IF DBH >= 6.0 THEN

CV4 = CF4 * BA * HT

TARIF = (CV4 * 0.912733) / (BA - 0.087266)

IF (TARIF <= 0.0) TARIF=0.01

CVTS = (CV4 * TERM) / (BA - 0.087266)

CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733

ELSEIF

DBH < 6.0 THEN

CV4_TMP = CF4_TMP * BA_TMP * HT

TARIF_TMP = (CV4_TMP * 0.912733) / (BA_TMP - 0.087266)

IF (TARIF_TMP <= 0.0) TARIF_TMP = 0.01

'CALCULATE An **ADJUSTED TARIF** FOR SMALL TREES (Both DBH and TMP_DBH are used)

TARIF = TARIF_TMP * (0.5 * (TMP_DBH - DBH)**2 + (1.0 + 0.063 * (TMP_DBH - DBH)**2))

IF (TARIF <= .0.0) TARIF = 0.01

CVTS = TARIF * TERM

CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733

CV4 = CF4 * BA * HT (calculated with actual DBH and BA)

END IF

IF DBH < 5.0 THEN CV4 = NULL

IF DBH >= 5.0 THEN KEEP CV4 (i.e. don't keep CV4_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 24

$$CVTS \cong \exp \{ 0.62597 + 1.9967 \ln DBH + 0.9642 \ln HT \}, \quad (1)$$

$$TARIF \cong \frac{CVTS \partial 0.912733}{\left[\left[\left[\left[1.033 \partial 1.0 + 1.382937 \partial \exp \left\{ 0.4015292 \partial \left(\frac{DBH}{10.0} \right) \right\} \right] \right] \partial BA + 0.087266 + 0.174533 \right] \right]} \quad (2)$$

$$CV4 \cong \frac{TARIF \partial BA + 0.087266}{0.912733}, \quad (3)$$

$$CVT \cong \frac{TARIF \partial 0.9679 + 0.1051 \partial 0.5523 DBH^{0.15} \left[\left[\left[\left[1.033 \partial 1.0 + 1.382937 \partial \exp \left\{ 0.4015292 \partial \left(\frac{DBH}{10.0} \right) \right\} \right] \right] \partial BA + 0.087266 + 0.174533 \right] \right]}{0.912733} \quad (4)$$

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA = .005454154 x DBH²

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

SOFTWOOD BOARDFOOT VOLUME EQUATIONS

$$RC6 \cong 0.993 \cdot \left[0.993 \cdot 0.62^{DBH^{0.60}} \right]$$

$$CV6 \cong RC6 \cdot CV4$$

IF CV6 > CV4 THEN CV6 = CV4

$$CUBUS \cong CV4 \cdot CV6$$

$$B4 \cong \frac{TARIF}{0.912733}$$

$$RS616L \cong 0.174439 \cdot 0.117594 \cdot \log(DBH) \cdot \log(B4) \cdot \frac{8.210585}{DBH^2} \cdot 0.236693 \cdot \log(B4) \cdot 0.00001345 \cdot B4^2 \cdot 0.00001937 \cdot DBH^2$$

$$RS616 \cong 10.0^{RS616L}$$

$$RS632 \cong 1.001491 \cdot \frac{6.924097}{TARIF} \cdot 0.00001351 \cdot DBH^2$$

$$SV616 \cong RS616 \cdot CV6$$

$$SV632 \cong RS632 \cdot SV616$$

$$SCRIB \cong SV632$$

note: West-side Scribner conifer volumes are based on 32 foot logs, for areas other than western Oregon and western Washington SCRIB = sv616

$$RI6 \cong 0.2904154 \cdot 3.466328 \cdot \log(DBH) \cdot TARIF \cdot 0.02765985 \cdot DBH \cdot 0.00008205 \cdot TARIF^2 \cdot \frac{11.29598}{DBH^2}$$

$$XINT6 \cong RI6 \cdot CV6$$

Where:

B4 = BINGO FACTOR

CUBUS = CUBIC FOOT VOLUME, UPPER-STEM PORTION

RC6 = RATIO TO CONVERT CUBIC 4-INCH TOP TO CUBIC 6-INCH TOP

CV6 = CUBIC FOOT VOLUME, 6-INCH TOP (SAWLOG)

RS616 = RATIO TO CONVERT CUBIC 6-INCH TOP TO SCRIB 6-INCH TOP IN 16-FT LOGS

RS632 = RATIO TO CONVERT SCRIB 6-INCH TOP IN 16-FT LOGS TO SCRIB 6-INCH TOP IN 32-FT LOGS (WEST-SIDE ONLY)

SV632 = SCRIBNER VOLUME--6-INCH TOP (IN 32-FT LOGS) (WEST-SIDE ONLY)

SV616 = SCRIBNER VOLUME--6-INCH TOP (IN 16-FT LOGS)

RI6 = RATIO TO CONVERT CUBIC 6-INCH TOP TO INTERNATIONAL 1/4 INCH 6-INCH TOP

XINT6 = INTERNATIONAL 1/4 INCH VOLUME--6-INCH TOP (IN 16-FT LOGS)

HARDWOOD CUBIC VOLUME EQUATIONS

Volume equation numbers

Species Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
312	Bigleaf maple	37	25	37	25	37
313	Boxelder	37	25	37	25	38
320	Norway maple	37	--	--	--	--
321	Rocky Mountain maple	45	45	45	45	45
322	Bigtooth maple	45	45	45	45	45
333	California buckeye	--	--	--	--	43
341	Tree of heaven	26	--	26	--	--
351	Red alder	25	26	26	26	26
352	White alder	26	26	26	26	26
361	Pacific madrone	40	25	--	--	40
374	Water birch	25	25	25	25	25
375	Paper birch	25	25	25	25	25
431	Golden chinkapin	32	25	32	--	32
475	Curlleaf mountain-mahogany	45	45	45	45	45
492	Pacific dogwood	25	25	25	25	37
500	Hawthorn	25	25	25	25	42
510/511	Eucalyptus	--	--	--	--	31
542	Oregon ash	38	25	38	25	38
547	Velvet ash	--	--	--	--	38
590/591	Holly	25	25	25	25	25
600	Walnut	--	--	--	--	38
603	Northern California black walnut	38	--	--	38	38
604	Southern California black walnut	--	--	--	--	38
611	Sweet gum	--	--	--	--	26
631	Tanoak	34	--	--	--	34
660	Apples	25	25	25	25	42
661	Oregon crabapple	25	25	25	25	42
730	California sycamore	--	--	--	--	42
731	American sycamore	--	--	--	--	42
746	Quaking aspen	25	25	25	25	28
747	Black cottonwood	25	25	25	25	27
748	Fremont poplar	--	--	--	--	27
756	honey mesquite	--	--	--	--	46
758	screwbean mesquite	--	--	--	--	46
760	Cherry	25	25	25	25	26
763	Common chokecherry	25	25	25	25	41
768	Bitter cherry	25	25	25	25	26
771	Sweet cherry	25	--	--	--	--

HARDWOOD CUBIC VOLUME EQUATIONS

Volume equation numbers (Continued)

Species Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
801	California live oak	--	--	--	--	43
805	Canyon live oak	42	--	--	--	42
807	Blue oak	--	--	--	--	39
811	Englemann oak	--	--	--	--	36
815	Oregon white oak	41	25	41	25	41
818	California black oak	38	--	38	--	38
821	California white oak	35	--	--	--	35
826	Chinkapin oak	--	--	--	--	38
839	Interior live oak	--	--	--	--	44
901	Black locust	37	--	37	25	38
920	Willows	25	25	25	25	40
922	Black willow	40	--	--	--	40
926	Balsam willow	25	--	--	--	--
927	White willow	25	25	--	--	--
929	Weeping willow	--	--	25	--	--
981	California-laurel	33	--	--	--	33
990	Desert ironwood	--	--	46	46	46
997	Russian-olive	37	25	37	25	38
998	Unknown hardwood	25	25	25	25	41
999	Unknown Tree	25	25	25	25	41

HARDWOOD VOLUME EQUATION SOURCES

EQUATION 25	ALDER	(CURTIS/BRUCE, PNW-56 and DNR 24)
EQUATION 26	ALDER	(BC-ALDER--DNR RPT#24,1977)
EQUATION 27	COTTONWOOD	(BC-COTTONWOOD--DNR RPT#24,1977)
EQUATION 28	ASPEN	(BC-ASPEN--DNR RPT#24,1977)
EQUATION 29	BIRCH	(BC-BIRCH--DNR RPT#24,1977)
EQUATION 30	BIGLEAF MAPLE	(BC-MAPLE--DNR RPT#24,1977)
EQUATION 31	EUCALYPTUS	(MEMO,COLIN D. MacLEAN 1/27/83,(REVISED 2/7/83))
EQUATION 32	G.CHINQUAPIN	(PILLSBURY (H,D), CHARLES BOLSINGER 1/3/83)
EQUATION 33	C.LAUREL	(PILLSBURY (H,D), CHARLES BOLSINGER 1/3/83)
EQUATION 34	TANOAK	(PILLSBURY (H,D), CHARLES BOLSINGER 1/3/83)
EQUATION 35	CALIF WHITE OAK	(PILLSBURY (H,D), CHARLES BOLSINGER 1/3/83)
EQUATION 36	ENGELMANN OAK	(PILLSBURY (H,D), CHARLES BOLSINGER 1/3/83)
EQUATION 37	BIGLEAF MAPLE	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION 38	CALIF BLACK OAK	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION 39	BLUE OAK	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION 40	PACIFIC MADRONE	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION 41	ORE WHITE OAK	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION 42	CANYON LIVE OAK	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION 43	COAST LIVE OAK	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION 44	INT LIVE OAK	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION 45	MTN. MAHOGANY	(Chojnacky, 1985)
EQUATION 46	MESQUITE	(Chojnacky, 1985)

Equation 25

Curtis, Robert O., Bruce, David, and Caryanne VanCoevering. 1968. Volume and taper tables for red alder. US Forest Serv. Res. Pap. PNW-56. PNW Forest & Range Exp. Sta., Portland, Oregon. 35p.

Equations 26,27,28,29,30

Brckett, Michael. 1977. Notes on TARIF tree-volume computation. DNR report #24. State of Washington, Department of Natural Resources, Olympia, WA. 132p. (see page 5)

Equation 31

Colin MacLean and Tom Farrenkopf. 1983. Eucalyptus volume equation. In-house memo describing the volume equation for CVTS, to be used for all species of Eucalyptus. The equation was developed from 111 trees. On file at the PNW Research Station,Portland,OR

Equations 32 - 44

Pillsbury, Norman H. and Michael L. Kirkley. 1984. Equations for Total, Wood, and Saw-log Volume for Thirteen California Hardwoods. PNW Research Note, PNW-414. Pacific Northwest Research Station, Portland Oregon. 52p.

Equations 45, 46

Chojnacky D.C., 1985. Pinyon-Juniper Volume Equations for the Central Rocky Mountain States. Res. Note INT-339, USDA, Forest Service, Intermountain Res. Station, Ogden, UT 84401.

EQUATION 26

$$CVTSL \cong 02.672775 + 1.920617 \log(DBH) + 1.074024 \log(HT) \quad (1)$$

$$CVTS = 10^{CVTSL} \quad (2)$$

$$TARIF \cong \frac{CVTS + 0.912733}{\left[\left(1.033 + 1.0 + 1.382937 \exp \left(0.4015292 + \frac{DBH}{10.0} \right) \right) + BA + 0.087266 + 0.174533 \right]} \quad (3)$$

$$CVT \cong \frac{TARIF + 0.9679 + 0.1051 + 0.5523^{DBH + 1.5}}{0.912733} \left[\left(1.033 + 1.0 + 1.382937 \exp \left(0.4015292 + \frac{DBH}{10.0} \right) \right) + BA + 0.087266 + 0.174533 \right] \quad (4)$$

$$CV4 \cong \frac{TARIF + 0.087266}{0.912733} \quad (5)$$

$$RC8 \cong 0.983 - 0.983 + 0.65^{DBH + 0.6},$$

$$CV8 \cong RC8 + CV4 \quad (6)$$

$$CV4X \cong CV4$$

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA = .005454154 x DBH²

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 27

$$CVTSL \cong 0.2945047 + 1.803973 \log(DBH) + 1.238853 \log(HT) \quad (1)$$

$$CVTS = 10^{CVTSL} \quad (2)$$

$$TARIF \cong \frac{CVTS + 0.912733}{\left[\left(1.033 + 1.0 + 1.382937 \exp \left(0.4015292 \left(\frac{DBH}{10.0} \right) \right) \right) + BA + 0.087266 + 0.174533 \right]} \quad (3)$$

$$CVT \cong \frac{TARIF + 0.9679 + 0.1051 + 0.5523 DBH^{0.15}}{0.912733} \left[\left(1.033 + 1.0 + 1.382937 \exp \left(0.4015292 \left(\frac{DBH}{10.0} \right) \right) \right) + BA + 0.087266 + 0.174533 \right] \quad (4)$$

$$CV4 \cong \frac{TARIF + BA + 0.087266}{0.912733} \quad (5)$$

$$RC8 \cong 0.983 - 0.983 + 0.65 DBH^{0.86},$$

$$CV8 \cong RC8 + CV4 \quad (6)$$

$$CV4X \cong CV4$$

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA = .005454154 x DBH²

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 28

$$CVTSL \cong 0.2635360 + 1.946034 \log(DBH) + 1.024793 \log(HT) \quad (1)$$

$$CVTS = 10^{CVTSL} \quad (2)$$

$$TARIF \cong \frac{CVTS + 0.912733}{\left[\left(1.033 + 1.0 + 1.382937 \exp \left(-0.4015292 \left(\frac{DBH}{10.0} \right) \right) \right) + BA + 0.087266 + 0.174533 \right]} \quad (3)$$

$$CVT \cong \frac{TARIF + 0.9679 + 0.1051 + 0.5523 DBH^{0.15}}{0.912733} \left[\left(1.033 + 1.0 + 1.382937 \exp \left(-0.4015292 \left(\frac{DBH}{10.0} \right) \right) \right) + BA + 0.087266 + 0.174533 \right] \quad (4)$$

$$CV4 \cong \frac{TARIF + BA + 0.087266}{0.912733} \quad (5)$$

$$RC8 \cong 0.983 - 0.983 + 0.65 DBH^{0.86},$$

$$CV8 \cong RC8 + CV4 \quad (6)$$

$$CV4X \cong CV4$$

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA = .005454154 x DBH²

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 29

$$CVTSL \cong 02.757813 + 1.911681 \log(DBH) + 1.105403 \log(HT) \quad (1)$$

$$CVTS = 10^{**} CVTSL \quad (2)$$

$$TARIF \cong \frac{CVTS \cdot 0.912733}{\left[\left(1.033 \cdot 1.0 \cdot 1.382937 \cdot \exp \left(0.4015292 \cdot \left(\frac{DBH}{10.0} \right) \right) \right) \cdot BA \cdot 0.087266 \cdot 0.174533 \right]} \quad (3)$$

$$CVT \cong \frac{TARIF \cdot 0.9679 + 0.1051 \cdot 0.5523 \cdot DBH^{0.15}}{0.912733} \cdot \left[\left(1.033 \cdot 1.0 \cdot 1.382937 \cdot \exp \left(0.4015292 \cdot \left(\frac{DBH}{10.0} \right) \right) \right) \cdot BA \cdot 0.087266 \cdot 0.174533 \right] \quad (4)$$

$$CV4 \cong \frac{TARIF \cdot BA \cdot 0.087266}{0.912733} \quad (5)$$

$$RC8 \cong 0.983 - 0.983 \cdot 0.65^{DBH^{0.6}},$$

$$CV8 \cong RC8 \cdot CV4 \quad (6)$$

$$CV4X \cong CV4$$

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA = .005454154 x DBH²

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 30

$$CVTSL \cong 02.770324 + 1.885813 \log(DBH) + 1.119043 \log(HT) \quad (1)$$

$$CVTS = 10^{**} CVTSL \quad (2)$$

$$TARIF \cong \frac{CVTS \cdot 0.912733}{\left[\left(1.033 \cdot 1.0 \cdot 1.382937 \cdot \exp\left(0.4015292 \cdot \frac{DBH}{10.0}\right) \right) \cdot BA \cdot 0.087266 \cdot 0.174533 \right]} \quad (3)$$

$$CVT \cong \frac{TARIF \cdot 0.9679 + 0.1051 \cdot DBH^{0.15}}{0.912733} \cdot \left[\left(1.033 \cdot 1.0 \cdot 1.382937 \cdot \exp\left(0.4015292 \cdot \frac{DBH}{10.0}\right) \right) \cdot BA \cdot 0.087266 \cdot 0.174533 \right] \quad (4)$$

$$CV4 \cong \frac{TARIF \cdot BA \cdot 0.087266}{0.912733} \quad (5)$$

$$RC8 \cong 0.983 - 0.983 \cdot 0.65^{DBH^{0.6}},$$

$$CV8 \cong RC8 \cdot CV4 \quad (6)$$

$$CV4X \cong CV4$$

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA = .005454154 x DBH²

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 31

$$CVTS \cong 0.0016144 \partial DBH^2 \partial HT \quad (1)$$

$$TARIF \cong \frac{+CVTS \partial 0.912733,}{\left[\left[\left[\left[\left[1.033 \partial 1.0 \cdot 1.382937 \partial \exp \left(0.4015292 \partial \left(\frac{DBH}{10.0} \right) \right) \right] \right] \right] \right] \right] \partial +BA \cdot 0.087266, 0.174533} \quad (2)$$

$$CVT \cong \frac{TARIF \partial \left[0.9679 \partial 0.1051 \partial 0.5523^{DBH \partial 1.5} \right] \partial \left[\left[\left[\left[\left[1.033 \partial 1.0 \cdot 1.382937 \partial \exp \left(0.4015292 \partial \left(\frac{DBH}{10.0} \right) \right) \right] \right] \right] \right] \right] \partial +BA \cdot 0.087266, 0.174533}{0.912733} \quad (3)$$

$$CV4 \cong \frac{TARIF \partial +BA \partial 0.087266,}{0.912733} \quad (4)$$

$$RC8 \cong 0.983 - 0.983 \partial 0.65^{+DBH \partial 8.6},$$

$$CV8 \cong RC8 \partial CV4 \quad (5)$$

$$CV4X \cong CV4$$

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA = .005454154 x DBH²

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 32

$$CVTS \cong 0.0120372263 \partial DBH^{2.02232} \partial HT^{0.68638} \quad (1)$$

$$CV4 \cong 0.0055212937 \partial DBH^{2.07202} \partial HT^{0.77467} \quad (2)$$

$$CV8 \cong 0.0018985111 \partial DBH^{2.38285} \partial HT^{0.77105} \quad (3)$$

$$CVT \cong CVTS * RTS \quad (4)$$

$$RTS \cong 0.96790 \partial 0.1051 \partial 0.5523^{(DBH^{0.15})}$$

$$CV4X \cong CVT \partial \left[0.99875 \partial \frac{43.336}{DBH^3} \partial \frac{124.717}{DBH^4} \cdot \frac{0.193437 \partial HT}{DBH^3} \cdot \frac{479.83}{\left[DBH^3 \partial HT \right]} \right] \quad (5)$$

$$TARIF \cong \frac{CV8 \partial 0.912733}{\left[0.983 \partial 0.983 \partial 0.65^{DBH^{0.86}} \right] \partial BA \partial 0.087266} \quad (6)$$

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH²

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 33

$$CVTS \cong 0.0057821322 \partial DBH^{1.94553} \partial HT^{0.88389} \quad (1)$$

$$CV4 \cong 0.0016380753 \partial DBH^{2.05910} \partial HT^{1.05293} \quad (2)$$

$$CV8 \cong 0.0007741517 \partial DBH^{2.23009} \partial HT^{1.03700} \quad (3)$$

$$CVT \cong CVTS * RTS \quad (4)$$

$$RTS \cong 0.96790 \partial 0.1051 \partial 0.5523^{(DBH^{0.15})}$$

$$CV4X \cong CVT \partial \left[0.99875 \partial \frac{43.336}{DBH^3} \partial \frac{124.717}{DBH^4} \cdot \frac{-0.193437 \partial HT}{DBH^3} \cdot \frac{479.83}{\left[DBH^3 \partial HT \right]} \right] \quad (5)$$

$$TARIF \cong \frac{CV8 \partial 0.912733}{\left[0.983 \partial 0.983 \partial 0.65^{DBH^{0.6}} \right] \partial BA \partial 0.087266} \quad (6)$$

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH²

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 34

If HT > 120 feet then set HT = 120 feet

$$CVTS \cong 0.0058870024 \partial DBH^{1.94165} \partial HT^{0.86562} \quad (1)$$

$$CV4 \cong 0.0005774970 \partial DBH^{2.19576} \partial HT^{1.14078} \quad (2)$$

$$CV8 \cong 0.0002526443 \partial DBH^{2.30949} \partial HT^{1.21069} \quad (3)$$

$$CVT \cong CVTS * RTS \quad (4)$$

$$RTS \cong 0.96790 \partial 0.1051 \partial 0.5523^{(DBH^{0.5})}$$

$$CV4X \cong CVT \partial \left[0.99875 \partial \frac{43.336}{DBH^3} \partial \frac{124.717}{DBH^4} \partial \frac{0.193437 \partial HT}{DBH^3} \partial \frac{479.83}{DBH^3 \partial HT} \right] \quad (5)$$

$$TARIF \cong \frac{CV8 \partial 0.912733}{\left[0.983 \partial 0.983 \partial 0.65^{DBH^{0.6}} \right] \partial BA \partial 0.087266} \quad (6)$$

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH²

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 35

$$CVTS \cong 0.0042870077 \partial DBH^{2.33631} \partial HT^{0.74872} \quad (1)$$

$$CV4 \cong 0.0009684363 \partial DBH^{2.39565} \partial HT^{0.98878} \quad (2)$$

$$CV8 \cong 0.0001880044 \partial DBH^{1.87346} \partial HT^{1.62443} \quad (3)$$

$$CVT \cong CVTS * RTS \quad (4)$$

$$RTS \cong 0.96790 \partial 0.1051 \partial 0.5523^{(DBH^{0.15})} \quad (4)$$

$$CV4X \cong CVT \partial \left[0.99875 \partial \frac{43.336}{DBH^3} \partial \frac{124.717}{DBH^4} \cdot \frac{0.193437 \partial HT}{DBH^3} \cdot \frac{479.83}{\left[DBH^3 \partial HT \right]} \right] \quad (5)$$

$$TARIF \cong \frac{CV8 \partial 0.912733,}{\left[0.983 \partial 0.983 \partial 0.65^{DBH^{0.6}}, \right] \partial BA \partial 0.087266,} \quad (6)$$

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH²

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 36

$$CVTS \cong 0.0191453191 \partial DBH^{2.40248} \partial HT^{0.28060} \quad (1)$$

$$CV4 \cong 0.0053866353 \partial DBH^{2.61268} \partial HT^{0.31103} \quad (2)$$

$$CV8 = CV4 \quad (3)$$

$$CVT \cong CVTS * RTS \quad (4)$$

$$RTS \cong 0.96790 \partial 0.1051 \partial 0.5523^{(DBH^{0.15})} \quad (4)$$

$$CV4X \cong CVT \partial \left[0.99875 \partial \frac{43.336}{DBH^3} \partial \frac{124.717}{DBH^4} \cdot \frac{0.193437 \partial HT}{DBH^3} \cdot \frac{479.83}{\partial DBH^3 \partial HT} \right] \quad (5)$$

$$TARIF \cong \frac{CV8 \partial 0.912733}{\left[0.983 \partial 0.983 \partial 0.65^{DBH^{0.6}} \right] \partial BA \partial 0.087266} \quad (6)$$

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH²

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 37

$$CVTS \cong 0.0101786350 \partial DBH^{2.22462} \partial HT^{0.57561} \quad (1)$$

$$CV4 \cong 0.0034214162 \partial DBH^{2.35347} \partial HT^{0.69586} \quad (2)$$

$$CV8 \cong 0.0004236332 \partial DBH^{2.10316} \partial HT^{1.08584} \partial FC^{0.40017} \quad (3)$$

$$CVT \cong CVTS * RTS \quad (4)$$

$$RTS \cong 0.96790 \partial 0.1051 \partial 0.5523^{(DBH^{0.15})} \quad (4)$$

$$CV4X \cong CVT \partial \left[0.99875 \partial \frac{43.336}{DBH^3} \partial \frac{124.717}{DBH^4} \partial \frac{0.193437 \partial HT}{DBH^3} \partial \frac{479.83}{DBH^3 \partial HT} \right] \quad (5)$$

$$TARIF \cong \frac{CV8 \partial 0.912733}{\partial \left[0.983 \partial 0.983 \partial 0.65 \partial DBH^{0.86} \right] \partial BA \partial 0.087266} \quad (6)$$

WHERE:

DBH= DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH²

FC= HARDWOOD FORM CLASS

CVTS= CUBIC FOOT VOLUME, TOP AND STUMP

TARIF= TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 38

$$CVTS \cong 0.0070538108 \partial DBH^{1.97437} \partial HT^{0.85034} \quad (1)$$

$$CV4 \cong 0.0036795695 \partial DBH^{2.12635} \partial HT^{0.83339} \quad (2)$$

$$CV8 \cong 0.0012478663 \partial DBH^{2.68099} \partial HT^{0.42441} \partial FC^{0.28385} \quad (3)$$

$$CVT \cong CVTS * RTS \quad (4)$$

$$RTS \cong 0.96790 \partial 0.1051 \partial 0.5523^{(DBH^{0.15})} \quad (4)$$

$$CV4X \cong CVT \partial \left[0.99875 \partial \frac{43.336}{DBH^3} \partial \frac{124.717}{DBH^4} \cdot \frac{0.193437 \partial HT}{DBH^3} \cdot \frac{479.83}{\left[DBH^3 \partial HT \right]} \right] \quad (5)$$

$$TARIF \cong \frac{CV8 \partial 0.912733}{\left[0.983 \partial 0.983 \partial 0.65^{DBH^{0.6}} \right] \partial BA \partial 0.087266} \quad (6)$$

WHERE:

DBH= DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH²

FC=HARDWOOD FORM CLASS

CVTS = CUBIC FOOT VOLUME, TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 39

$$CVTS \cong 0.0125103008 \partial DBH^{2.33089} \partial HT^{0.46100} \quad (1)$$

$$CV4 \cong 0.0042324071 \partial DBH^{2.53987} \partial HT^{0.50591} \quad (2)$$

$$CV8 \cong 0.0036912408 \partial DBH^{1.79732} \partial HT^{0.83884} \partial FC^{0.15958} \quad (3)$$

$$CVT \cong CVTS * RTS \quad (4)$$

$$RTS \cong 0.96790 \partial 0.1051 \partial 0.5523^{(DBH^{0.15})} \quad (4)$$

$$CV4X \cong CVT \partial \left[0.99875 \partial \frac{43.336}{DBH^3} \partial \frac{124.717}{DBH^4} \cdot \frac{0.193437 \partial HT}{DBH^3} \cdot \frac{479.83}{\left[DBH^3 \partial HT \right]} \right] \quad (5)$$

$$TARIF \cong \frac{CV8 \partial 0.912733}{\left[0.983 \partial 0.983 \partial 0.65^{DBH^{0.6}} \right] \partial BA \partial 0.087266} \quad (6)$$

WHERE:

DBH= DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH²

FC=HARDWOOD FORM CLASS

CVTS = CUBIC FOOT VOLUME, TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 40

If HT > 120 feet then set HT = 120 feet

$$CVTS \cong 0.0067322665 \partial DBH^{1.96628} \partial HT^{0.83458} \quad (1)$$

$$CV4 \cong 0.0025616425 \partial DBH^{1.99295} \partial HT^{1.01532} \quad (2)$$

$$CV8 \cong 0.0006181530 \partial DBH^{1.72635} \partial HT^{1.26462} \partial FC^{0.37868} \quad (3)$$

$$CVT \cong CVTS * RTS \quad (4)$$

$$RTS \cong 0.96790 \partial 0.1051 \partial 0.5523^{(DBH^{0.15})} \quad (4)$$

$$CV4X \cong CVT \partial \left[0.99875 \partial \frac{43.336}{DBH^3} \partial \frac{124.717}{DBH^4} \partial \frac{0.193437 \partial HT}{DBH^3} \partial \frac{479.83}{DBH^3 \partial HT} \right] \quad (5)$$

$$TARIF \cong \frac{CV8 \partial 0.912733}{\left[0.983 \partial 0.983 \partial 0.65^{DBH^{0.6}} \right] \partial BA \partial 0.087266} \quad (6)$$

WHERE:

DBH= DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA= BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH²

FC=HARDWOOD FORM CLASS

CVTS = CUBIC FOOT VOLUME, TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 41

$$CVTS \cong 0.0072695058 \partial DBH^{2.14321} \partial HT^{0.74220} \quad (1)$$

$$CV4 \cong 0.0024277027 \partial DBH^{2.25575} \partial HT^{0.87108} \quad (2)$$

$$CV8 \cong 0.0008281647 \partial DBH^{2.10651} \partial HT^{0.91215} \partial FC^{0.32652} \quad (3)$$

$$CVT \cong CVTS * RTS \quad (4)$$

$$RTS \cong 0.96790 \partial 0.1051 \partial 0.5523^{(DBH^{0.15})} \quad (4)$$

$$CV4X \cong CVT \partial \left[0.99875 \partial \frac{43.336}{DBH^3} \partial \frac{124.717}{DBH^4} \cdot \frac{0.193437 \partial HT}{DBH^3} \cdot \frac{479.83}{\left[DBH^3 \partial HT \right]} \right] \quad (5)$$

$$TARIF \cong \frac{CV8 \partial 0.912733}{\left[0.983 \partial 0.983 \partial 0.65^{DBH^{0.6}} \right] \partial BA \partial 0.087266} \quad (6)$$

WHERE:

DBH= DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH²

FC=HARDWOOD FORM CLASS

CVTS = CUBIC FOOT VOLUME, TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 42

$$CVTS \cong 0.0097438611 \partial DBH^{2.20527} \partial HT^{0.61190} \quad (1)$$

$$CV4 \cong 0.0031670596 \partial DBH^{2.32519} \partial HT^{0.74348} \quad (2)$$

$$CV8 \cong 0.0006540144 \partial DBH^{2.24437} \partial HT^{0.81358} \partial FC^{0.43381} \quad (3)$$

$$CVT \cong CVTS * RTS \quad (4)$$

$$RTS \cong 0.96790 \partial 0.1051 \partial 0.5523^{(DBH^{0.15})} \quad (4)$$

$$CV4X \cong CVT \partial \left[0.99875 \partial \frac{43.336}{DBH^3} \partial \frac{124.717}{DBH^4} \cdot \frac{0.193437 \partial HT}{DBH^3} \cdot \frac{479.83}{\left[DBH^3 \partial HT \right]} \right] \quad (5)$$

$$TARIF \cong \frac{CV8 \partial 0.912733}{\left[0.983 \partial 0.983 \partial 0.65^{DBH^{0.6}} \right] \partial BA \partial 0.087266} \quad (6)$$

WHERE:

DBH= DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH²

FC=HARDWOOD FORM CLASS

CVTS = CUBIC FOOT VOLUME, TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 43

$$CVTS \cong 0.0065261029 \partial DBH^{2.31958} \partial HT^{0.62528} \quad (1)$$

$$CV4 \cong 0.0024574847 \partial DBH^{2.53284} \partial HT^{0.60764} \quad (2)$$

$$CV8 \cong 0.0006540144 \partial DBH^{2.24437} \partial HT^{0.81358} \partial FC^{0.43381} \quad (3)$$

$$CVT \cong CVTS * RTS \quad (4)$$

$$RTS \cong 0.96790 \partial 0.1051 \partial 0.5523^{(DBH^{0.15})} \quad (4)$$

$$CV4X \cong CVT \partial \left[0.99875 \partial \frac{43.336}{DBH^3} \partial \frac{124.717}{DBH^4} \cdot \frac{0.193437 \partial HT}{DBH^3} \cdot \frac{479.83}{\left[DBH^3 \partial HT \right]} \right] \quad (5)$$

$$TARIF \cong \frac{CV8 \partial 0.912733}{\left[0.983 \partial 0.983 \partial 0.65^{DBH^{0.6}} \right] \partial BA \partial 0.087266} \quad (6)$$

WHERE:

DBH= DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH²

FC=HARDWOOD FORM CLASS

CVTS = CUBIC FOOT VOLUME, TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 44

$$CVTS \cong 0.0136818837 \partial DBH^{2.02989} \partial HT^{0.63257} \quad (1)$$

$$CV4 \cong 0.0041192264 \partial DBH^{2.14915} \partial HT^{0.77843} \quad (2)$$

$$CV8 \cong 0.0006540144 \partial DBH^{2.24437} \partial HT^{0.81358} \partial FC^{0.43381} \quad (3)$$

$$CVT \cong CVTS * RTS \quad (4)$$

$$RTS \cong 0.96790 \partial 0.1051 \partial 0.5523^{(DBH^{0.15})} \quad (4)$$

$$CV4X \cong CVT \partial \left[0.99875 \partial \frac{43.336}{DBH^3} \partial \frac{124.717}{DBH^4} \cdot \frac{0.193437 \partial HT}{DBH^3} \cdot \frac{479.83}{\left[DBH^3 \partial HT \right]} \right] \quad (5)$$

$$TARIF \cong \frac{CV8 \partial 0.912733}{\left[0.983 \partial 0.983 \partial 0.65^{DBH^{0.6}} \right] \partial BA \partial 0.087266} \quad (6)$$

WHERE:

DBH= DBH(CM) CONVERTED TO INCHES (DBH/2.54)

HT = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES) BA= .005454154 x DBH²

FC=HARDWOOD FORM CLASS

CVTS = CUBIC FOOT VOLUME, TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

EQUATION 45

IF (DRC >= 3 AND HT > 0) then Factor = DRC x DRC x HT;

IF STEMS =1 then

VOLUME = (-0.13363 + (0.128222 x (Factor^{1/3})) + 0 .080208)³

ELSE IF STEMS > 1 THEN

VOLUME = (-0.13363 + (0.128222 x (Factor^{1/3})))³

IF VOLUME <=0 then VOLUME = 0.1

WHERE:

VOLUME = cubic foot volume from ground level to a 1.5-inch minimum branch diameter
(includes live wood, dead wood, and bark)

STEMS = number of stems 3 inches and larger within the first foot above DRC. When STEMS=1 it is a single stemmed tree

DRC (inches) = Diameter at the root collar

HT (feet) = Total height of the tree

No boardfoot equation is available

Equation 46

IF (DRC >= 3 AND HT > 0) then Factor = DRC x DRC x HT;

IF STEMS > 1 then

if DRC**2 * HT/1000 <=2 then

VOLUME = 0.020 + 1.8972 * DRC**2*HT/1000 + 0.5756 * (DRC**2*HT/1000)**2

Else

VOLUME = 6.927 + 1.8972 * DRC**2*HT/1000 - 9.210 / (DRC**2*HT/1000)

IF STEMS =1 then

if DRC**2 * HT/1000 <=2 then

VOLUME = -0.043 + 2.3378 * DRC**2*HT/1000 + 0.8024 * (DRC**2*HT/1000)**2

Else

VOLUME = 9.586 + 2.3378 * DRC**2*HT/1000 - 12.839 / (DRC**2*HT/1000)

IF VOLUME <=0 then VOLUME = 0.1

WHERE:

VOLUME = cubic foot volume from ground level to a 1.5-inch minimum branch diameter
(includes live wood, dead wood, and bark)

STEMS = number of stems 3 inches and larger within the first foot above DRC. When STEMS=1 it is a single stemmed tree.

DRC (inches) = Diameter at the root collar

HT (feet) = Total height of the tree

HARDWOOD BOARDFOOT VOLUME RATIOS and EQUATIONS

$$\text{CUBUS} \cong \text{CV4} \div \text{CV8} \quad (1)$$

$$\text{RC6} \cong 0.993 \div 0.993 \div 0.62^{DBH^{0.6}}, \quad (2)$$

IF Hardwood Equation Number is 25 to 31 THEN set

CV4X = CVT

TARIFX = TARIF (note that TARIF was calculated in the cubic volume equation)

Otherwise, for all other hardwood equation numbers, calculate CV4X and TARIFX as follows:

$$\text{CV4X} \cong \text{CVT} \div 0.998750 \frac{43.336}{\text{DBH}^3} \div \frac{124.717}{\text{DBH}^4} \cdot \frac{0.193437 \div \text{HT}}{\text{DBH}^3} \cdot \frac{479.83}{\text{DBH}^3 \div \text{HT}}$$

$$\text{TARIFX} \cong \frac{\text{CV8} \div 0.912733}{0.9830 \div 0.983 \div 0.65^{DBH^{0.6}} \div \text{BA} \div 0.087266}$$

If TARIF or TARIFX are <0 then set them to .01

$$\text{CV6} \cong \text{RC6} \div \text{CV4X} \quad (3)$$

$$\text{B4} \cong \frac{\text{TARIFX}}{0.912733}$$

$$\text{RS616L} \cong 0.174439 \cdot 0.117594 \div \log^{DBH} \cdot \log(\text{B4}) \div \frac{8.210585}{\text{DBH}^2} \cdot 0.236693 \div \log(\text{B4}) \div 0.00001345 \div \text{B4}^2 \div 0.00001937 \div \text{DBH}^2 \quad (4)$$

$$\text{RS616} \cong 10.0^{RS616L} \quad (5)$$

$$\text{SV616} \cong \text{RS616} \div \text{CV6}$$

$$\text{RI6} \cong 02.904154 \cdot 3.466328 \div \log^{DBH} \div \text{TARIFX} \cdot 0.02765985 \div \text{DBH} \div 0.00008205 \div \text{TARIFX}^2 \cdot \frac{11.29598}{\text{DBH}^2} \quad (6)$$

$$\text{XINT6} \cong \text{RI6} \div \text{CV6} \quad (7)$$

$$\text{RS616} \cong 0.990 \div 0.58 \div 0.484^{DBH^{0.5}}, \quad (8)$$

$$\text{SV816} \cong \text{RS816} \div \text{SV616} \quad (9)$$

Calculated on hardwood species only:

$$\text{RI8} \cong 0.990 \div 0.55 \div 0.485^{DBH^{0.5}} \quad (10)$$

$$\text{XINT8} \cong \text{XINT6} \div \text{RI8} \quad (11)$$

WHERE:

B4 = BINGO FACTOR

CUBUS = CUBIC FOOT VOLUME, UPPER-STEM PORTION

RC6 = RATIO TO CONVERT CUBIC 4-INCH TOP TO CUBIC 6-INCH TOP

CV6 = CUBIC FOOT VOLUME, 6-INCH TOP (SAWLOG)

RS616 = RATIO TO CONVERT CUBIC 6-INCH TOP TO SCRIB 6-INCH TOP IN 16-FT LOGS

SV616 = SCRIBNER VOLUME--6-INCH TOP (IN 16-FT LOGS)

RS816 = RATIO TO CONVERT CUBIC 6-INCH TOP TO SCRIB 8-INCH TOP IN 16-FT LOGS

SV816 = SCRIBNER VOLUME--8-INCH TOP (IN 16-FT LOGS)

XINT6 = INTERNATIONAL ¼ INCH VOLUME--6-INCH TOP (IN 16-FT LOGS)

RI8 = RATIO TO CONVERT INTERNATIONAL ¼ INCH 6-INCH TOP TO INTERNATIONAL ¼ INCH 8-INCH TOP

XINT8 = INTERNATIONAL ¼ INCH VOLUME--8-INCH TOP (IN 8-FT LOGS)

REGIONAL BIOMASS EQUATIONS USED BY FIA TO ESTIMATE BOLE, BARK, AND BRANCHES

Updated 09-19-2014

(text in red has been updated since the last version of this document)

BIOMASS OF THE TREE STEM

Tree stem biomass, regardless of whether it is merchantable bole or total stem, is calculated from cubic volume estimates and the wood density factor (in tables below) as follows:

Cubic volume = green cubic volume in cubic feet (ft³)

Wood density = (Specific gravity of a tree species) * (62.4 lbs/ft³)

Weight of water = 62.4 pounds/cubic foot

Biomass of the tree stem (in tons) = (cubic foot volume * wood density) / 2000

The tables below contain specific gravity and wood density values for many species.

BIOMASS EQUATIONS AND PROCEDURES

Softwoods – specific gravity

Code	Species	Specific gravity	Wood density
10	fir spp.	0.36	22.46
11	Pacific silver fir	0.4	24.96
14	bristlecone fir	0.36	22.46
15	white fir	0.37	23.09
17	grand fir	0.35	21.84
19	subalpine fir	0.31	19.34
20	California red fir	0.36	22.46
21	Shasta red fir	0.36	22.46
22	noble fir	0.37	23.09
41	Port-Orford-cedar	0.39	24.34
42	Alaska yellow-cedar	0.42	26.21
50	Cypress spp	0.41	25.58
52	Modoc cypress	0.41	25.58
54	Monterey cypress	0.41	25.58
55	Sargent's cypress	0.41	25.58
62	California juniper	0.45	28.08
64	western juniper	0.45	28.08
65	Utah juniper	0.68	42.43
66	Rocky Mountain juniper	0.45	28.08
72	subalpine larch	0.49	30.58
73	western larch	0.48	29.95
81	incense-cedar	0.35	21.84
90	spruce spp.	0.36	22.46
92	Brewer spruce	0.36	22.46
93	Engelmann spruce	0.33	20.59
98	Sitka spruce	0.33	20.59
100	pine spp.	0.43	26.83
101	whitebark pine	0.43	26.83
102	Bristlecone pine	0.43	26.83
103	knobcone pine	0.39	24.34
104	foxtail pine	0.43	26.83
108	lodgepole pine	0.38	23.71
109	Coulter pine	0.43	26.83
113	limber pine	0.37	23.09
116	Jeffrey pine	0.37	23.09
117	sugar pine	0.34	21.22
119	western white pine	0.36	22.46

Softwoods – specific gravity
(continued)

Code	Species	Specific gravity	Wood density
120	bishop pine	0.45	28.08
122	ponderosa pine	0.38	23.71
124	Monterey pine	0.4	24.96
127	gray pine	0.4	24.96
130	Scotch pine	0.43	26.83
133	singleleaf pinyon	0.43	26.83
137	Washoe pine	0.43	26.83
142	Great Basin bristlecone pine	0.43	26.83
201	bigcone Douglas-fir	0.45	28.08
202	Douglas-fir	0.45	28.08
211	redwood	0.36	22.46
212	giant sequoia	0.34	21.22
231	Pacific yew	0.6	37.44
242	western redcedar	0.31	19.34
251	California torreyia	0.41	25.58
263	western hemlock	0.42	26.21
264	mountain hemlock	0.42	26.21
299	Unknown dead conifer	0.41	25.58

Hardwoods – specific gravity

Code	Species	Specific gravity	Wood density
312	bigleaf maple	0.44	27.46
313	boxelder	0.42	26.21
320	Norway maple	0.47	29.33
321	Rocky Mountain maple	0.47	29.33
333	California buckeye	0.33	20.59
341	ailanthus	0.46	28.70
351	red alder	0.37	23.09
352	white alder	0.37	23.09
361	Pacific madrone	0.58	36.19
374	water birch	0.51	31.82
375	paper birch	0.48	29.95
431	golden chinkapin	0.42	26.21
475	curl-leaf mountain-mahogany	0.52	32.45
492	Pacific dogwood	0.58	36.19
500	Hawthorn	0.52	32.45
510	eucalyptus spp.	0.52	32.45
511	Tasmanian bluegum	0.52	32.45
540	ash spp.	0.51	31.82
542	Oregon ash	0.5	31.20
591	American holly	0.5	31.20
600	walnut spp.	0.44	27.46
603	northern California black walnut	0.44	27.46
604	southern California black walnut	0.44	27.46
611	sweetgum	0.46	28.70
631	tanoak	0.58	36.19
661	Oregon crab apple	0.61	38.06
730, 731	California sycamore	0.46	28.70
746	quaking aspen	0.35	21.84
747	black cottonwood	0.31	19.34
748	Fremont cottonwood	0.41	25.58
756,758	mesquite	0.78	48.67
760	cherry and plum spp.	0.47	29.33
763	chokecherry	0.47	29.33
768	bitter cherry	0.47	29.33
771	sweet cherry, domesticated	0.47	29.33
801	California live oak	0.59	36.82
805	canyon live oak	0.7	43.68
807	blue oak	0.59	36.82
811	Engelmann oak	0.59	36.82
815	Oregon white oak	0.64	39.94
818	California black oak	0.51	31.82

Hardwoods – specific gravity
(continued)

Code	Species	Specific gravity	Wood density
821	California white oak	0.55	34.32
826	chinkapin oak	0.59	36.82
839	interior live oak	0.59	36.82
901	black locust	0.66	41.18
920	willow spp.	0.36	22.46
922	black willow	0.36	22.46
926	balsam willow	0.36	22.46
927	white willow	0.36	22.46
981	California-laurel	0.51	31.82
990	desert ironwood	0.52	32.45
997	Russian-olive	0.52	32.45
998	Unknown dead hardwood	0.52	32.45
999	Other or unknown live tree	0.52	32.45

SOFTWOOD BIOMASS EQUATION ASSIGNMENTS

BIOMASS OF BARK

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
11	Pacific silver fir	22	22	22	22	22
14	Bristlecone fir	--	--	--	--	2
15	White fir	1	2	1	2	1
17	Grand fir	2	2	2	2	2
19	Subalpine fir	3	3	3	3	3
20	California red fir	4	--	3	--	4
21	Shasta red fir	4	--	4	--	4
22	Noble fir	5	5	5	5	5
41	Port-Orford-cedar	38	13	13	13	13
42	Alaska-cedar	23	23	23	23	13
50	Cypress	--	--	--	--	13
52	Baker cypress	--	--	--	--	13
54	Monterey cypress	--	--	--	--	13
55	Sargent's cypress	--	--	--	--	13
56	Mcnabb cypress	--	--	--	--	13
62	California juniper	--	--	--	--	16
64	Western juniper	16	16	16	16	16
65	Utah juniper	--	--	--	--	16
66	Rocky mountain juniper	--	--	16	--	16
72	Subalpine larch	--	24	24	24	--
73	Western larch	24	24	24	24	24
81	Incense cedar	12	12	12	12	12
92	Brewer spruce	7	--	7	7	7
93	Engelmann spruce	7	7	7	7	7
98	Sitka spruce	6	6	6	6	6
101	Whitebark pine	11	11	11	11	14
102	Bristlecone pine	--	--	--	--	14
103	Knobcone pine	14	14	14	--	14
104	Foxtail pine	--	--	--	--	14
108	Lodgepole pine	14	14	14	14	14
109	Coulter pine	--	--	--	--	9
113	Limber pine	--	--	14	--	14
116	Jeffrey pine	9	--	9	--	9
117	Sugar pine	10	--	10	--	10
119	Western white pine	11	11	11	11	11
120	Bishop pine	14	--	14	--	14
122	Ponderosa pine	9	9	9	9	9
124	Monterey pine	--	--	--	--	14
127	Gray pine	--	--	--	--	9
133	Singleleaf pinyon	--	--	--	--	14
137	Washoe pine	--	--	--	--	14

SOFTWOOD BIOMASS EQUATION ASSIGNMENTS

--continued--

BIOMASS OF BARK

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
142	Great Basin bristlecone pine	--	--	--	--	14
201	Bigcone Douglas-fir	--	--	--	--	8
202	Douglas-fir	8	8	25	25	8
211	Redwood (when DBH > 39.37 inches)	17	17	17	17	17
211	Redwood (when DBH <= 39.37 inches)	13	13	13	13	13
212	Giant Sequoia (when DBH > 39.37 inches)	17	--	17	--	17
212	Giant Sequoia (when DBH <= 39.37 inches)	13	--	13	--	13
231	Pacific yew	38	13	13	38	13
242	Western redcedar	38	13	13	13	13
251	California nutmeg	--	--	--	--	13
263	Western hemlock	26	26	26	26	15
264	Mountain hemlock	21	21	21	21	21
298	Unknown Conifer	21	21	21	21	21

SOFTWOOD BIOMASS EQUATION ASSIGNMENTS

BIOMASS OF LIVE BRANCHES

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
11	Pacific silver fir	18	18	18	18	18
14	Bristlecone fir	--	--	--	--	1
15	White fir	1	1	1	1	1
17	Grand fir	1	1	1	1	1
19	Subalpine fir	2	2	2	2	2
20	California red fir	3	--	2	--	3
21	Shasta red fir	3	--	3	--	3
22	Noble fir	3	3	3	3	3
41	Port-Orford-cedar	10	10	10	10	10
42	Alaska-cedar	19	19	19	19	10
50	Cypress	--	--	--	--	10
52	Baker cypress	--	--	--	--	10
54	Monterey cypress	--	--	--	--	10
55	Sargent's cypress	--	--	--	--	10
56	Mcnabb cypress	--	--	--	--	10
62	California juniper	--	--	--	--	13
64	Western juniper	13	13	13	13	13
65	Utah juniper	--	--	--	--	13
66	Rocky mountain juniper	--	--	13	--	13
72	Subablpine larch	--	20	20	20	--
73	Western larch	20	20	20	20	20
81	Incense cedar	10	10	10	10	10
92	Brewer spruce	4	--	4	4	4
93	Engelmann spruce	4	4	4	4	4
98	Sitka spruce	5	5	5	5	5
101	Whitebark pine	9	9	9	9	11
102	Bristlecone pine	--	--	--	--	11
103	Knobcone pine	11	11	11	--	11
104	Foxtail pine	--	--	--	--	11
108	Lodgepole pine	11	11	11	11	11
109	Coulter pine	--	--	--	--	7
113	Limber pine	--	--	11	--	11
116	Jeffrey pine	7	--	7	--	7
117	Sugar pine	8	--	8	--	8
119	Western white pine	9	9	9	9	9
120	Bishop pine	11	--	11	--	11
122	Ponderosa pine	7	7	7	7	7
124	Monterey pine	--	--	--	--	11
127	Gray pine	--	--	--	--	7
130	Scotch pine	11	--	--	--	--
133	Singleleaf pinyon	--	--	--	--	11
137	Washoe pine	--	--	--	--	7
142	Great Basin bristlecone pine	--	--	--	--	11

SOFTWOOD BIOMASS EQUATION ASSIGNMENTS
--continued--

BIOMASS OF LIVE BRANCHES

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
201	Bigcone Douglas-fir	--	--	--	--	6
202	Douglas-fir	6	6	22	22	6
211	Redwood	10	10	10	--	10
212	Giant Sequoia	10	--	10	--	10
231	Pacific yew	10	10	10	10	10
242	Western redcedar	10	10	10	10	10
251	California nutmeg	--	--	--	--	10
263	Western hemlock	23	23	23	23	12
264	Mountain hemlock	24	24	24	24	17
298	Unknown Conifer	24	24	24	24	17

HARDWOOD BIOMASS EQUATION ASSIGNMENTS

BIOMASS OF BARK

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
312	Bigleaf maple	--	29	--	29	--
313	Boxelder	--	29	--	29	--
320	Norway maple	--	--	--	--	--
321	Rocky Mountain maple	--	--	--	--	--
333	California buckeye	--	--	--	--	--
341	Tree of heaven	20	--	20	--	--
351	Red alder	20	20	20	20	20
352	White alder	20	20	20	20	20
361	Pacific madrone	--	34	--	34	--
374	Water birch	27	27	27	27	27
375	Paper birch	27	27	27	27	27
431	Golden chinkapin	--	32	--	--	--
475	Curlleaf mountain-mahogany	--	--	--	--	--
492	Pacific dogwood	29	29	29	29	--
500	Hawthorn	37	37	37	37	--
510/511	Eucalyptus	--	--	--	--	--
542	Oregon ash	--	39	--	39	--
547	Velvet ash	--	--	--	--	--
590	Holly	27	27	27	27	27
600	Walnut	--	--	--	--	--
603	N. California black walnut	--	--	--	--	--
604	S. California black walnut	--	--	--	--	--
611	Sweetgum	--	--	--	--	20
631	Tanoak	--	--	--	--	--
660	Apple	37	37	37	37	--
661	Crab apple	37	37	37	37	--
730/731	California sycamore	37	37	37	37	--
746	Quaking aspen	18	18	18	18	18
747	Black cottonwood	28	28	28	28	28
748	Fremont poplar	--	--	--	--	18
756	Honey mesquite	--	--	--	--	--
758	Screwbean mesquite	--	--	--	--	--
760	Cherrys	27	27	27	27	27
763	Common chokecherry	27	27	27	27	35
768	Bitter cherry	27	27	27	27	27
771	Sweet cherry	27	--	--	--	--

HARDWOOD BIOMASS EQUATION ASSIGNMENTS

BIOMASS OF BARK

(continued)

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
801	California live oak	--	--	--	--	--
805	Canyon live oak	--	--	--	--	--
807	Blue oak	--	--	--	--	--
811	Englemann oak	--	--	--	--	--
815	Oregon white oak	--	35	--	35	--
818	California black oak	--	--	--	--	--
821	California white oak	--	--	--	--	--
826	Chinkapin oak	--	--	--	--	--
839	Interior live oak	--	--	--	--	--
850	Oak-evergreen	--	--	--	--	--
901	Black locust	--	--	--	29	--
920	Willows	34	34	34	34	--
922	Black willow	--	--	--	--	--
926	Balsam willow	34	--	--	--	--
927	White willow	34	34	--	--	--
929	Weeping willow	--	--	34	--	--
981	California-laurel	--	--	--	--	--
990	Desert ironwood	--	--	--	--	--
997	Russian-olive	--	29	--	29	--
998	Unknown hardwood	20	20	20	20	--
999	Unknown Tree	39	39	39	39	--

Hardwood volume for SPECIES 312, 313, 320, 333, 361, 431, 492, 542, 600, 603, 604, 631, 801, 805, 807, 811, 815, 818, 821, 826, 839, 901, 920, 922, 981, 997 are calculated with Pillsbury equations in western Oregon, western Washington and California; this means that total stem volume includes branches and bark, thus bark biomass and live branch biomass are not available as separate components of biomass. Refer to the Volume Equation document for species assignments to individual equations.

HARDWOOD BIOMASS EQUATION ASSIGNMENTS

BIOMASS OF LIVE BRANCHES

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
312	Bigleaf maple	--	27	--	27	--
313	Boxelder	--	16	--	16	--
321	Rocky Mountain maple	--	--	--	--	--
333	California buckeye	--	--	--	--	--
341	Tree of heaven	16	--	16	--	--
351	Red alder	16	16	16	16	16
352	White alder	16	16	16	16	16
361	Pacific madrone	--	28	--	--	--
374	Water birch	25	25	25	25	25
376	paper birch	25	25	25	25	25
431	Golden chinkapin	--	29	--	--	--
475	Curlleaf mountain-mahogany	--	--	--	--	--
492	Pacific dogwood	16	16	16	16	--
500	Hawthorn	16	16	16	16	--
510	Eucalyptus	--	--	--	--	28
542	Oregon ash	--	16	--	16	--
590/591	Holly	26	26	26	26	26
600	Walnut	--	--	--	--	--
603	N. California black walnut	--	--	--	--	--
604	S. California black walnut	--	--	--	--	--
611	Sweetgum	--	--	--	--	16
631	Tanoak	--	--	--	--	--
661	Oregon crabapple	16	16	16	16	--
730, 731	California sycamore	--	--	--	--	--
746	Quaking aspen	14	14	14	14	14
747	Black cottonwood	15	15	15	15	15
748	Fremont poplar	--	--	--	--	5
755	Mesquite	--	--	--	--	--
756	Honey mesquite	--	--	--	--	--
758	Screwbean mesquite	--	--	--	--	--
760	Cherry	25	25	25	25	25
763	Common chokecherry	25	25	25	25	16
768	Bitter cherry	25	25	25	25	25
771	Sweet cherry	25	--	--	--	--

HARDWOOD BIOMASS EQUATION ASSIGNMENTS

BIOMASS OF LIVE BRANCHES

(continued)

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
801	California live oak	--	--	--	--	--
805	Canyon live oak	--	--	--	--	--
807	Blue oak	--	--	--	--	--
811	Englemann oak	--	--	--	--	--
815	Oregon white oak	--	--	--	--	--
818	California black oak	--	--	--	--	--
821	California white oak	--	--	--	--	--
826	Chinkapin oak	--	--	--	--	--
839	Interior live oak	--	--	--	--	--
901	Black locust	--	--	--	--	--
920	Willows	--	--	--	--	--
922	Black willow	--	--	--	--	--
926	Balsam willow	16	--	--	--	--
927	White willow	16	16	--	--	--
929	Weeping willow	--	--	16	--	--
981	California-laurel	--	--	--	--	--
990	Desert ironwood	--	--	--	--	--
997	Russian-olive	--	16	--	16	--
998	Unknown hardwood	16	16	16	16	--
999	Unknown Tree	16	16	16	16	--

Hardwood volume for SPECIES 312, 313, 320, 333, 361, 431, 492, 542, 600, 603, 604, 631, 801, 805, 807, 811, 815, 818, 821, 826, 839, 901, 920, 922, 981, 997 are calculated with Pillsbury equations in western Oregon, western Washington and California; this means that total stem volume includes branches and bark, thus bark biomass and live branch biomass are not available as separate components of biomass. Refer to the Volume Equation document for species assignments to individual equations.

BIOMASS EQUATIONS

BIOMASS OF BARK

**All equations produce Biomass of Bark in Kilograms ---
to convert to tons multiply by 0.0011023**

Log in the equations is = NATURAL LOG

EQUATION 1

BIOPAK EQUATION 379

$$BB = \frac{\exp(2.1069 + 2.7271 \times \log(DBH))}{1000}$$

EQUATION 2

BIOPAK EQUATION 887

$$BB = 0.6 + 16.4 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 3

BIOPAK EQUATION 917

$$BB = 1.0 + 17.2 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 4

BIOPAK EQUATION 382

$$BB = \frac{\exp(1.47146 + 2.8421 \times \log(DBH))}{1000}$$

EQUATION 5

BIOPAK EQUATION 251

$$BB = \frac{\exp(2.79189 + 2.4313 \times \log(DBH))}{1000}$$

EQUATION 6

BIOPAK EQUATION 845

$$BB = 1.3 + 12.6 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 7

BIOPAK EQUATION 875

$$BB = 4.5 + 9.3 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 8

BIOPAK EQUATION 5

$$BB = \exp(-4.3103 + 2.4300 \times \log(DBH))$$

EQUATION 9

BIOPAK EQUATION 705

$$BB = \exp(-3.6263 + 1.34077 \times \log(DBH) + 0.8567 \times \log(HT))$$

EQUATION 10

BIOPAK EQUATION 391

$$BB = \frac{\exp(2.183174 + 2.6610 \times \log(DBH))}{1000}$$

EQUATION 11

BIOPAK EQUATION 899

$$BB = 1.2 + 11.2 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 12 (updated)

BIOPAK EQUATION 385

$$BB = \frac{\exp(-13.3146 + 2.8594 \times \log(DBH)) * 1000}{1000}$$

EQUATION 13

BIOPAK EQUATION 461

$$BB = 0.336 + 0.00058 \times DBH^2 \times HT$$

EQUATION 14

BIOPAK EQUATION 904

$$BB = 3.2 + 9.1 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 15

BIOPAK EQUATION 174

$$BB = \exp(-4.371 + 2.259 \times \log(DBH))$$

EQUATION 16

BIOPAK EQUATION 54

$$BB = \exp(-10.175 + 2.6333 \times \log(DBH \times \pi))$$

EQUATION 17

BIOPAK EQUATION 394

$$BB = \frac{\exp(7.189689 + 1.5837 \times \log(DBH))}{1000}$$

EQUATION 18

BIOPAK EQUATION 942

$$BB = 1.3 + 27.6 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 19

$$BB = 0.0$$

EQUATION 20

BIOPAK EQUATION 275

$$BB = \exp(-4.6424 + 2.4617 \times \log(DBH))$$

EQUATION 21

BIOPAK EQUATION 911

$$BB = 0.9 + 27.4 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 22

BIOPAK EQUATION 881

$$BB = 1.0 + 15.6 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 23

BIOPAK EQUATION 923

$$BB = 1.8 + 9.6 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 24

BIOPAK EQUATION 893

$$BB = 2.4 + 15.0 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 25

BIOPAK EQUATION 857

$$BB = 3.6 + 18.2 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 26

BIOPAK EQUATION 455

$$BB = -0.025 + 0.00134 \times DBH^2 \times HT$$

EQUATION 27

BIOPAK EQUATION 948

$$BB = -1.2 + 29.1 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 28

BIOPAK EQUATION 930

$$BB = 1.2 + 15.5 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 29 (Bigleaf maple)

$$ADBH = \frac{(DBH - 0.21235)}{0.94782} \quad 1$$

$$OUTERVOL = 0.0000246916 \times (ADBH^{2.354347} (HT^{0.69586})) \quad 2$$

$$INNERVOL = 0.0000246916 \times (DBH^{2.354347} (HT^{0.69586})) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 30 (California Black Oak)

$$ADBH = \frac{(DBH + 0.68133)}{0.95767} \quad 1$$

$$OUTERVOL = 0.0000386403 \times (ADBH^{2.12635} (HT^{0.83339})) \quad 2$$

$$INNERVOL = 0.0000386403 \times (DBH^{2.12635} (HT^{0.83339})) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 31 (Canyon Live Oak)

$$ADBH = \frac{(DBH + 0.48584)}{0.96147} \quad 1$$

$$OUTERVOL = 0.0000248325 \times (ADBH^{2.32519} (HT^{0.74348})) \quad 2$$

$$INNERVOL = 0.0000248325 \times (DBH^{2.32519} (HT^{0.74348})) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 32 (Golden Chinkapin)

$$ADBH = \frac{(DBH - 0.39534)}{0.90182} \quad 1$$

$$OUTERVOL = 0.000056884 \times (ADBH^{2.07202} (HT^{0.77467})) \quad 2$$

$$INNERVOL = 0.000056884 \times (DBH^{2.07202} (HT^{0.77467})) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 33 (California Laurel)

$$ADBH = \frac{(DBH + 0.32491)}{0.96579} \quad 1$$

$$OUTERVOL = 0.0000237733 \times (ADBH^{2.05910} (HT^{1.05293})) \quad 2$$

$$INNERVOL = 0.0000237733 \times (DBH^{2.05910} (HT^{1.05293})) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 34 (Pacific Madrone)

$$ADBH = \frac{(DBH + 0.03425)}{0.98155} \quad 1$$

$$OUTERVOL = 0.0000378129 \times (ADBH^{1.99295} (HT^{1.01532})) \quad 2$$

$$INNERVOL = 0.0000378129 \times (DBH^{1.99295} (HT^{1.01532})) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 35 (Oregon White Oak)

$$ADBH = \frac{(DBH + 0.78034)}{0.95956} \quad 1$$

$$OUTERVOL = 0.0000236325 \times (ADBH^{2.25575} (HT^{0.87108})) \quad 2$$

$$INNERVOL = 0.0000236325 \times (DBH^{2.25575} (HT^{0.87108})) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 36 (Tanoak)

$$ADBH = \frac{(DBH + 4.1177)}{0.95354} \quad 1$$

$$OUTERVOL = 0.0000081905 \times (ADBH^{2.19576} (HT^{1.14078})) \quad 2$$

$$INNERVOL = 0.0000081905 \times (DBH^{2.19576} (HT^{1.14078})) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 37 (Blue oak)

$$ADBH = \frac{(DBH + 0.44003)}{0.95354} \quad 1$$

$$OUTERVOL = 0.0000204864 \times (ADBH^{2.53987} (HT^{0.50591})) \quad 2$$

$$INNERVOL = 0.0000204861 \times (DBH^{2.53987} (HT^{0.50591})) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 38**BIOPAK EQUATION**

$$BB = 3.3 + 9.0 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 39**BIOPAK EQUATION 936**

$$BB = -1.2 + 24.0 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

WHERE

Log	= NATURAL LOG
DBH	= DIAMETER OF TREE IN CENTIMETERS
HT	= HEIGHT OF TREE IN METERS
DENSFAC	= DENSITY FACTOR FOR SPECIES
BB	= BIOMASS OF BARK, WEIGHT IN KILOGRAMS, OF THE BARK ON THE TREE BOLE
π	= 3.141593

BIOMASS EQUATIONS

BIOMASS OF LIVE BRANCHES

**All equations produce Biomass of Live Branches in Kilograms ---
to convert to tons multiply by 0.0011023**

Log in the equations is = NATURAL LOG

Log = natural log

EQUATION 1

BIOPAK EQUATION 889

$$BLB = 13.0 + 12.4 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 2

BIOPAK EQUATION 919

$$BLB = 3.6 + 44.2 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 3

BIOPAK EQUATION 28

$$BLB = \exp(-4.1817 + 2.3324 \times \log(DBH))$$

EQUATION 4

BIOPAK EQUATION 877

$$BLB = 16.8 + 14.4 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 5

BIOPAK EQUATION 847

$$BLB = 9.7 + 22.0 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 6

BIOPAK EQUATION 2

$$BLB = \exp(-3.6941 + 2.1382 \times \log(DBH))$$

EQUATION 7

BIOPAK EQUATION 702

$$BLB = \exp(-4.1068 + 1.5177 \times \log(DBH) + 1.0424 \times \log(HT))$$

EQUATION 8

$$BLB = \exp(-7.637 + 3.3648 \times \log(DBH))$$

EQUATION 9

BIOPAK EQUATION 901

$$BLB = 9.5 + 16.8 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 10

BIOPAK EQUATION 459

$$BLB = 0.199 + 0.00381 \times DBH^2 \times HT$$

EQUATION 11

BIOPAK EQUATION 907

$$BLB = 7.8 + 12.3 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 12

$$BLB = \exp(-4.570 + 2.271 \times \log(DBH))$$

EQUATION 13

BIOPAK EQUATION 51

$$BLB = \exp(-7.2775 + 2.3337 \times \log(DBH \times \pi))$$

EQUATION 14

BIOPAK EQUATION 944

$$BLB = 1.7 + 26.2 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 15

BIOPAK EQUATION 932

$$BLB = 2.5 + 36.8 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 16

$$BLB = \exp(-4.5648 + 2.6232 \times \log(DBH)) - BF$$

$$\text{where: } BF = (\exp(-4.5648 + 2.6232 \times \log(DBH))) \times \frac{1}{(2.7638 + 0.062 \times DBH^{1.3364})}$$

EQUATION 17

$$BLB = \exp(-5.2581 + 2.6045 \times \log(DBH))$$

EQUATION 18

BIOPAK EQUATION 883

$$BLB = 4.5 + 22.7 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 19

BIOPAK EQUATION 925

$$BLB = 5.3 + 9.7 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 20

BIOPAK EQUATION 895

$$BLB = 20.4 + 7.7 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 21

BIOPAK EQUATION 446

$$BLB = 0.626 + 0.00079 \times DBH^2 \times HT$$

EQUATION 22

BIOPAK EQUATION 859

$$BLB = 12.6 + 23.5 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 23

Weyerhaeuser Co Equation

$$BLB = 0.047 + 0.00413 \times DBH^2 \times HT$$

EQUATION 24

BIOPAK EQUATION 913

$$BLB = 4.2 + 17.4 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 25

BIOPAK EQUATION 950

$$BLB = -0.6 + 45.1 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 26

BIOPAK EQUATION 938

$$BLB = 8.1 + 21.5 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 27

Snell et.al 1983, bigleaf maple

$$BLB = \exp(4.0543553 + 2.1505 \times \log(DBH)) \left(1 - \frac{1}{(4.6762 + 0.0163 \times DBH^{2.039})} \right) / 1000$$

EQUATION 28

Snell et.al 1983, pacific madrone

$$BLB = \exp(3.0136553 + 2.4839 \times \log(DBH)) \left(1 - \frac{1}{(1.6013 + 0.1060 \times DBH^{1.309})} \right) / 1000$$

EQUATION 29

Snell et.al 1983, giant chinkapin

$$BLB = \exp(3.1980553 + 2.2699 \times \log(DBH)) \left(1 - \frac{1}{(1.6048 + 0.2979 \times DBH^{0.6828})} \right) / 1000$$

WHERE

Log = NATURAL LOG

DBH = DIAMETER OF TREE IN CENTIMETERS

HT = HEIGHT OF TREE IN METERS

BLB = BIOMASS OF LIVE BRANCHES,
WEIGHT IN KILOGRAMS, OF THE WOOD AND BARK OF LIVE BRANCHES IN THE CROWN π = 3.141593

ATTACHMENT N

Legal Constraints Affecting Forest Management Activities on the Project Area

- Z'Berg-Nejedly Forest Practice Act of 1973 (California Public Resources Code – Division 4, Chapter 8): Designed to protect, enhance & restore California's timberland.
- California Forest Practice Rules (Title 14, California Code of Regulations, Chapter 4): Regulations used to implement the Forest Practice Act that govern timber operations.
- California Timberland Productivity Act of 1982 (Gov.C. 51100 et seq.): The intent of this Act is to *"encourage investment in timberlands based on reasonable expectation of harvest"*, and to *"discourage premature or unnecessary conversion of timberland to urban and other uses"*.
- California Environmental Quality Act (CEQA) (Pub.Res.C. 21000 et seq.): statute that requires state and local agencies to identify the significant environmental impacts of their actions and to avoid or mitigate those impacts, if feasible.
- Porter-Cologne Water Quality Control Act (California Water Code, Division 7. Water Quality): This is the primary vehicle for implementation of California's responsibilities under the federal 1972 Clean Water Act.
- Clean Water Act of 1972 (33 U.S.C. §1251 et seq.): The Act (CWA) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters.
- California Endangered Species Act (Fish & G.C. 2050 et seq.): Protects and Preserves all native species of fishes, amphibians, reptiles, birds, mammals, invertebrates, and plants, and their habitats, that are threatened with extinction.
- Endangered Species Act of 1973 (16 U.S.C. 1531-1544, 87 Stat. 884): The Act provides for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife, and plants depend.