State of California
California Environmental Protection Agency
California Air Resources Board
U.S. FOREST OFFSET PROJECT DATA REPORT
INITIAL REPORTING PERIOD - IMPROVED FOREST MANAGEMENT

U.S. FOREST OFFSET PROJECT DATA REPORT INITIAL REPORTING PERIOD - IMPROVED FOREST MANAGEMENT

OPR Staff Use Only	**Date Report Received:**	**OPR Tracking Number:**	**Date Report Reviewed:**	*OPR Staff Use Only*

*Entities submitting the project's first Offset Project Data Report must submit the information requested in both **Initial Reporting Period** and the **Annual Reporting** forms to the appropriate Offset Project Registry. For every reporting year thereafter, submit only the information requested in the Annual Reporting form.*

PART I. ENTITY SUBMITTING REPORT

Is this form being submitted by the Offset Project Operator (OPO) or by the Authorized Project Designee (APD)? *Note: The person completing this form should be an OPO/APD employee.* ☐ **OPO** ☒ **APD**

Name of Person Completing Form:	**Organization, if applicable:**
James D. Clark	NCRM, Inc.

Date Form Completed:	**Phone Number:**	**Email Address:**
12/14/2016	707-485-7211	jimclark@ncrm.com

PART II. OFFSET PROJECT INFORMATION

Offset Project Name:	**OPR Project ID#:**	**ARB Project ID#** (if known)**:**
Willits Woods IFM	CAR1140	CAFR5170

Offset Project Commencement Date:	**First Reporting Period Start Date:**	**First Reporting Period End Date:**
December 22, 2003	January 1, 2015	December 31, 2015

Provide an explanation and justification for the commencement date. Specify the action(s) that identify the offset project commencement date.
The offset project commencement date is the initiation date of Early Action Project CAR661, the date that Coastal Ridges LLC purchased the Willits Woods property

Optional: Provide the nearest town/city to the Project Area:
Willits, CA

PART III. OPO/APD INFORMATION

A. OPO

OPO Name:	**OPO's CITSS ID#:**
Coastal Ridges LLC, a California Limited Liability Company	CA 1150

Mailing Address:	**City:**	**State:**	**Zip:**
PO Box 537	Willits	CA	94490

Contact Person:	**Phone Number:**	**Email Address:**
Lori Withey	707-459-3096	loriwithey@sbcglobal.net

B. APD (if applicable) ☐ No APD/Not Applicable

APD Name:	**APD's CITSS ID#:**
James D. Clark	CA 1569

Mailing Address:	**City:**	**State:**	**Zip:**
PO Box 435	Calpella	CA	95418

Contact Person:	**Phone Number:**	**Email Address:**
James D. Clark	707-485-7211	jimclark@ncrm.com

PART IV. LAND OWNERSHIP

A. Is the Offset Project Operator (OPO) the owner in fee for the Project Area?
Further documentation is required for all projects. Submit as attachment labeled "Attachment A." See Part X of this OPDR document for more information.
If "no," explain how the entity identified as the OPO has the right to undertake and list the project.

☒ **Yes**
☐ **No**

B. Optional: 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 OPO 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 copies of documentation demonstrating explicit approval of the project's management activities and baseline, as well as the public vetting process used; attachment should be labeled "Attachment B." See Part X of this document for more information.

☒ **Private**
☐ **Public**

1. Describe the public process that was used to evaluate the forest management activities and policy decisions concerning the offset project.
N/A

2. Describe the explicit approval process used by the public entity to initiate and maintain this offset project, including the offset project's management activities and baseline.
N/A

D. Does 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 document for more information.

☐ **QCE**
☐ **Public Ownership**

1. Date that the QCE was recorded.
N/A

2. Optional: Is the project located 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**

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 Optional 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 document for more information.

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

☐ **Yes**
☐ **No**

2. Optional: Provide a description of land ownership within the Project Area.
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 document for more information.

Latitude of Offset Project Location:	Longitude of Offset Project Location:	Project Area Total Acreage:
39.3435	-123.4378	17,682.33

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 OPDR for the Initial Reporting Period V.A.

B. Identify and describe the governing jurisdiction(s) applicable to the Project Area.
See Addendum to OPDR for the Initial Reporting Period V.B.

C. Describe how the Project Area was determined.
See Addendum to OPDR for the Initial Reporting Period V.C..

D. Describe the existing land cover, and land use of the Project Area.
See Addendum to OPDR for the Initial Reporting Period V.D.

E. Describe the forest vegetation types within the Project Area boundary.
See Addendum to OPDR for the Initial Reporting Period V.E.

F. Describe the site classes within the Project Area boundary.
See Addendum to OPDR for the Initial Reporting Period V.F.

G. Describe the land pressures and climate zone/classification applicable to the Project Area.
See Addendum to OPDR for the Initial Reporting Period V.G.

H. Describe the historical land uses, current zoning, and projected land use within the Project Area and surrounding areas.
See Addendum to OPDR for the Initial Reporting Period V.H.

I. Describe the forest conditions within the Project Area, including species composition, age class distribution, and management history.
See Addendum to OPDR for the Initial Reporting Period V.I.

PART VI. OFFSET PROJECT ELIGIBILITY

A. Does the Project Area have a canopy cover that is greater than 10 percent?
Supporting documentation is required. Submit as attachment labeled "Attachment F." See Part X of this document for more information.
See Addendum to OPDR for the Initial Reporting Period VI.A.

☒ **Yes** ☐ **No**

B. Optional: Are the associated project lands currently in compliance with all local, state, and federal regulatory requirements?

☒ **Yes** ☐ **No**

Optional: If no, provide an explanation of the non-compliance.
N/A

C. Does the entity submitting this report declare that the offset project has not and does not employ broadcast fertilization?

☒ **Yes** ☐ **No**

D. Indicate how the offset project meets the definition of Natural Forest Management per Table 3.2 in the U.S. Forest protocol:

1. Native species:

a) Does the project consist of at least 95% native species based on the estimated sum of carbon in the standing live carbon pool? Improved Forest Management Projects are assessed using estimates of basal area per acre.
If "no," proceed to question 1b. Otherwise, skip to question D2.
See Addendum to OPDR for the Initial Reporting Period VI.D.1(a).

☒ **Yes** ☐ **No**

b) Describe how the project will meet this requirement.
N/A

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?
If "no," proceed to questions 2b and 2c. Otherwise skip to question D3.
See Addendum to OPDR for the Initial Reporting Period VI.D.2(a).

☒ **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 regeneration or commercial harvesting is either planned or initiated 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 OPDR for the Initial Reporting Period VI.D.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?

If "no," proceed to question 3c. Otherwise, skip to question D4.

☒ **Yes** ☐ **No**

See Addendum to OPDR for the Initial Reporting Period VI.D.3(b).

c) If the project does not meet the age class requirement at this time, explain how the project intends to demonstrate progress to meet this requirement over time; such that forest lands in ages less than 20 years old are reduced and make up no more than 40% of the Project Area.

N/A

4. Structural elements (standing and lying dead wood):
How does the project ensure that structural elements are retained in sufficient quantities throughout the project life?

See Addendum to OPDR for the Initial Reporting Period VI.D.4.

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

See Addendum to OPDR for the Initial Reporting Period VI.E.

F. 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**

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

This question is applicable to both voluntary and compliance markets. If "yes" proceed to questions G1 and G2. Otherwise, skip to Part VII.

☒ **Yes** ☐ **No**

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

☐ **Yes** ☒ **No**

2. Optional: Has this project transitioned to the Compliance Offset Protocol U.S. Forest Projects after previously being listed as an early action offset project?

☒ **Yes** ☐ **No**

PART VII. CARBON STOCK INVENTORY

A. Provide a description of the inventory methodology 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 either the Compliance Offset Protocol U.S. Forest Projects, October 20, 2011 or the Compliance Offset Protocol U.S. Forest Projects, November 14, 2014.

IFM-1 Standing Live:

See Addendum to OPDR for the Initial Reporting Period VII.A.

IFM-3 Standing Dead:

See Addendum to OPDR for the Initial Reporting Period VII.A.

IFM-6 Soil (if applicable):

See Addendum to OPDR for the Initial Reporting Period VII.A.

IFM-7 Carbon in in-use forest products:

See Addendum to OPDR for the Initial Reporting Period VII.A.

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

See Addendum to OPDR for the Initial Reporting Period VII.A.

IFM- 9 Biological emissions from site preparation:

See Addendum to OPDR for the Initial Reporting Period VII.A.

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

See Addendum to OPDR for the Initial Reporting Period VII.A.

IFM-17 Biological emissions from decomposition of forest products:

See Addendum to OPDR for the Initial Reporting Period VII.A.

B. Describe the calculation methodologies 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 OPDR for the Initial Reporting Period VII.B.

IFM-3 Standing Dead:
See Addendum to OPDR for the Initial Reporting Period VII.B.

IFM-6 Soil (if applicable):
See Addendum to OPDR for the Initial Reporting Period VII.B.

IFM-7 Carbon in in-use forest products:
See Addendum to OPDR for the Initial Reporting Period VII.B.

IFM-8 Forest product carbon in landfills (if applicable):
See Addendum to OPDR for the Initial Reporting Period VII.B.

IFM- 9 Biological emissions from site preparation:
See Addendum to OPDR for the Initial Reporting Period VII.B.

IFM-14 Biological emissions/removals from change in harvesting on forestland outside project area:
See Addendum to OPDR for the Initial Reporting Period VII.B.

IFM-17 Biological emissions from decomposition of forest products:
See Addendum to OPDR for the Initial Reporting Period 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 OPDR for the Initial Reporting Period VII.C.

IFM-3 Standing Dead:
See Addendum to OPDR for the Initial Reporting Period VII.C.

IFM-6 Soil (if applicable):
See Addendum to OPDR for the Initial Reporting Period VII.C.

IFM-7 Carbon in in-use forest products:
See Addendum to OPDR for the Initial Reporting Period VII.C.

IFM-8 Forest product carbon in landfills (if applicable):
See Addendum to OPDR for the Initial Reporting Period VII.C.

IFM- 9 Biological emissions from site preparation:
See Addendum to OPDR for the Initial Reporting Period VII.C.

IFM-14 Biological emissions/removals from change in harvesting on forestland outside project area:
See Addendum to OPDR for the Initial Reporting Period VII.C.

IFM-17 Biological emissions from decomposition of forest products:
See Addendum to OPDR for the Initial Reporting Period VII.C.

D. Provide a summary of inventory confidence statistics.
See Addendum to OPDR for the Initial Reporting Period VII.D.

E. Provide the calculation of the offset project's reversal risk rating and contribution to the Forest Buffer Account.
See Addendum to OPDR for the Initial Reporting Period 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 U.S. Forest protocol.
Please see the Modeling Plan included as Attachment M.

2. Describe and estimate the project's baseline onsite carbon stocks. Explain any annual changes in baseline carbon stocks over time.
A graph of the baseline onsite carbon stocks, labeled "Attachment G," must be portrayed depicting time on the x-axis and metric tons CO2-e on the y-axis. Include a written characterization describing any annual change in baseline carbon stocks over time. See Part X of this document for more information. A diagram of the baseline incorporating all required carbon stocks, labeled "Attachment H," is also required.
This information is contained in the Modeling plan included as Attachment M.

3. Optional: Identify the approved growth model that will be used for the project.
Cryptos Emulator and/or FORSEE

4. **Harvest Planning**
   a. **Is harvesting planned in the Project Area?** ☒ **Yes** ☐ **No**
   If "yes," proceed to question 4b. Otherwise, skip to question A5.

   b. **Optional:** Does the project use a harvest schedule model? ☐ **Yes** ☒ **No**
   If "yes," proceed to question 4c. Otherwise, skip to question A5.

   c. **Optional:** Explain how you are addressing 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 OPDR for the Initial Reporting Period VIII.A.5.

6. **Provide a projection of baseline and actual harvesting volumes from the Project Area over 100 years.**
A projection may be provided in an attachment, labeled "Attachment I". Include a narrative with a clear explanation of how the OPO/APD arrived at the baseline and actual harvest volumes is determined

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

1. **Provide the initial above ground standing live carbon stock (per acre) for the project.**
108.09 MgCO2e

2. **Provide the Common Practice statistic (per acre) associated with the Project Area.**
186.25 MgCO2e

3. **Summarize how the Project's initial above-ground standing live carbon stock compares to Common Practice.**
At the Project's commencement date of 12/22/2003, the Project's initial above-ground standing live carbon stocks were below the Common Practice statistic listed above.
Are the initial above-ground standing live carbon stocks above or below Common Practice? ☐ **Above** ☒ **Below**

If below Common Practice, what is the High Stocking Reference for the Project Area? Describe the Project Area's live tree carbon stocks over the previous 10 years.
Further documentation is required if project is below Common Practice. Submit supporting documents as attachments labeled "Attachment J." See Part X of this document for more information. An affidavit must be submitted testifying that the inventory depicted over the past 10 years is reasonably accurate.
See Addendum to OPDR for the Initial Reporting Period VIII.B.3.

4. **Optional:** Does the Forest Owner(s) and its affiliate(s) own land in fee or hold timber rights on land outside the Project Area? ☒ **Yes** ☐ **No**
If "no," skip to question B.5.

Optional: 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)? ☐ **Yes** ☒ **No**
If "no," skip to question B.5.

Optional: 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**
If "no," skip to question B.5.

Optional: Identify the Minimum Baseline Level for above-ground standing live carbon stocks for the Project Area:

5. **Provide a description of any and all legal constraints affecting forest management activities in the Project Area. Include documentation of legal constraints and a description of each constraint (referring to Section 6.2.1.2); for each constraint provide a narrative that constraint has on forest management.**
Submit supporting documents as attachment labeled "Attachment K". See Part X of this reporting document for more information.
This information is contained in the Modeling plan included as Attachment M.

6. **Provide a description of the modeling techniques used to simulate the effect of any constraints on carbon stocks.**
This information is contained in the Modeling plan included as Attachment M.
Optional: Provide a description of the modeling techniques used to simulate forest management activities that may affect carbon stocks.

7. **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**
Supporting documentation is required. Submit as attachment labeled "Attachment L." See Part X of this listing document for

more information.
See Addendum to OPDR for the Initial Reporting Period VIII.B.7.

C. Required for Improved Forest Management Projects on Public Lands ONLY

1. **Provide a projection of future changes to Project Area forest carbon stocks extrapolating from historical trends.**
   N/A

2. **Explain how current public policy affects onsite carbon stocks and how the baseline modeling incorporates constraints imposed by all applicable statutes, regulations, policies, plans, and activity-based funding.**
   N/A

3. **Have carbon stocks in the Project Area been increasing or declining over the preceding ten-year period?** ☐ Increasing ☐ Declining

PART IX. OTHER OFFSET PROGRAMS

A. Have any GHG reductions or GHG removal enhancements associated with the Project Lands ever been listed or registered with, or otherwise claimed by, another registry or program, or sold to a third party prior to listing? ☒ Yes ☐ No
If "yes," identify the registry or program and provide details on the issued credits below.

B. Have any lands within the Project Area ever been listed or registered with an offset project registry or program in the past? ☒ Yes ☐ No
If "yes," identify the registry or program and provide details on the issued credits below.

C. 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? ☒ Yes ☐ No
If "yes," identify the goal(s) and provide details on the reductions and removal enhancements (under "Number of Credits Issued") below.

Registry / Program / Goal(s):	Reporting Period(s):	Vintage(s):	Number of Credits Issued:
Climate Action Reserve	2004	2004	45,859
Climate Action Reserve	2005	2005	108,940
Climate Action Reserve	2006	2006	117,275
Climate Action Reserve	2007	2007	126,078
Climate Action Reserve	2008	2008	135,375
Climate Action Reserve	2009	2009	145,194
Climate Action Reserve	2010	2010	155,565
Climate Action Reserve	2011	2011	166,517
Climate Action Reserve	2012	2012	163,731
Climate Action Reserve	2013	2013	162,354
Climate Action Reserve	2014	2014	173,951

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. If the project is a private lands project, mark "N/A" in the box below. The OPO may provide an "Attachment B" page with a "This Page Left Intentionally Blank - Private Lands Project" notation on the page. ☒ N/A

C. If a Qualified Conservation Easement (QCE) has been recorded, provide a copy. The information contained in this form and the documents attached to it will be submitted to ARB so submitting a copy of the QCE as an attachment to this document fulfills the requirement in 9.1.1.1(18)(a) of the U.S. Forest protocol 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(l) 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 CO_2e depicted on the y-axis.**

H. **Attach a diagram of the final baseline incorporating all required carbon stocks.**

I. **Provide a projection of baseline and actual harvesting volumes from the Project Area over 100 years.**

J. **For IFM 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. Also include a summary of volume harvested over the past 10 years.** ☐ **N/A**

K. **For IFM projects on private lands ONLY: Attach supporting documentation identifying the legal constraints within the Project Area. A 'constraints' table with the following categories may be provided for simplicity with the following information: narrative of legal constraint, identification of specific governing law guiding the constraint, acreage, silviculture method, retention strategy.** ☐ **N/A**

L. **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. OPO/APD SIGNATURE

Note: The person signing this Initial Reporting Period report should be the same person signing the accompanying U.S. Forest Offset Project Data Report Annual Reporting Period – All Project Types report.

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:** 12/14/2016

Background for U.S. Forest Offset Project Data Report Initial Reporting Period – Improved Forest Management

Section 95976(d) of the Cap-and-Trade Regulation specifies reporting requirements for offset projects participating in the Compliance Offset Program. Offset Project Operators (OPO) or Authorized Project Designees (APD) are required to submit an Offset Project Data Report (OPDR) within four months of the end of each (annual) Reporting Period. The Compliance Offset Protocol U.S. Forest Projects, October 20, 2011 and Compliance Offset Protocol U.S. Forest Projects, November 14, 2014 both require additional information to be included with the initial OPDR. This form is designed to help OPOs and APDs provide the extra information required for an initial OPDR by U.S. Forest offset projects. The information in this form is submitted to the approved Offset Project Registry that is listing the offset project and should also be provided to the ARB-accredited verification body that will be verifying the Offset Project Data Report.

The information to be provided in this form closely mirrors information provided in the application for listing a U.S. Forest offset project. OPOs and APDs may wish to copy the information in their project's application for listing to the extent that the information provided at the time of that application has not changed.

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 U.S. Forest Offset Project Data Report Initial Reporting Period – Improved Forest Management

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 Submitting Report:

- Indicate whether the Offset Project Operator (OPO) or Authorized Project Designee (APD) is submitting the Offset Project Data Report.
- 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. Also provide the project's identification number from the approved Offset Project Registry listing the project. The ARB project identification number may also be provided if known.
- Indicate the offset project commencement date and the start and end dates of the first reporting period. Unlike with the listing form, approximations are no longer acceptable for these dates since precise dates should be known.
- 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 triggered by the transfer of property ownership, recordation of a conservation easement on the Project Area, or when submitting the offset project listing information.

Part III. OPO/APD Information:

- Enter contact information for the OPO and APD submitting the report. 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 report 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 report for more information on the precise requirements.
- The Project Area should be determined following the requirements of Section 4 of the U.S. Forest protocol.
- 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 report 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 U.S. Forest protocol.
- Details on the Natural Forest Management criteria can be found in Table 3.2 in the U.S. Forest protocol.

Part VII. Carbon Stock Inventory:

- Projects are required to have completed a full carbon stock inventory for the initial Offset Project Data Report. Unlike the inventory provided at the time of listing, a general description of the project's inventory methods with preliminary best estimates is no longer sufficient to meet the regulatory requirements. If the project's inventory methodology changed between the time of listing and submission of the initial OPDR, this change should be reported as a change to the information submitted at project listing when submitting the first OPDR.
- Section 6.2 of either the Compliance Offset Protocol U.S. Forest Projects, October 20, 2011 or 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. (There are some differences in section 6.2 and Appendix A between the two versions.)
- Follow the steps in Appendix D of the U.S. Forest protocol 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. Unlike the listing application, for this OPDR an approximation of the contribution to the Forest Buffer Account is not acceptable.

Part VIII. Offset Project Baseline:

- For this OPDR, unlike the project listing application, projects are required to have a finalized baseline. A modeling plan with preliminary best estimates is no longer sufficient to meet the regulatory requirements. If the project's modeling plan or baseline estimates changed between the time of listing and submission of the initial OPDR, this change 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.

- A diagram and graph are required to complement the descriptions provided in this part. See Part X of this report for more information on the precise requirements.
- Section 6.2 of either the Compliance Offset Protocol U.S. Forest Projects, October 20, 2011 or 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. (There are some differences in section 6.2 and Appendix B between the two versions.)
- ARB approved growth models can be found in Appendix B, Section B.1 of either the Compliance Offset Protocol U.S. Forest Projects, October 20, 2011 or the Compliance Offset Protocol U.S. Forest Projects, November 14, 2014. (There are some differences in Appendix B between the two versions.)

Part IX. Other Offset Programs:

- Answer all questions. If the answer to any 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 Initial Reporting Period-Offset Project Data Reporting Form.
- 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. OPO/APD Signature:

- The individual signing the document must be registered in CITSS as the OPO's Primary Account Representative or Alternate Account Representative for the entity submitting the information. 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 individual's signature, printed name, corporate title, and date signed.
- There are no attestations for this report. The attestations required for the Offset Project Data Report are included in the form U.S. Forest Offset Project Data Report Annual Reporting Period – All Project Types.

Please contact your Offset Project Registry with any questions regarding the OPDR.

Willits Woods IFM

CAR 1140, CAFR5170

Offset Project Name: Willits Woods

Addendum to OPDR for the Initial Reporting Period Form

Under

Air Resources Board

Compliance Offset Protocol – U.S. Forest Projects

Adopted: November 14, 2014

Prepared December 14, 2016

Offset Project Operator	Authorized Project Designee
Coastal Ridges LLC, a California Limited Liability Company **96 North Main St. Willits, CA 95490** **(707) 459-3096**	**James D. Clark** **PO Box 435 Calpella, CA 95418** **(707) 485-7211**

Reporting Period

The reporting period for this Initial OPDR is from 1/1/2015 to 12/31/2015.

Protocol Version

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

The OPDR and all other project documentation and reports that reference carbon stocks have been prepared and submitted by James D. Clark, California Registered Professional Forester (No. 2528).

Introduction

Willits Woods IFM 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 "Protocol"). The Offset Project Operator is Coastal Ridges LLC, a California Limited Liability Company. The Project is approximately 17,682 acres in size. The Willits Woods project is an Early Action project that was initially registered under the Climate Action Reserve's Forest Project Protocol Version 3.2. With this Initial OPDR, the Willits Woods project is seeking to transition to the Compliance Protocol.

V.A.

The Project is located within the Northern California Coast and Southern Cascades Supersections, and within the Coast Redwood/Douglas-fir Mixed Conifer and Southern Cascade Mixed Conifer Assessment Areas. The Project Area is classified as both "High" and "Low" Site Class within the above referenced Assessment Areas.

Supersection	Assessment Area	Site Class	Project Acres
Northern California Coast	Coast Redwood/Douglas-fir Mixed Conifer	High	17,068.85
		Low	381.04
Southern Cascades	Mixed Conifer	High	232.44
Total			17,682.33

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 report 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 calculated from the Project's GIS data.

V.D.

The existing land cover on the Willits Woods IFM Project Area is generally timberland with small areas of brush land, grasslands and rock outcroppings. The Willits Woods property is zoned Timber Production (TP). The permitted uses on TP land are timber production, row crops (including vineyard) and one single-family residence per legal parcel.

V.E.

The following Wildlife Habitat Relationship (WHR) vegetation types occur on the Willits Woods:

DFR	DOUGLAS FIR
RDW	REDWOOD
MHW	MONTANE HARDWOOD
AGS	ANNUAL GRASS
COW	COASTAL OAK WOODLAND
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* sp.), California laurel, and other California hardwoods. On most sites redwood would dominate if vegetation succession were allowed to proceed naturally.

V.F.

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

V.G.

The Willits Woods IFM 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. Certificates of Compliance for the 92 separate legal parcels comprising the Willits Woods Project Area have been obtained, thus allowing for the sale and development of these parcels to rural residential home and/or vineyard sites. Residential uses would involve the development of home sites while road use and human activity on the property would increase.

The Willits Woods IFM 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. The cooling pacific fog follows the path of Big River onto the property where temperatures range from an average of low of 32 degrees F in January to an average high of 85 degrees F in August. Average annual rainfall for the property is approximately 60 inches per year.

V.H.

There is a long history of human occupation and use within the Project Area. Homesteading began in the mid-1800's and small ranches in the area raised pigs, sheep, horses, and cows. Clearings on the landscape that were flat to gently sloped were planted to annual grains or pasture for forage and hay. Fruit trees and small gardens were common near homesteads. Since early in its history the region was grazed and its timber harvested. Roads and fences and a

few foundations are evidence of this agrarian past. Some of the worn fences have been replaced, and some wagon roads updated to graded gravel roads that meander about the property. Modern timber harvesting operations in the Project Area began in the 1930's and continued intermittently until modern times.

Land use in the vicinity and on the Project Area consists of timber production, grazing, and rural residential uses. These uses are expected to continue into the foreseeable future.
The Willits Woods, beginning with the ownership of Coastal Ridges LLC, has been managed under a policy of reduced timber harvesting during the period 12/22/2003 to 12/31/2015. This policy was followed in spite of the fact that there were approved timber harvest plans on portions of the property and timber prices were sufficiently high during most of this period to harvest timber at a profit. As a result of the management decision to forego timber harvesting, carbon stocks within the Project Area increased relative to baseline levels. The reduction in timber harvesting during this period had the combined effect of (i) increasing the overall age of the forest by increasing rotation ages, and (ii) increasing the stocking of trees on understocked areas of the property thus increasing site occupation and increasing forest productivity.

V.I.

The Willits Woods IFM Project Area is characterized by a mix of predominantly Douglas-fir, tanoak, and Pacific madrone with some redwood, ponderosa pine, sugar pine, and hardwoods, consisting of true oak, bigleaf maple, California bay laurel, and other native hardwoods and conifers. The Willits Woods 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 80 years to 20 years. There has been no timber harvesting on the Project Area since 2003. Presently, the Project Area is covered by several approved timber harvest plans.

VI.A.

The Willits Woods IFM 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 2008 inventory, which indicated over 90% overlapping canopy for most stands.

VI.D.1.(a)

Approximately 98.3% of the Project's biomass is in native species, with approximately 1.7% consisting of a knobecone pine hybrid, and thus the Project meets the 95% criteria for carbon in native species. Regeneration activities proposed under the Project will utilize only native species.

VI.D.2.

(a) The Willits Woods Project Area is characterized by a mix of predominantly redwood, tanoak, and Douglas-fir, with ponderosa pine, nutmeg, 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 12/31/2015, the Project Area is composed of approximately 28% Douglas-fir, 23% redwood, 2% other conifers, 36% tanoak, 4% pacific madrone, and 7% other hardwoods by basal area. The Willits Woods 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.D.3.

(a) Commercial harvesting is planned within the Project Area; however, since the project start date, no commercial harvest activity has taken place. The Willits Woods IFM project will employ natural forest management practices as described in items VI.D.1, VI.D.2, VI.D.3(b), and VI.D.4 as well as sustainable harvesting practices when commercial harvesting occurs in the future. Coastal Ridges obtained approval of an Option A from the California Department of Forestry and Fire Protection ("CAL-FIRE") for its Willits Woods ownership, which comprises all of Coastal Ridge's forestland ownership. The Option A document describes how Coastal Ridges' forestlands will demonstrate sustainable long-term timber harvesting. All harvest documents currently approved on the Willits Woods Project Area have been approved subject to the provisions of Coastal Ridges' Option A document.

(b) In the future, the Willits Woods owner will employ management practices which meet the sustainable management requirements under Table 3.2 (page 21) of the Compliance Offset Protocol by maintaining less than 40% of the Project's forested acreage in ages less than 20 years at a watershed scale up to 10,000 acres. As the Project Area is larger than 10,000 acres, the Project Area has been split by CALWATER planning watersheds in order to determine compliance with the above requirement. The Project is located within ten CALWATER planning watersheds with approximately 48% of its timbered acreage within the Olds Creek (1113.200102), James Creek (1113.300301), Broadus Creek (1111.610103), Upper North Fork Big River (1113.300305), East Branch North Fork Big River (1113.300303), Baechtel Creek (1111.610101), or Russell Brook (1113.300202) watershed group, and 52% of its timbered acreage within the Martin Creek (1113.300201), Rice Creek (1113.300203), or Mill Creek (1114.330101) watershed group. Due to past unevenaged management, no

more than 40% of the forested area in each watershed group described above is currently less than 20 years in age.

VI.D.4.

Coastal Ridges does not actively remove lying dead wood as a part of its stand management activities. In fact, Coastal Ridges hardwood reduction program since 2003, and the hardwood reductions performed by Pioneer Resources, Inc in 2001 have contributed significant amounts of lying dead wood within the timber stands in general. It is expected that the accumulation of lying dead wood will be commensurate with recruitment from standing dead trees. Coastal Ridges 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. Coastal Ridges does not currently, nor does it intend in the future to actively pursue salvage operations on its timberlands. Coastal Ridges 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.

In the case of the Willits Woods Project, the project area has not 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. The project currently contains an average of 0.42 Mg C per acre and 0.6% of standing live carbon stocks in standing dead wood. The project will continue to make progress towards the above mentioned standing dead wood target.

VI.E.

Since 2003 there has been no commercial timber harvesting within the Project Area leading to a significant increase in carbon stocks. The OPO chose to forgo all conifer harvesting during this period in order to allow both conifer and carbon stocking to increase. The projected target stand condition for the Willits Woods Project, will be characterized by a multi-aged conifer

stand containing between 180 to 210 square feet of conifer basal area per acre, and approximately 32,000 board feet per acre of conifer volume. At that time hardwoods will comprise approximately 35% of the stand basal area.

The OPO intends to allow conifer and hardwood stocking levels to develop on the Project Area in excess of those defined by the baseline analysis which projects carbon stocks levels over time following a harvest scenario which impliments the minimum requirements of the California Forest Practice Rules as well as other financial and legal constraints. When timber harvesting is initiated on the Project Area, the OPO intends to balance harvest with growth such that conifer board foot volume is maintained or increased over time, excepting those portions of the Project Area which may in the future experience a Significant Disturbance.

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 OPO as to whether or not to commercially harvest the Project Area combined with the constraints imposed by the California Forest Practice Rules, and specific terms of the Forest Project Protocol will guide carbon stock levels over time.

VII.A.

IFM-1 Standing Live:

Standing live carbon has been inventoried based on sample plots installed as part of a forest inventory in 2008. The inventory specifications are included as Attachment N. The cruise design consists of the installation of sample points on a systematic grid 25.4 chains by 25.4 chains in size anchored with a random starting location.

The sample design includes the installation of fixed area plots to measure both live and dead conifers and hardwoods. A 1/250th acre fixed area plot was installed at each sample

point to sample conifers and hardwood trees 1" DBH to 3.4" DBH; a 1/50th acre fixed area plot was installed at each sample point to sample conifer trees 3.5" DBH to 10.4" DBH, and hardwood trees 3.5" DBH and larger; and, a 1/5th acre fixed area plot was installed at each sample point to sample conifer trees 10.5" DBH and larger.

Attachment N 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 is 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.

Inventory monitoring and update procedures are described in Attachment N.

IFM-3 Standing Dead:

As described above, and in Attachment N, standing dead trees were 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 not been generated by the Project as no 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. No forest products have been generated by the Project as no 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 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 includes documentation of analytic methods and biomass equations used to translate 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 2.5" 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 O . 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 and standing dead trees. These equations will be referred to as the "FIA equations" herein. Each species can have as many as three 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
Redwood	Equation 24	Equations 13 & 17	Equation 10
Douglas-fir	Equation 3	Equation 8	Equation 6
Cypress	Equation 19	Equation 13	Equation 10
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
White fir	Equation 23	Equation 1	Equation 1
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
Live oak	Equation 44	None	None
Black oak	Equation 38	None	None
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 16
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.

To calculate the proportion of the bole that is missing, missing volume was deducted from trees based on grading of 16-foot log segments recorded during the 2008 cruise. Cull logs or cull logs with suckers resulted in 5% of volume being deducted from the log while goose pens resulted in a volume deduction as recorded for that log, and missing logs, resulted in a 100% deduction from log volume. The proportion of tree volume by log segment was taken from Mason, Bruce, and Girard table which estimates the proportion of a trees total volume by log segment.

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 88 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.

As plots are reinventoried going forward, missing volume of each tree will be 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 will 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 2/3^{rds} 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 will be 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 will be 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 will then be calculated and multiplied by various biomass components of the tree as calculated above to calculate the net biomass of each component.

IFM-3 Standing Dead:

Data on standing dead trees were collected as a part of the 2008 Willits Woods inventory, as well as an additional sample in 2016. 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.

To calculate the proportion of the bole remaining standing, each standing dead tree is assigned a total height based on the DBH to total height regressions calculated from the 2008 cruise data. Based on average 16-foot log height by species and DBH developed from the 2008 cruise data, while considering the field recorded height, a 16-foot log height to the nearest whole log where a log height was not recorded in the field. The field recorded total height is then compared to the calculated height to determine the proportion of the tree's bole volume which was missing, by assigning missing 16-foot log segments, and then deducting the proportion of the trees volume in the missing logs. The proportion of tree volume by log segment was taken from Mason, Bruce, and Girard table which estimates the proportion of a trees total volume by log segment.

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).

As plots are reinventoried going forward, missing volume of each tree will be 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 will 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 will be 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 will be 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 will then be calculated and multiplied by various biomass components of the tree as calculated above to calculate the net biomass of each component.

Relative Density by Species and Decay Class:

	Decay Class (DC)				
Species	**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
California Nutmeg	0.994	0.951	0.902	0.605	0.605
Knobcone pine	0.953	0.950	0.927	0.598	0.598
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
Interior live oak	1.02	0.841	0.705	0.591	0.591
Pacific madrone	0.982	0.793	0.618	0.525	0.525
California white oak	1.02	0.841	0.705	0.591	0.591
Bigleaf maple	0.979	0.766	0.565	0.450	0.450
Tanoak	0.982	0.793	0.618	0.525	0.525
Other Coastal Hardwoods	1.020	0.700	0.858	0.591	0.591

Biomass components by Decay Class included in the calculation of standing dead carbon stocks are listed in the table below. Classes 3 through 5 are considered "Highly Decayed", and only bole volume is included.

Decay Class	Conifers	Hardwoods
1	All Aboveground tree portions	All Aboveground tree portions
2	Bole and Bark only	Bole and Bark only
3	Bole only	Bole only
4	Bole only	Bole only
5	Bole only	Bole only

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 CV6 (cubic foot volume above stump to a 6-inch top) 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 for the Douglas-fir forest type and the Redwood Forest Type and are included in Table C.1 of Appendix C of the Protocol weighted by Project Acreage within each Assessment Area where the Coast Redwood Douglas-fir Mixed Conifer assessment area uses the C1 value for the Redwood forest type, and the Mixed Conifer assessment area uses the C1 value for the Douglas-fir forest type. 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	96.705%
% Hardwood lumber	0.011%
% Softwood Plywood	2.214%
% Oriented Strandboard	0.000%
% Non-Structural Panels	0.242%
% Miscellaneous Products	0.101%
% Paper	0.728%

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

Average carbon stored in in-use wood products is calculated using equation C.1. Carbon is converted to CO_2-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 6.1and 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 based on the CV6 (cubic foot volume above stump to a 6-inch top) values derived from the FIA equations. The wood densities utilized are those for the Mixed Conifer forest type and the Redwood Forest Type and are included in Table C.1 of Appendix C of the Protocol weighted by Project Acreage within each Assessment Area where the Coast Redwood Douglas-fir Mixed Conifer assessment area uses the C1 value for the Redwood forest type, and the Mixed Conifer assessment area uses the C1 value for the Douglas-fir forest type. 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 table below lists 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 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	96.705%
% Hardwood lumber	0.011%
% Softwood Plywood	2.214%
% Oriented Strandboard	0.000%
% Non Structural Panels	0.242%
% Miscellaneous Products	0.101%
% Paper	0.728%

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

Average wood products carbon stored in landfills is calculated using equation C.2. Carbon is converted to CO_2-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 6.1and 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. The current standing live carbon pool is 4,524,686 $MgCO_2e$.

IFM-3 Standing Dead: This carbon pool will be calculated each year as described in parts A and B above. The current standing dead carbon pool is 27,299 $MgCO_2e$.

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. No harvesting has occurred 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. No harvesting has occurred 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. No harvesting has occurred during the initial reporting period, and as such this pool is calculated as -16,284 $MgCO_2e$ for the initial reporting period.

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) were used to calculate the sampling error for the Willits Woods IFM Project once mean standing live and standing dead pools have been determined for the 2008 inventory data grown forward to the end of the reporting period. Estimates of the inventory confidence statistics, based on the confidence statistics as of 12/31/2015, are as follows:

Mean standing live and standing dead pools	**70.26**	**Mg C per acre**
SE of mean	2.381	Mg C per acre
SE of mean as %	3.389%	2.381 ÷ 70.26
Sampling Error of 90% CI	5.574%	(3.389%) * 1.645
Inventory Confidence Deduction (nearest 1/10th %)	0.6%	5.6% - 5.0%

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 41,758 ROCs.

VIII.A.5.

Following the calculation methodologies described in section VII B above, the baseline modeling presented in the Modeling Plan (Attachment M) 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 were generated by the baseline analysis.

Woods Products Class	Mg C/ acre	Total Mg CO2e
Average Annual Carbon 100-year In-Use	0.210	12,981.56
Average Annual Carbon 100-year Landfill	0.136	8,386.33
Average Annual Carbon in Harvested Trees Prior to Delivery to the Mill	1.316	81,418.23

VIII.B.3.

Based on the information available to the Offset Project Operator at this time, the highest value for above-ground standing live carbon stocks per acre within the Project Area during the 10-year period preceding the Project commencement date was equal to the above-ground standing live carbon stocks at the end of the last year of this 10-year period, which is equal to the Project's initial above-ground standing live carbon stocks (ICS). Therefore, the "High Stocking Reference" (HSR) is equal to 80% of the Project's ICS value of 108.09 MgCO2e per acre as reported in Part VIII.B.1 of this OPDR, or 86.47 MgCO2e per acre.

VIII.B.7.

In modeling the baseline for standing live carbon stocks, the OPO must incorporate financial constraints that could affect baseline growth and harvesting scenarios. The Willits Woods IFM Project utilizes a financial analysis of the baseline harvesting regime that captures all relevant costs and returns, taking into account all legal, physical, and biological constraints. This financial analysis has been included as Attachment L of this OPDR. 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 OPDR:

Attachment A - Title Reports for the Willits Woods

Attachment E – Maps of the Project Area, including an ESRI Geodatabase that represents the Project Area.

Attachment F – Orthophoto Maps of the Project Area.

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

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

Attachment I – Baseline and Actual Harvest Volumes

Attachment J – High Stocking Reference Affidavit

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

Attachment L – Financial Analysis of the Baseline Scenario

Attachment M –Modeling Plan

Attachment N –Inventory Specification

Attachment O – Volume and Biomass Equations

ATTACHMENT A



Redwood Empire Title Company of Mendocino County

405 S. Orchard Avenue, P. O. Box 238
Ukiah, CA 95482
Phone: (707)462-8666 Ÿ Fax: (707)462-5010

Our No.: **20140511DN**
Your No.:
Seller: **Coastal Ridges, LLC**
Buyer: **Chevron**

When replying Please Contact:
ESCROW OFFICER: **Debbie Niesen**
dniesen@redwoodtitle.com

PRELIMINARY REPORT

Property Address: **"Willits Woods", Mendocino County, Ca, Willits, CA 95490**

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 April 8, 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 as to Parcels One through Fifty Six and Tracts One through Eight and Parcel One of Tract Nine and Tracts Ten and 11 through 35; an easement as to Parcel Two of Tract Nine and Tract 36

2. Title to said estate or interest at the date hereof is vested in:

   Coastal Ridges, LLC, a California limited liability company

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. 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.

4. Easement(s) for the purposes stated herein and incidental purposes as provided in the document:
   Recorded: June 20, 1903 in Book 93 of Deeds, Page 320
   For: road

5. Easement(s) for the purposes stated herein and incidental purposes as provided in the document:
   Recorded: July 16, 1903 in Book 94 of Deeds, page 66
   For: road

6. Easement(s) for the purposes stated herein and incidental purposes as provided in the document:
   Recorded: September 15, 1903 in Book 94 of Deeds, Page 122
   For: right of way

7. Easement(s) for the purposes stated herein and incidental purposes as provided in the document:
   Recorded: May 28, 1906 in Book 99 of Deeds, Page 595
   For: right of way for road

8. Easement(s) for the purposes stated herein and incidental purposes as provided in the document:
   Recorded: November 9, 1910 in Book 118 of Deeds, Page 102
   For: road

9. Easement(s) for the purposes stated herein and incidental purposes as provided in the following instrument
   Recorded: June 24, 1912 in Book 118 of Deeds, Page 196
   In Favor of: County of Mendocino
   For: road

10. Easement(s) for the purposes stated herein and incidental purposes as provided in the document:
    Recorded: April 29, 1921 in Book 164 of Deeds, Page 344
    For: right of way

11. Easement(s) for the purposes stated herein and incidental purposes as provided in the document:
    Recorded: October 7, 1939 in Book 132, Page 410 and November 4, 1943 in Book 168, Page 89, Official Records
    For: right of way

12. Easement(s) for the purposes stated herein and incidental purposes as provided in the document:
    Recorded: October 5, 1940 in Book 144, Page 91, Official Records
    For: all purposes

13. Easement(s) for the purposes stated herein and incidental purposes as provided in the document:
    Recorded: November 26, 1941 in Book 152, Page 380, Official Records
    For: all purposes

14. Easement(s) for the purposes stated herein and incidental purposes as provided in the document:
Recorded: November 8, 1946 in Book 206, Page 18, Official Records
For: all purposes

15. Terms and provisions as contained in an instrument,
Entitled : Deed
Recorded: March 24, 1948 in Book 232, Page 293, Official Records

16. Easement(s) for the purposes stated herein and incidental purposes as provided in the document:
Recorded: November 12, 1948 in Book 236, Page 469, Official Records
For: right of way for road

17. Easement(s) for the purposes stated herein and incidental purposes as provided in the following instrument
Recorded: April 3, 1950 in Book 262, page 311, Official Records
In Favor of: Pacific Gas and Electric Company
For: public utilities

18. Easement(s) for the purposes stated herein and incidental purposes as provided in the following instrument
Recorded: May 3, 1950 in Book 262, Pages 385 and 390, Official Records
In Favor of: County of Mendocino and State of California
For: road

19. Easement(s) for the purposes stated herein and incidental purposes as provided in the following instrument
Recorded: June 5, 1951 in Book 290, Page 440 and June 25, 1951 in Book 292, Page 130, Official Records
In Favor of: County of Mendocino
For: road

20. Easement(s) for the purposes stated herein and incidental purposes as provided in the document:
Recorded: March 18, 1952 in Book 311, Page 386, Official Records
For: roads

21. Easement(s) for the purposes stated herein and incidental purposes as provided in the document:
Recorded: March 18, 1952 in Book 311, Page 388, Official Records
For: road

22. Easement(s) for the purposes stated herein and incidental purposes as provided in the document:
Recorded: May 7, 1953 in Book 343, Page 340, Official Records
For: all purposes

23. Reservation of all oil, gas and minerals and any implied right to enter upon a portion of the land for the development of oil, gas and minerals as contained the deed recorded May 7, 1953 in Book 343, Page 340, Official Records.

24. Easement(s) for the purposes stated herein and incidental purposes as provided in the document:
Recorded: November 2, 1955 in Book 412, Page 456, Official Records
For: transporting men, materials and forest products

25. Reservation of all oil, gas and minerals and any implied right to enter upon a portion of the land for the development of oil, gas and minerals as contained the deed recorded November 2, 1955 in Book 412, Page 456, Official Records.

26. Easement(s) for the purposes stated herein and incidental purposes as provided in the document:
Recorded: June 26, 1957 in Book 463, Page 159, Official Records
For: right to cross

a. Terms and provisions contained in the document above referred to.

27. Any facts, rights, interests or claims that may exist or arise by reason of matters, if any, disclosed by those certain Record of Survey maps filed March 29, 1960 in Map Case 2, Drawer 1, Page 34, February 14, 1962 in Map Case 2, Drawer 1, Page 128, February 14, 1962 in Map Case 2, Drawer 1, Page 129 and February 28, 1962 in Map Case 2, Drawer 8, Page 26, Mendocino County Records.

28. Easement(s) for the purposes stated herein and incidental purposes as provided in the document:
Recorded: December 12, 1967 in Book 754, Page 330, Official Records
For: all purposes

29. Reservation of oil and gas and appurtenances thereto by the United States of America recorded December 31, 1985 in Book 1539, Page 38, Official Records.

30. Easement(s) for the purposes stated herein and incidental purposes as provided in the document:
Recorded: April 3, 1989 in Book 1742, Page 715, Official Records
For: ingress, egress, public utilities

31. Easement(s) for the purposes stated herein and incidental purposes as provided in the document:
Recorded: March 13, 1992 in Book 1974, Page 450, Official Records
For: ingress, egress, public utilities

32. Covenants, Conditions and Restrictions contained in the deed recorded March 13, 1992 in Book 1974, Page 450, Official Records.

33. Any claim or loss arising from any defect or invalidity in, or unenforceability of, the rights described as Parcel Two of Tract Nine, Parcel Two of Tract 12 and Tract 36 herein occasioned by the failure of the instrument which created said rights to contain a sufficient description for the location of such easement, anything contained in the policy or endorsements thereto to the contrary notwithstanding.

34. Easement, terms and provisions as contained in an instrument,
Entitled : Easement Agreement
Executed By : Coastal Ridges, LLC and Climate Action Reserve
Recorded: June 6, 2012 as 2012-08545, Official Records

35. Terms and provisions as contained in an instrument,
Entitled : Restrictive Covenant and Project Implementation Agreement
Executed By : Climate Action Reserve and Coastal Ridges, LLC
Recorded: June 6, 2012 as 2012-08546, Official Records

a. First Amendment of Restrictive Covenant and Project Implementatin Agreement recorded April 3, 2013 as 2013-04950, Official Records.

b. Second Amendment of Restrictive Covenant and Project Implementatin Agreement recorded March 4, 2014 as 2014-02532, Official Records.

36. Deed of Trust to secure an indebtedness of the amount stated below and any other amounts payable under the terms thereof,
Amount : $15,000,000.00
Trustor/Borrower : Coastal Ridges, LLC, a California limited liability company
Trustee: Redwood Empire Title Company of Mendocino County
Beneficiary/Lender: Umpqua Bank
Dated: December 26, 2013
Recorded: December 27, 2013 as 2013-19098, Official Records

37. Financing Statement (UCC-1) as follows:
Debtor: Coastal Ridges, LLC
Secured Party: Umpqua Bank
Recorded: December 27, 2013 as 2013-19099, Official Records

END OF SCHEDULE B

INFORMATIONAL NOTES:

1. Taxes and assessments, general and special, for the fiscal year 2013 - 2014, 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

EXHIBIT "A"

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

PARCEL ONE

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 4:

THE SOUTH HALF OF THE SOUTHEAST QUARTER; THE SOUTH HALF OF THE NORTH HALF OF THE SOUTHEAST QUARTER; AND THE EAST ONE-HALF OF THE SOUTHWEST ONE-QUARTER.

SECTION 9:

THE NORTHEAST ONE-QUARTER OF THE NORTHWEST ONE-QUARTER.

APN: 147-010-25

PARCEL TWO

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 5:

GOVERNMENT LOT 12.

SECTION 6:

THE SOUTHWEST ONE-QUARTER OF THE NORTHEAST ONE-QUARTER AND THE NORTH ONE-HALF OF THE SOUTHEAST ONE-QUARTER.

APN: 147-010-11

PARCEL THREE

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 5:

GOVERNMENT LOT 13.

SECTION 7:

THE NORTHEAST ONE-QUARTER OF THE NORTHEAST ONE-QUARTER.

SECTION 8:

GOVERNMENT LOTS 4 AND 5.

APN: 147-010-16

PARCEL FOUR

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 5:

GOVERNMENT LOT 14.

SECTION 8:

GOVERNMENT LOTS 2, 3 AND 7.

APN: 147-010-17

PARCEL FIVE

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 6:

GOVERNMENT LOTS 5, 6, AND 7 AND THE SOUTHEAST ONE-QUARTER OF THE NORTHWEST ONE-QUARTER.

APN: 147-010-09

PARCEL SIX

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 6:

THE SOUTH ONE-HALF OF THE SOUTHEAST ONE-QUARTER AND THE SOUTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER.

SECTION 7:

GOVERNMENT LOT 1 AND THE NORTHEAST ONE-QUARTER OF THE NORTHWEST ONE-QUARTER. EXCEPTING THEREFROM THOSE PORTIONS OF SAID LOT 1 LYING WESTERLY OF THE SUMMIT OF THE RIDGE WHICH DIVIDES THE WATERSHEDS OF TWO ROCK CREEK AND THE EAST BRANCH OF BIG RIVER.

APN: 147-010-12

PARCEL SEVEN

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 5:

LOT 4.

SECTION 6:

GOVERNMENT LOTS 1 AND 2.

TOWNSHIP 18 NORTH, RANGE 14 WEST, MDB&M

SECTION 31:

GOVERNMENT LOT 4 AND THE SOUTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER AND THE SOUTHWEST ONE-QUARTER OF THE SOUTHEAST ONE-QUARTER.

APN: 38-120-96, 147-010-10, X04

PARCEL EIGHT

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 7:

THE WEST ONE-HALF OF THE NORTHEAST ONE-QUARTER AND THE SOUTHEAST ONE-QUARTER OF THE NORTHWEST ONE-QUARTER AND THE NORTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER.

APN: 147-010-13

PARCEL NINE

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 7:

THE SOUTHEAST ONE-QUARTER OF THE NORTHEAST ONE-QUARTER AND THE NORTH ONE-HALF OF THE SOUTHEAST ONE-QUARTER.

SECTION 8:

THE SOUTHEAST ONE-QUARTER OF THE NORTHWEST ONE-QUARTER AND THE SOUTHWEST ONE-QUARTER.

APN: 147-010-15

PARCEL TEN

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 7:

GOVERNMENT LOTS 2, 3 AND 4 AND THE SOUTH ONE-HALF OF THE SOUTHEAST ONE-QUARTER AND THE SOUTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER.

EXCEPTING THEREFROM THOSE PORTIONS OF SAID LOTS 2, 3 AND 4 LYING WESTERLY OF THE SUMMIT OF THE RIDGE WHICH DIVIDES THE WATERSHEDS OF TWO ROCK CREEK AND THE EAST BRANCH OF BIG RIVER.

SECTION 18:

GOVERNMENT LOT 1 AND THE NORTHEAST ONE-QUARTER OF THE NORTHWEST ONE-QUARTER.

APN: 147-010-14, 147-020-04

PARCEL ELEVEN

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 8:

THE WEST ONE-HALF OF THE SOUTHEAST ONE-QUARTER.

SECTION 17:

THE NORTHWEST ONE-QUARTER AND THE NORTHWEST ONE-QUARTER OF THE NORTHEAST ONE-QUARTER AND THE NORTH ONE-HALF OF THE SOUTHWEST ONE-QUARTER AND THE SOUTHWEST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER AND THE NORTHWEST ONE-QUARTER OF THE SOUTHEAST ONE-QUARTER.

APN: 147-010-19, 147-020-12

PARCEL TWELVE

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 8:

GOVERNMENT LOTS 8, 9 AND 16.

SECTION 17:

GOVERNMENT LOT 1.

APN: 147-010-20, 147-020-13

PARCEL THIRTEEN

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 9:

THE WEST ONE-HALF OF THE NORTHWEST ONE-QUARTER AND THE SOUTHEAST ONE-QUARTER OF THE NORTHWEST ONE-QUARTER AND THE NORTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER AND THE NORTHWEST ONE-QUARTER OF THE SOUTHEAST ONE-QUARTER.

APN: 147-010-21

PARCEL FOURTEEN

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 9:

THE WEST ONE-HALF OF THE SOUTHWEST ONE-QUARTER AND THE SOUTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER AND THE SOUTHWEST ONE-QUARTER OF THE SOUTHEAST ONE-QUARTER.

APN: 147-010-22

PARCEL FIFTEEN

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 9:

THE NORTHEAST ONE-QUARTER.

APN: 147-010-26

PARCEL SIXTEEN

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 9:

THE NORTHEAST ONE-QUARTER OF THE SOUTHEAST ONE-QUARTER.

SECTION 10:

GOVERNMENT LOTS 4, 5, 6, 9 AND 10.

APN: 147-010-27, 147-061-19

PARCEL SEVENTEEN

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 9:

THE SOUTHEAST ONE-QUARTER OF THE SOUTHEAST ONE-QUARTER.

SECTION 10:

THE SOUTH ONE-HALF OF THE SOUTHWEST ONE-QUARTER.

SECTION 15:

THE NORTHWEST ONE-QUARTER OF THE NORTHWEST ONE-QUARTER.

APN: 147-010-28, 147-061-20, 147-051-05

PARCEL EIGHTEEN

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 10:

GOVERNMENT LOTS 7 AND 8.

SECTION 11:

GOVERNMENT LOT 7.

APN: 147-061-24, 147-065-01

PARCEL NINETEEN

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 10:

GOVERNMENT LOTS 13, 14, 15 AND 16.

SECTION 11:

GOVERNMENT LOTS 22 AND 23.

APN: 147-061-25, 147-065-02

PARCEL TWENTY

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 14:

GOVERNMENT LOTS 16, 17, 18 AND 21.

APN: 147-052-03, 16

PARCEL TWENTY-ONE

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 14:

GOVERNMENT LOTS 19 AND 20.

SECTION 22:

GOVERNMENT LOT 9.

SECTION 23:

THE NORTHWEST ONE-QUARTER OF THE NORTHWEST ONE-QUARTER.

APN: 147-052-15,147-054-11

PARCEL TWENTY-TWO

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 14:

GOVERNMENT LOT 10.

SECTION 15:

GOVERNMENT LOTS 9 AND 10 AND THE WEST ONE-HALF OF THE NORTHEAST ONE-QUARTER.

EXCEPTING THEREFROM THAT PORTION CONVEYED TO RICHARD WOOD IN INSTRUMENT RECORDED AUGUST 31, 1984 IN BOOK 1472 AT PAGE 505 OF THE OFFICIAL RECORDS OF MENDOCINO COUNTY, CALIFORNIA.

APN: 147-051-08, 147-052-01

PARCEL TWENTY-THREE

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 15:

GOVERNMENT LOTS 2, 3, 4, 5, 6, 7 AND 8.

APN: 147-051-06, 07

PARCEL TWENTY-FOUR

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 15:

GOVERNMENT LOTS 11 AND 12 AND THE WEST ONE-HALF OF THE SOUTHEAST ONE-QUARTER.

APN: 147-051-09

PARCEL TWENTY-FIVE

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 16: ALL.

APN: 147-020-17, 18

PARCEL TWENTY-SIX

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 17:

GOVERNMENT LOTS 7, 8, 9 AND 16.

APN: 147-020-14

PARCEL TWENTY-SEVEN

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 17:

GOVERNMENT LOTS 14 AND 15.

SECTION 20:

GOVERNMENT LOTS 3 AND 6.

APN: 147-020-15

PARCEL TWENTY-EIGHT

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 18:

GOVERNMENT LOT 2.

TOWNSHIP 17 NORTH, RANGE 15 WEST, MDB&M

SECTION 13:

THE EAST ONE-HALF OF THE NORTHEAST ONE-QUARTER AND THE NORTHEAST ONE-QUARTER OF THE SOUTHEAST ONE-QUARTER.

APN: 21-390-21, 147-020-05

PARCEL TWENTY-NINE

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 18:

THE NORTHEAST ONE-QUARTER AND THE SOUTHEAST ONE-QUARTER OF THE NORTHWEST ONE-QUARTER.

APN: 147-020-06

PARCEL THIRTY

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 18:

GOVERNMENT LOTS 3 AND 4 AND THE NORTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER AND THE NORTHWEST ONE-QUARTER OF THE SOUTHEAST ONE-QUARTER.

APN: 147-020-07

PARCEL THIRTY-ONE

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 18:

THE EAST ONE-HALF OF THE SOUTHEAST ONE-QUARTER AND THE SOUTHWEST ONE-QUARTER OF THE SOUTHEAST ONE-QUARTER AND THE SOUTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER.

APN: 147-020-08

PARCEL THIRTY-TWO

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 19:

GOVERNMENT LOTS 3 AND 4.

TOWNSHIP 17 NORTH, RANGE 15 WEST, MDB&M

SECTION 24:

THE NORTH ONE-HALF OF THE NORTHEAST ONE-QUARTER.

APN: 21-390-13, 147-020-09

PARCEL THIRTY-THREE

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 19:

THE EAST ONE-HALF OF THE NORTHWEST ONE-QUARTER AND THE WEST ONE-HALF OF THE NORTHEAST ONE-QUARTER.

APN: 147-020-10

PARCEL THIRTY-FOUR

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 19:

THE EAST ONE-HALF OF THE NORTHEAST ONE-QUARTER.

SECTION 20:

GOVERNMENT LOTS 4, 5, 11 AND 12.

APN: 147-020-11

PARCEL THIRTY-FIVE

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 20:

GOVERNMENT LOTS 1, 2, 7, 8, 9 AND 10.

APN: 147-020-16

PARCEL THIRTY-SIX

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 21:

THE NORTH ONE-HALF OF THE NORTHWEST ONE-QUARTER AND THE SOUTHWEST ONE-QUARTER OF THE NORTHWEST ONE-QUARTER AND THE NORTHWEST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER.

APN: 147-020-19

PARCEL THIRTY-SEVEN

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 21:

THE EAST ONE-HALF OF THE EAST ONE-HALF AND THE NORTHWEST ONE-QUARTER OF THE NORTHEAST ONE-QUARTER.

APN: 147-020-20, 21

PARCEL THIRTY-EIGHT

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 29:

GOVERNMENT LOTS 2, 7, 9, 10 AND 11.

APN: 147-032-02

PARCEL THIRTY-NINE

TOWNSHIP 17 NORTH, RANGE 15 WEST, MDB&M

SECTION 1:

GOVERNMENT LOTS 2, 3 AND 4 AND THE SOUTHEAST ONE-QUARTER OF THE NORTHWEST ONE-QUARTER AND THE SOUTHWEST ONE-QUARTER OF THE NORTHEAST ONE-QUARTER.

APN: 21-380-21

PARCEL FORTY

TOWNSHIP 17 NORTH, RANGE 15 WEST, MDB&M

SECTION 1:

THE SOUTHWEST ONE-QUARTER OF THE NORTHWEST ONE-QUARTER AND THE SOUTHWEST ONE-QUARTER.

APN: 21-380-22

PARCEL FORTY-ONE

TOWNSHIP 17 NORTH, RANGE 15 WEST, MDB&M

SECTION l:

GOVERNMENT LOT 1 AND THE SOUTHEAST ONE-QUARTER OF THE NORTHEAST ONE-QUARTER AND THE SOUTHEAST ONE-QUARTER.

APN: 21-380-23

PARCEL FORTY-TWO

TOWNSHIP 17 NORTH, RANGE 15 WEST, MDB&M

SECTION 2:

GOVERNMENT LOTS 1 AND 2 AND THE SOUTH ONE-HALF OF THE NORTHEAST ONE-QUARTER.

APN: 21-380-20

PARCEL FORTY-THREE

TOWNSHIP 17 NORTH, RANGE 15 WEST, MDB&M

SECTION 12:

THE SOUTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER AND THE SOUTHWEST ONE-QUARTER OF THE SOUTHEAST ONE-QUARTER.

EXCEPTING THEREFROM THAT PORTION LYING NORTHERLY AND WESTERLY OF THE SUMMTT OF THE RIDGE WHICH DIVIDES THE WATERSHEDS OF TWO ROCK CREEK AND THE EAST BRANCH OF BIG RIVER.

APN: 21-380-14

PARCEL FORTY-FOUR

TOWNSHIP 17 NORTH, RANGE 15 WEST, MDB&M

SECTION 13:

THE NORTHWEST ONE-QUARTER AND THE NORTHWEST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER,

EXCEPTING THEREFROM THAT PORTION OF THE NORTH ONE-HALF OF THE NORTHWEST ONE-QUARTER LYING NORTHERLY AND WESTERLY OF THE SUMMIT OF THE RIDGE WHICH DIVIDES THE WATERSHEDS OF TWO ROCK CREEK AND THE EAST BRANCH OF BIG RIVER.

APN: 21-390-19

PARCEL FORTY-FIVE

TOWNSHIP 17 NORTH, RANGE 15 WEST, MDB&M

SECTION 13:

THE WEST ONE-HALF OF THE NORTHEAST ONE-QUARTER AND THE NORTHWEST ONE-QUARTER OF THE SOUTHEAST ONE-QUARTER AND THE NORTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER.

APN: 21-390-20

PARCEL FORTY-SIX

TOWNSHIP 17 NORTH, RANGE 15 WEST, MDB&M

SECTION 13:

THE SOUTH ONE-HALF OF THE SOUTH ONE-HALF.

APN: 21-390-22

PARCEL FORTY-SEVEN

TOWNSHIP 18 NORTH, RANGE 14 WEST, MDB&M

SECTION 30:

THE WEST ONE-HALF OF THE SOUTHEAST ONE-QUARTER AND THE SOUTH ONE-HALF OF THE SOUTHWEST ONE-QUARTER AND THAT PORTION OF THE WEST ONE-HALF OF THE NORTHEAST

ONE-QUARTER DESCRIBED AS: BEGINNING AT THE QUARTER SECTION CORNER BETWEEN SECTIONS 19 AND 30, T18N, R14W, MDB&M; THENCE SOUTH, ON THE WEST SIDE OF SAID WEST ONE-HALF OF THE NORTHEAST ONE-QUARTER, A DISTANCE OF 43.69 CHAINS; THENCE NORTH 83° 34' EAST A DISTANCE OF 19.81 CHAINS TO THE SOUTHEAST CORNER OF SAID WEST ONE-HALF OF THE NORTHEAST ONE-QUARTER; THENCE NORTH 14 AND ONE-HALF DEGREES WEST A DISTANCE OF 42.85 CHAINS; THENCE WEST A DISTANCE OF 9 CHAINS TO THE PLACE OF BEGINNING.

EXCEPTING THEREFROM 2.65 ACRES IN SAID NORTHWEST ONE-QUARTER OF THE SOUTHEAST ONE-QUARTER AND 1.58 ACRES IN SAID SOUTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER AS RESERVED AND EXCEPTED IN THE DEED FROM JASPER M. WILLIAMS ET UX TO BOLTON INVESTMENT COMPANY, A CORPORATION, DATED MAY 29,1903, RECORDED IN BOOK 94 AT PAGE 122 OF DEEDS OF MENDOCINO COUNTY, CALIFORNIA.

APN: 38-120-90

PARCEL FORTY-EIGHT

TOWNSHIP 18 NORTH, RANGE 14 WEST, MDB&M

SECTION 31:

GOVERNMENT LOTS 1, 2 AND 3 AND THE EAST ONE-HALF OF THE NORTHWEST ONE-QUARTER.

APN: 38-120-19, 94

PARCEL FORTY-NINE

TOWNSHIP 18 NORTH, RANGE 14 WEST, MDB&M

SECTION 31:

THE WEST ONE-HALF OF THE NORTHEAST ONE-QUARTER AND THE NORTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER AND THE NORTHWEST ONE-QUARTER OF THE SOUTHEAST ONE-QUARTER.

APN: 38-120-95

PARCEL FIFTY

TOWNSHIP 18 NORTH, RANGE 15 WEST, MDB&M

SECTION 24:

GOVERNMENT LOTS 6 AND 7 AND THE SOUTHEAST ONE-QUARTER OF THE NORTHWEST ONE-QUARTER AND THE NORTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER.

APN: 21-330-06, 07

PARCEL FIFTY-ONE

TOWNSHIP 18 NORTH, RANGE 15 WEST, MDB&M

SECTION 24:

GOVERNMENT LOTS 14, 15, 16, 17 AND 18.

APN: 21-330-08

PARCEL FIFTY-TWO

TOWNSHIP 18 NORTH, RANGE 15 WEST, MDB&M

SECTION 25:

GOVERNMENT LOTS 1, 2, 3, 4, 5, 9 AND 10.

APN: 21-340-21

PARCEL FIFTY-THREE

TOWNSHIP 18 NORTH, RANGE 15 WEST, MDB&M

SECTION 25:

GOVERNMENT LOTS 8, 11, 12, 13, 14, 16, 17, 18, 19 AND 20,

EXCEPTING THEREFROM THAT PORTION OF GOVERNMENT LOT 14 CONVEYED TO WILLIAM W. BAREFOOTE IN INSTRUMENT RECORDED JANUARY 11, 1978 IN BOOK 1127 AT PAGE 106 OF THE OFFICIAL RECORDS OF MENDOCINO COUNTY, CALIFORNIA.

APN: 21-340-22

PARCEL FIFTY-FOUR

TOWNSHIP 18 NORTH, RANGE 15 WEST, MDB&M

SECTION 26:

THE EAST ONE-HALF OF THE NORTHEAST ONE-QUARTER AND THE EAST ONE-HALF OF THE SOUTHEAST ONE-QUARTER.

APN: 21-310-03

PARCEL FIFTY-FIVE

TOWNSHIP 18 NORTH, RANGE 15 WEST, MDB&M

SECTION 36:

GOVERNMENT LOTS 4, 5, 6, 7, 14, 15,16 AND 17 AND THE SOUTHWEST ONE-QUARTER AND THE NORTHWEST ONE-QUARTER.

APN: 21-340-10, 11, 13, 23, 24

PARCEL FIFTY-SIX

TOWNSHIP 18 NORTH, RANGE 15 WEST, MDB&M

SECTION 36:

GOVERNMENT LOTS 1, 2, 3, 8, 9, 10, 11, 12,13,18, 19 AND 20.

APN: 21-340-25

TRACT ONE:

TOWNSHIP 18 NORTH, RANGE 14 WEST, MDB&M

SECTION 29: THE NORTHWEST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER AND THE SOUTH ONE-HALF OF THE NORTHWEST ONE-QUARTER.

SECTION 30: THE EAST ONE-HALF OF THE SOUTHEAST ONE-QUARTER.

APN: 38-120-91

TRACT TWO:

TOWNSHIP 18 NORTH, RANGE 14 WEST, MDB&M

SECTION 29: THE EAST ONE-HALF OF THE SOUTHWEST ONE-QUARTER AND THE SOUTHWEST ONE-QUARTER SOUTHWEST ONE-QUARTER.

SECTION 32: THE NORTHEAST ONE-QUARTER OF THE NORTHWEST ONE-QUARTER.

APN: 38-120-92

TRACT THREE:

TOWNSHIP 18 NORTH, RANGE 14 WEST, MDB&M

SECTION 29: THE NORTHWEST ONE-QUARTER OF THE SOUTHEAST ONE-QUARTER AND THE SOUTH ONE-HALF OF THE NORTHEAST ONE-QUARTER OF THE SOUTHEAST ONE-QUARTER AND THE SOUTH ONE-HALF OF THE SOUTHEAST ONE-QUARTER.

SECTION 32: THE NORTH ONE-HALF OF THE NORTHEAST ONE-QUARTER.

APN: 38-120-93

TRACT FOUR:

TOWNSHIP 18 NORTH, RANGE 14 WEST, MDB&M

SECTION 31: THE EAST ONE-HALF OF THE NORTHEAST ONE-QUARTER.

SECTION 32: THE WEST ONE-HALF OF THE NORTHWEST ONE-QUARTER.

APN: 38-120-X86, X87, X88

TRACT FIVE:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 5:

GOVERNMENT LOTS 3 AND 4.

TOWNSHIP 18 NORTH, RANGE 14 WEST, MDB&M

SECTION 31:

THE EAST ONE-HALF OF THE SOUTHEAST ONE-QUARTER.

SECTION 32:

SOUTHWEST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER.

APN: 38-120-X86, X87; 147-010-X04, X05

TRACT SIX:

TOWNSHIP 18 NORTH, RANGE 14 WEST, MDB&M

SECTION 32: THE SOUTHEAST ONE-QUARTER OF THE NORTHWEST ONE-QUARTER AND THE NORTH ONE-HALF OF THE SOUTHWEST ONE-QUARTER AND THE SOUTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER.

APN: 38-120-X87, X88

TRACT SEVEN:

TOWNSHIP 18 NORTH, RANGE 14 WEST, MDB&M

SECTION 32: THE SOUTHWEST ONE-QUARTER OF THE NORTHEAST ONE-QUARTER AND THE NORTHWEST ONE-QUARTER OF THE SOUTHEAST ONE-QUARTER AND THE SOUTH ONE-HALF OF THE SOUTHEAST ONE-QUARTER.

APN: 38-120-97

TRACT EIGHT:

TOWNSHIP 18 NORTH, RANGE 14 WEST, MDB&M

SECTION 32: THE SOUTHEAST ONE-QUARTER OF THE NORTHEAST ONE-QUARTER AND THE NORTHEAST ONE-QUARTER OF THE SOUTHEAST ONE-QUARTER.

SECTION 33: THE NORTH ONE-HALF OF THE SOUTHWEST ONE-QUARTER.

APN: 38-120-98

TRACT NINE:

PARCEL ONE:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 4:

GOVERNMENT LOTS 3 AND 4.

TOWNSHIP 18 NORTH, RANGE 14 WEST, MDB&M

SECTION 33:

THE SOUTHWEST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER.

APN: 38-120-99; 147-010-23, X07

PARCEL TWO:

THE EASEMENT RESERVED BY R. AND J. TIMBER CO., A CALIFORNIA CORPORATION IN THE DEED TO ARTHUR A. HASCHAK RECORDED MAY 31, 1990 IN BOOK 1833 OF OFFICIAL RECORDS, PAGE 111, MENDOCINO COUNTY RECORDS.

TRACT TEN:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 5:

GOVERNMENT LOTS 5, 6 AND 11.

SECTION 6:

THE SOUTHEAST ONE-QUARTER OF THE NORTHEAST ONE-QUARTER.

APN: 147-010-X04, X05

TRACT 11:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MOUNT DIABLO BASE AND MERIDIAN.

SECTION 4:

NORTHWEST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER.

SECTION 5:

GOVERNMENT LOTS 1, 2, 7, 8, 9 AND 10.

APN: 147-010-06, X05, X07

TRACT 12:

PARCEL ONE:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MOUNT DIABLO BASE AND MERIDIAN.

SECTION 4:

THE SOUTH ONE-HALF OF THE NORTHWEST ONE-QUARTER.

APN: 147-010-24

PARCEL TWO:

THE EASEMENT RESERVED BY R. & J. TIMBER CO., A CAUFORNIA CORPORATION IN THE DEED TO ARTHUR A. HASCHAK RECORDED MAY 31, 1990 IN BOOK 1833 OF OFFICIAL RECORDS AT PAGE 111, MENDOCINO COUNTY RECORDS.

TRACT 13:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MOUNT DIABLO BASE AND MERIDIAN.

SECTION 4:

SOUTHWEST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER.

SECTION 5:

GOVERNMENT LOTS 15 AND 16.

SECTION 8:

GOVERNMENT LOT 1.

APN: 147-010-18

TRACT 14:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

THOSE PORTIONS OF SECTION, 3 AND 10 DESCRIBED AS FOLLOWS:

BEGINNING AT THE NORTHWEST CORNER OF GOVERNMENT LOT 5 OF SECTION 3 OF SAID TOWNSHIP AND RANGE; THENCE SOUTH, ALONG THE WEST LINE OF SAID SECTION 3, A DISTANCE OF 3960 FEET TO THE SECTION CORNER COMMON TO SECTIONS 3, 4, 9 AND 10 OF SAID TOWNSHIP AND RANGE; THENCE, CONTINUING SOUTH, ALONG THE SECTION LINE, TO THE SOUTHWEST CORNER OF GOVERNMENT LOT 4 OF SAID SECTION 10; THENCE EAST, ALONG THE SOUTH LINE OF SAID LOT 4 AND GOVERNMENT LOT 3, A DISTANCE OF 2096.9 FEET; THENCE NORTH TO A POINT ON THE SOUTH LINE OF GOVERNMENT LOT 14 OF SAID SECTION 3, WHERE IT IS INTERSECTED BY A FENCE LINE RUNNING IN A NORTHERLY AND SOUTHERLY DIRECTION; THENCE NORTH 16a 42" WEST, ALONG SAID FENCE LINE, 4134.4 FEET TO THE NORTH LINE OF GOVERNMENT LOT 5 OF SAID SECTION 3; THENCE WEST, ALONG SAID NORTH LINE, 857 FEET TO THE POINT OF BEGINNING, EXCEPTING THEREFROM GOVERNMENT LOT 4 OF SAID SECTION 10.

ALSO EXCEPTING THEREFROM THAT PORTION DESCRIBED IN THE DEED TO ARTHUR A. HASCHAK RECORDED MAY 31, 1990 IN BOOK 1833 OF OFFICIAL RECORDS AT PAGE 111, MENDOCINO COUNTY RECORDS.

APN: 147-061-18

TRACT 15:

TOWNSHIP 16 NORTH, RANGE 14 WEST, MDB&M

SECTION 3:

GOVERNMENT LOTS 3 AND 4 AND THE NORTH ONE-HALF OF THE SOUTHWEST ONE QUARTER.

SECTION 4:

NORTHEAST ONE-QUARTER OF THE SOUTHEAST ONE-QUARTER.

APN: 148-170-01,148-180-01, 148-140-03

TRACT 16:

THOSE PORTIONS OF THE FOLLOWING DESCRIBED PROPERTY LYING NORTHERLY AND EASTERLY OF THE SOUTHERLY AND WESTERLY LINE OF THE PARCEL DESCRIBED IN TRACT THREE, PARCEL ONE OF THE DEED FROM RICHARD L PADULA AND THOMAS F. BLANCHFIELD TO PIONEER RESOURCES UNDER RECORDING NO. 1998-12079 OF THE MENDOCINO COUNTY OFFICIAL RECORDS:

TOWNSHIP 16 NORTH, RANGE 14 WEST, MDB&M

SECTION 4:

GOVERNMENT LOTS 1, 2, 3, 6, 7 AND 8.

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 34:

GOVERNMENT LOTS 21 AND 22.

APN: 147-041-14, 148-130-04

TRACT 17:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 22:

THE NORTHWEST ONE-QUARTER.

APN: 147-054-19, 20

TRACT 18:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 22:

GOVERNMENT LOT5 10,11, 14 AND 15.

APN: 147-054-14, 15, 16

TRACT 19:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 22:

GOVERNMENT LOTS 5, 6, 7 AND 8.

APN: 147-054-13

TRACT 20:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 22:

GOVERNMENT LOTS 12, 13 AND 16.

SECTION 23:

GOVERNMENT LOT 13 AND THE NORTHWEST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER AND THE SOUTHWEST ONE-QUARTER OF THE NORTHWEST ONE-QUARTER.

APN: 147-054-17, I8

TRACT 21:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 23:

GOVERNMENT LOTS 14 AND 15 AND THE NORTHEAST ONE-QUARTER OF THE SOUTHWEST ONE-QUARTER AND THE SOUTHEAST ONE-QUARTER OF THE NORTHWEST ONE-QUARTER.

SECTION 26:

GOVERNMENT LOTS 3, 6 AND 11.

APN: 147-041-10, 147-055-02

TRACT 22:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 23:

GOVERNMENT LOTS 5, 6, 11 AND 12.

APN: 147-055-01

TRACT 23:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 26:

GOVERNMENT LOTS 4, 5,12 AND 13.

SECTION 27:

GOVERNMENT LOTS 1, 8, 9 AND 16.

APN: 147-041-09

TRACT 24:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 26:

GOVERNMENT LOT 14.

SECTION 34:

GOVERNMENT LOT 1.

SECTION 35:

GOVERNMENT LOTS 3 AND 4.

APN: 147-041-17

TRACT 25:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 27:

GOVERNMENT LOTS 2, 7, 10 AND 11.

APN: 147-041-07

TRACT 26:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 27:

GOVERNMENT LOTS 3, 4, 5, 6, 12 AND 13.

APN: 147-041-01

TRACT 27:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 27:

GOVERNMENT LOTS 14 AND 15.

SECTION 34:

GOVERNMENT LOT 2.

APN: 147-041-08

TRACT 28:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 28:

GOVERNMENT LOTS 1, 4, 5, 6 AND 7.

APN: 147-033-03, 06

TRACT 29:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 28:

GOVERNMENT LOT 8.

SECTION 33:

GOVERNMENT LOTS 5 AND 6.

SECTION 34:

GOVERNMENT LOTS 11 AND 12.

APN: 147-033-07, 147-036-02, 03, 09, 147-041-11

TRACT 30:

THOSE PORTIONS OF THE FOLLOWING DESCRIBED PROPERTY LYING NORTHERLY AND EASTERLY OF THE SOUTHERLY AND WESTERLY LINE OF THE PARCEL DESCRIBED IN TRACT THREE, PARCEL ONE OF THE DEED FROM RICHARD L. PADULA AND THOMAS F. BLANCHFIELD TO PIONEER RESOURCES UNDER RECORDING NO. 1998-12079 OF THE MENDOCINO COUNTY OFFICIAL RECORDS:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 32:

GOVERNMENT LOTS 1 AND 2.

SECTION 33:

GOVERNMENT LOTS 1, 7, 10, 11 AND 12 AND THE EAST ONE-HALF OF THE NORTHWEST ONE-QUARTER.

APN: 147-035-02, 147-036-08

TRACT 31:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 33:

GOVERNMENT LOTS 8 AND 9.

SECTION 34:

GOVERNMENT LOTS 19 AND 20.

APN: 147-036-07, 147-041-13

TRACT 32:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 34:

GOVERNMENT LOTS 9, 10, 13, 14, 15 AND 16.

APN: 147-041-12

TRACT 33:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 34:

GOVERNMENT LOTS 3, 4 AND 6.

SECTION 35:

GOVERNMENT LOT 5.

APN: 147-041-16

TRACT 34:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 34:

GOVERNMENT LOTS 17, 18, 23 AND 24.

APN: 147-041-15

TRACT 35:

TOWNSHIP 17 NORTH, RANGE 14 WEST, MDB&M

SECTION 34:

GOVERNMENT LOTS 5, 7 AND 8.

SECTION 35:

GOVERNMENT LOTS 10, 11, 12 AND 13.

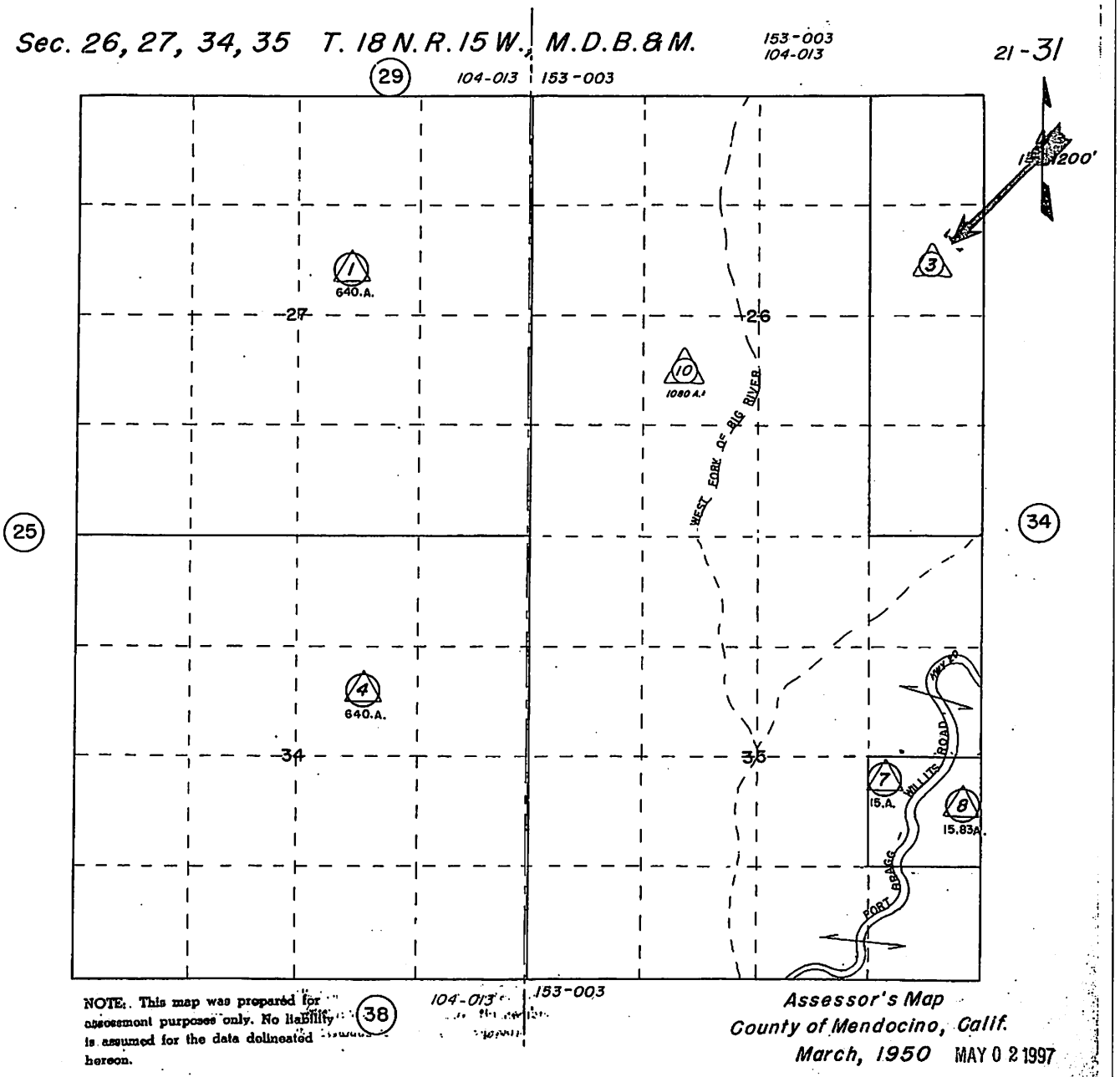
APN: 147-041-18

TRACT 36:

THE EASEMENTS CONVEYED IN THE DEED FROM SONOMA MOUNTAIN CO., TO RICHARD L PADULA, ET AL RECORDED MARCH 13, 1992 IN BOOK 1974 OF OFFICIAL RECORDS AT PAGE 450, MENDOCINO COUNTY RECORDS.

Mendocino, CA , 2013-2014 - 021-31, Sheet: 1 of 1

"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."



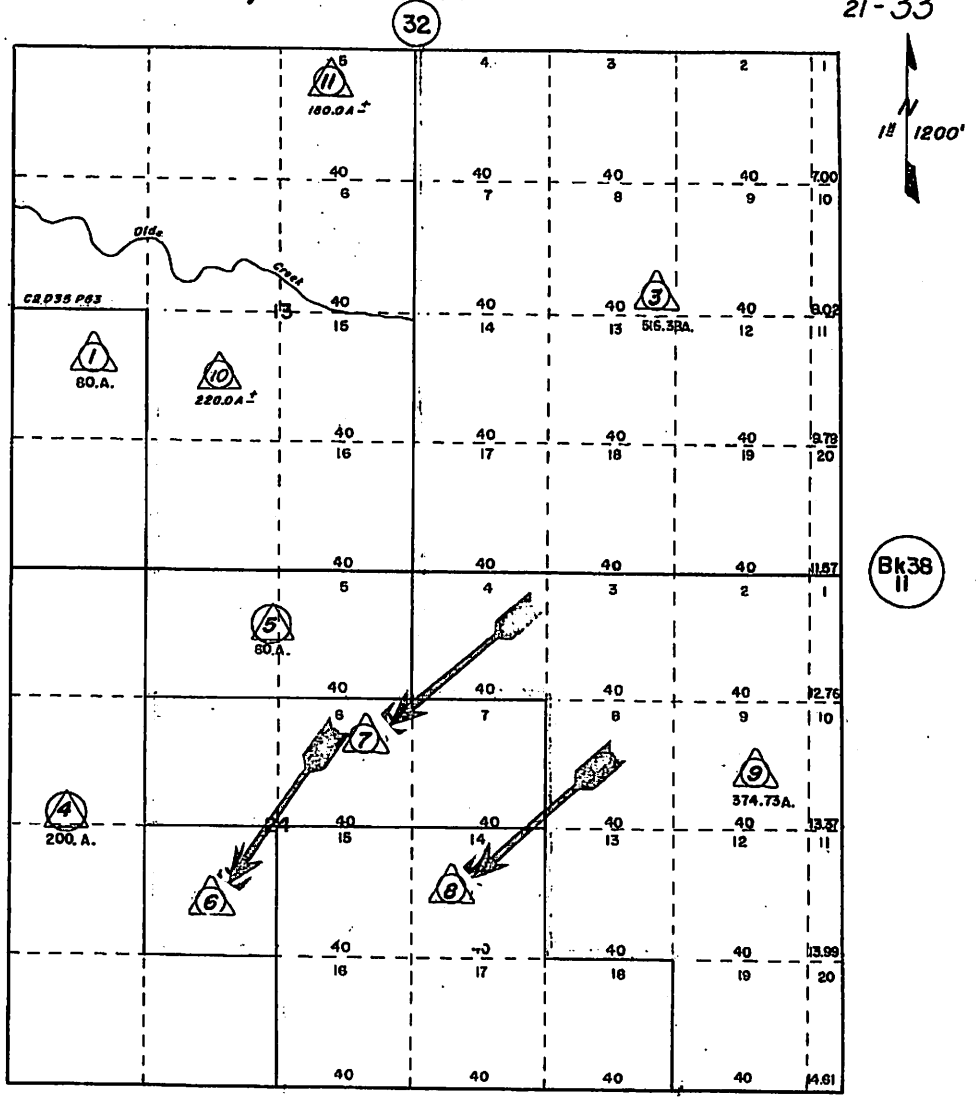
Mendocino, CA , 2013-2014 - 021-33, Sheet: 1 of 1

Sec. 13, 24 T. 18 N. R. 15 W., M.D.B.&M.

153-006

21-33

"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."



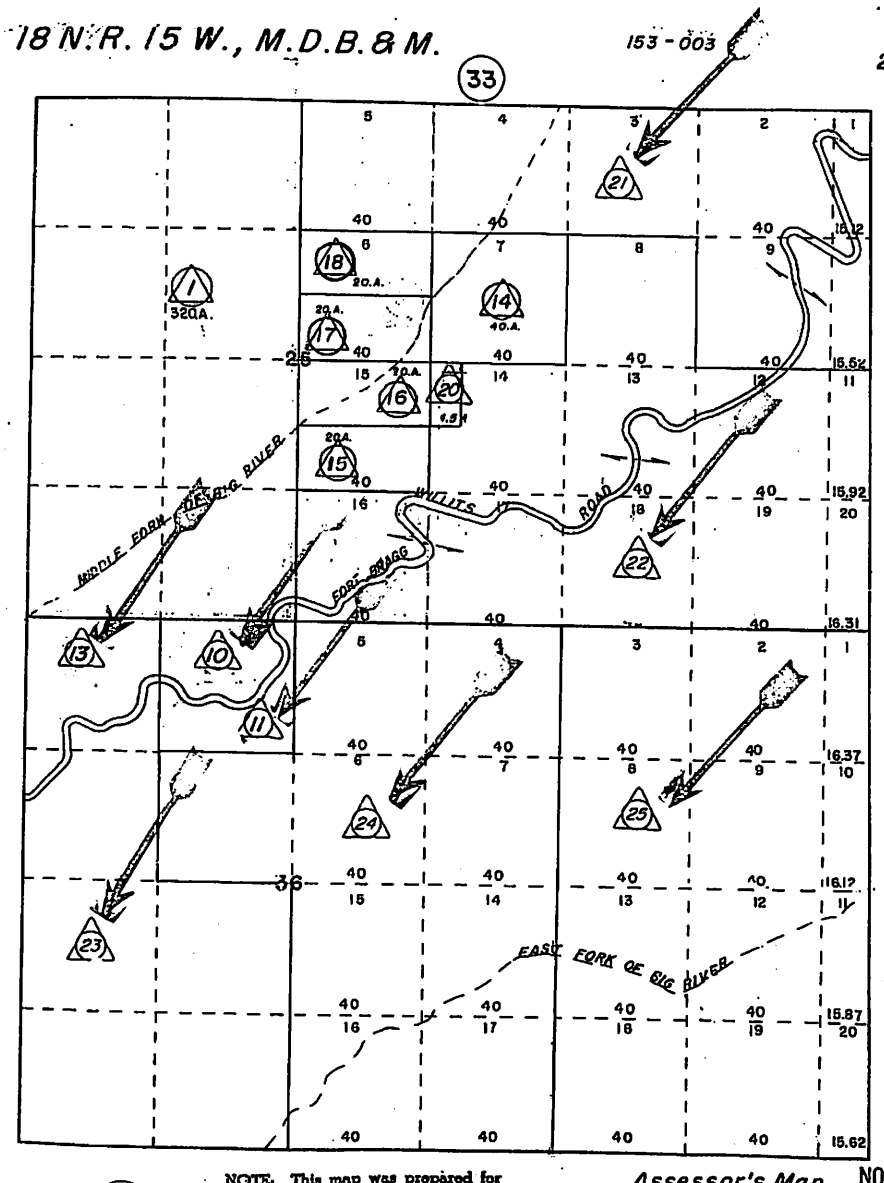
NOTE: This map was prepared for assessment purposes only. No liability is assumed for the data delineated hereon.

Assessor's Map
County of Mendocino, Calif.
March, 1950

Mendocino, CA , 2013-2014 - 021-34, Sheet: 1 of 1

Sec. 25, 36 T. 18 N. R. 15 W., M.D.B.&M.

"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."



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.
March, 1950

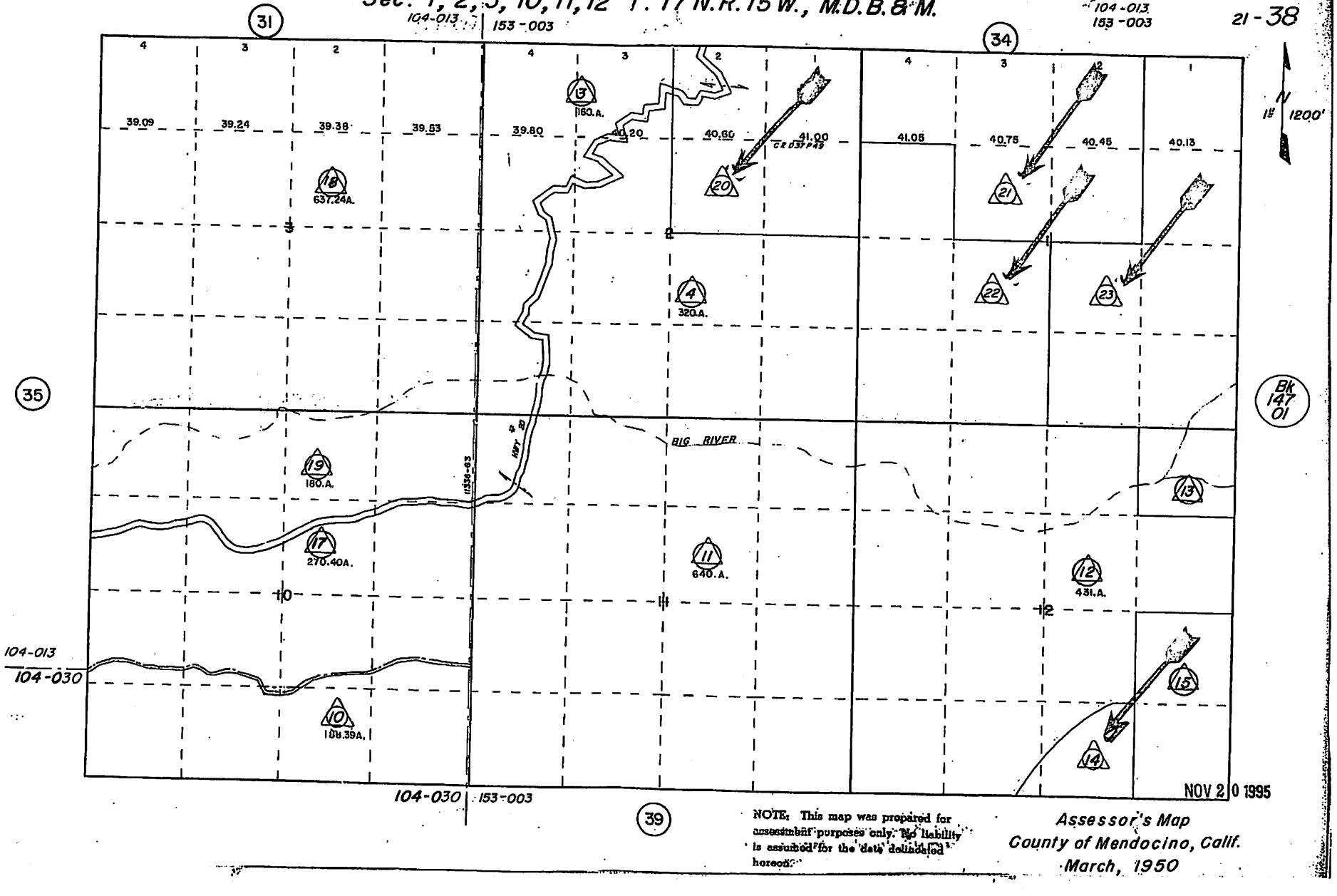
Mendocino, CA , 2013-2014 - 021-380-21-00, Sheet: 1 of 1

"Notice: This is neither a plat nor a survey. It is published 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, 10, 11, 12 T. 17N. R. 15W., M.D.B.&M.

104-030
104-013
153-003

21-38



NOV 2 0 1995

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

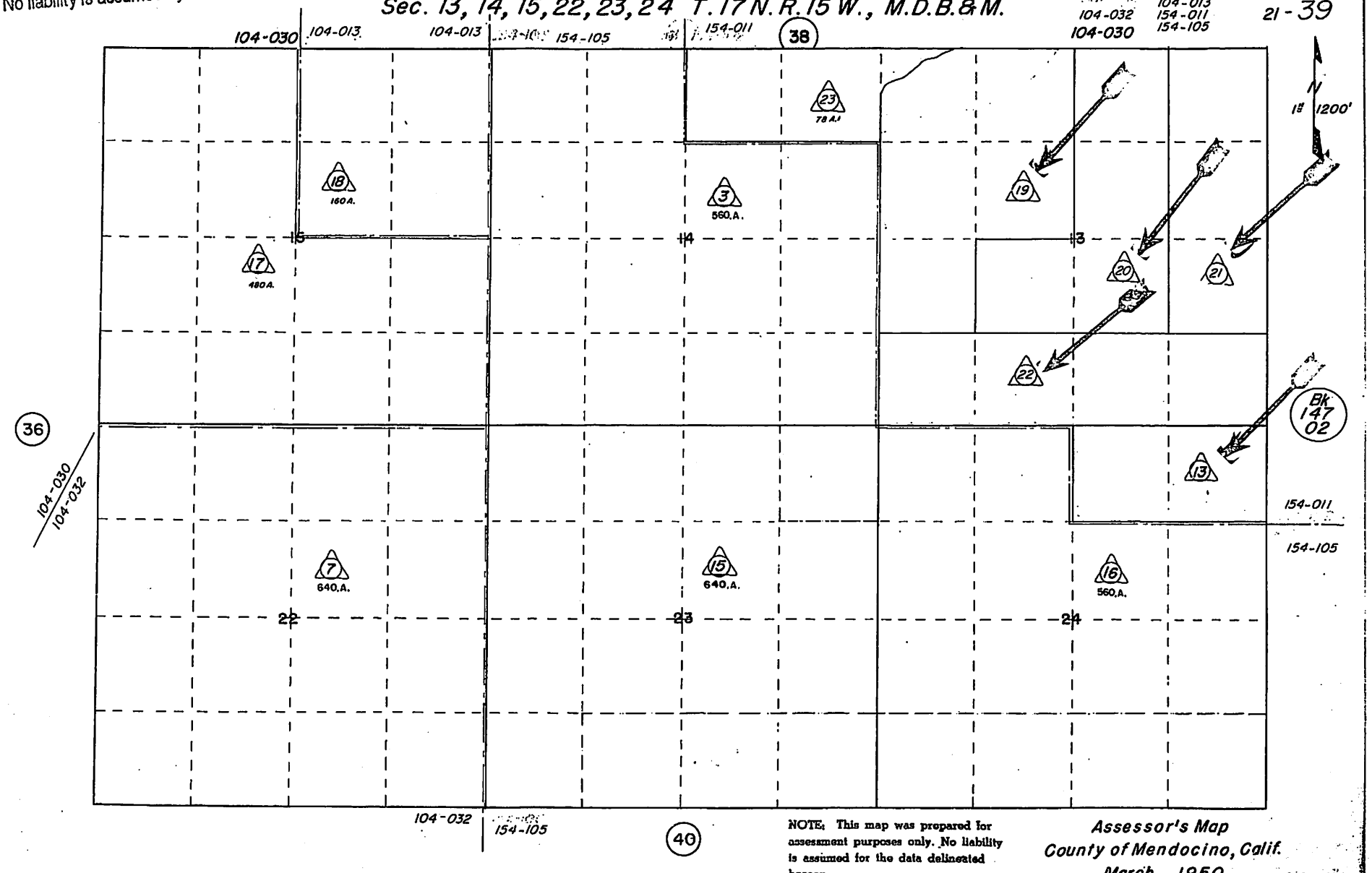
Assessor's Map
County of Mendocino, Calif.
March, 1950

Mendocino, CA , 2013-2014 - 021-390-21-00, Sheet: 1 of 1

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

Sec. 13, 14, 15, 22, 23, 24 T. 17 N. R. 15 W., M.D.B.&M.

21 - 39



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.
March, 1950

MAY 0 2 1997

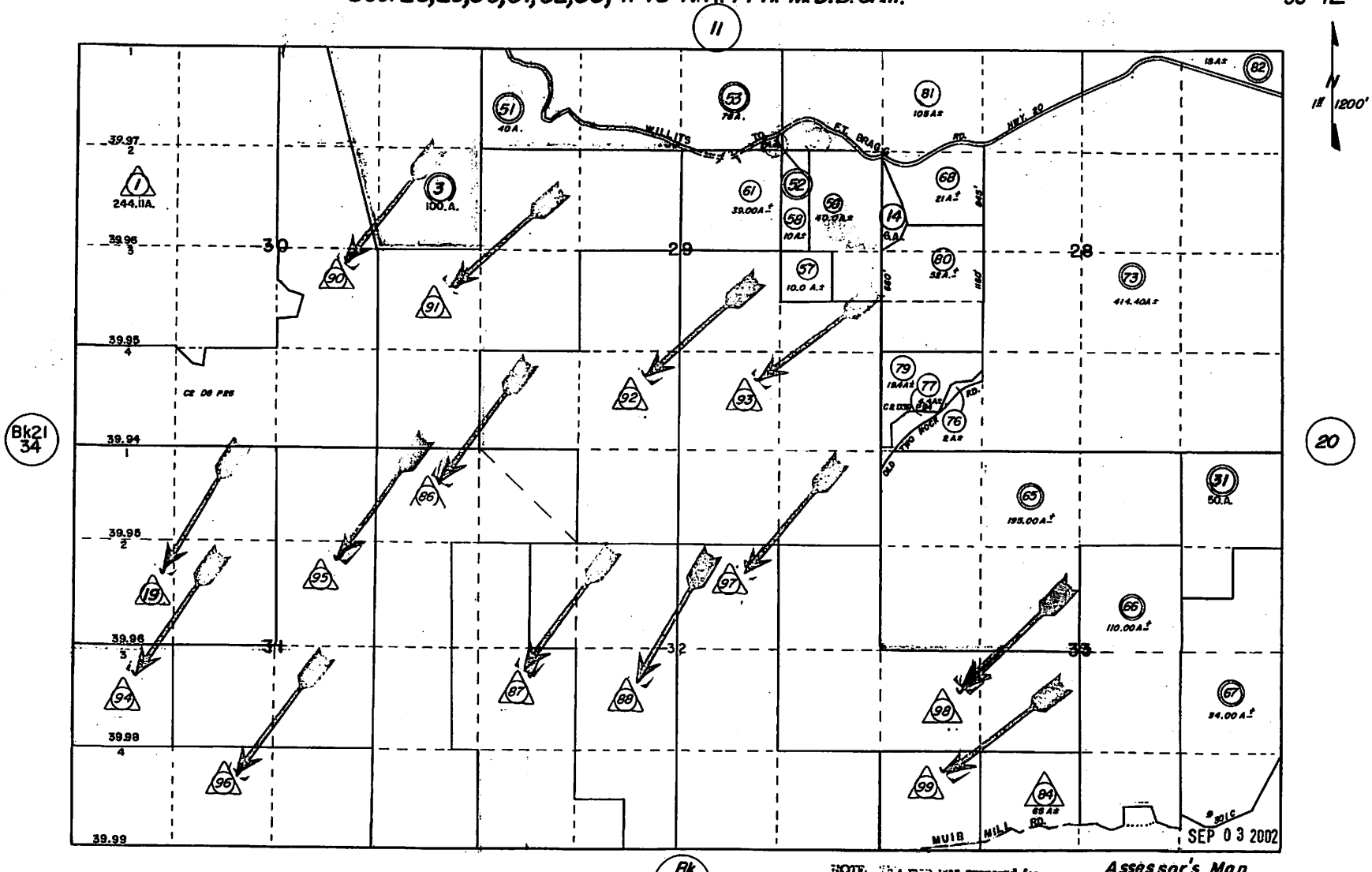
Mendocino, CA , 2013-2014 - 038-120-96-00, Sheet: 1 of 1

"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. 28,29,30,31,32,33, T. 18 N.R. 14 W. M.D.B.& M.

153-004

38-12



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.
March, 1981

Mendocino, CA , 2013-2014 - 147-010-25-00, Sheet: 1 of 1

"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."

147-01

Sec. 4,5, 6, 7, 8, 9, T. 17N. R. 14W. M. D. B. & M.

153-004
153-003
153-025

Bk 38

153-003 153-004

N
1" = 1200'

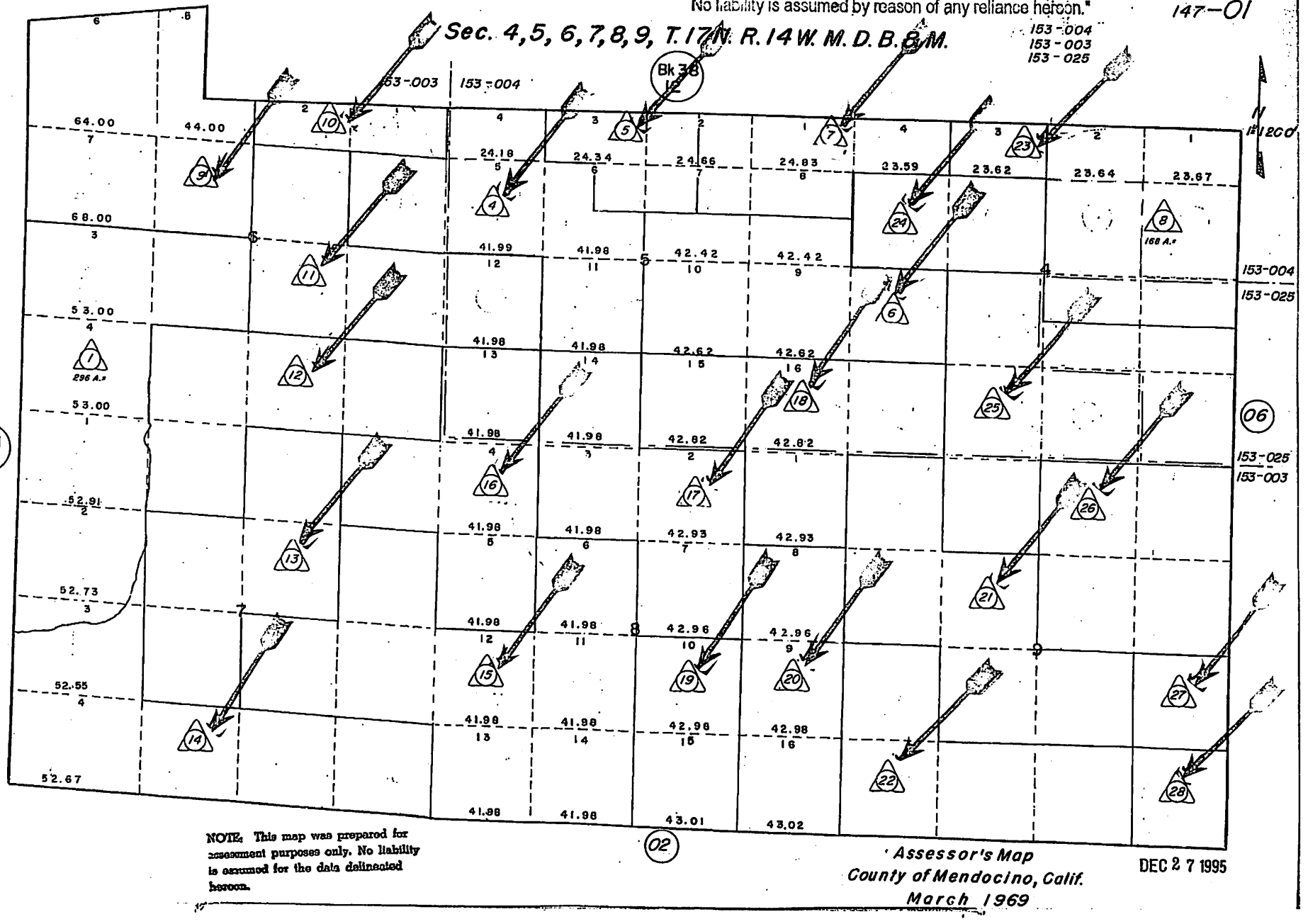
153-004
153-025

06

153-025
153-003

Bk21
38

02

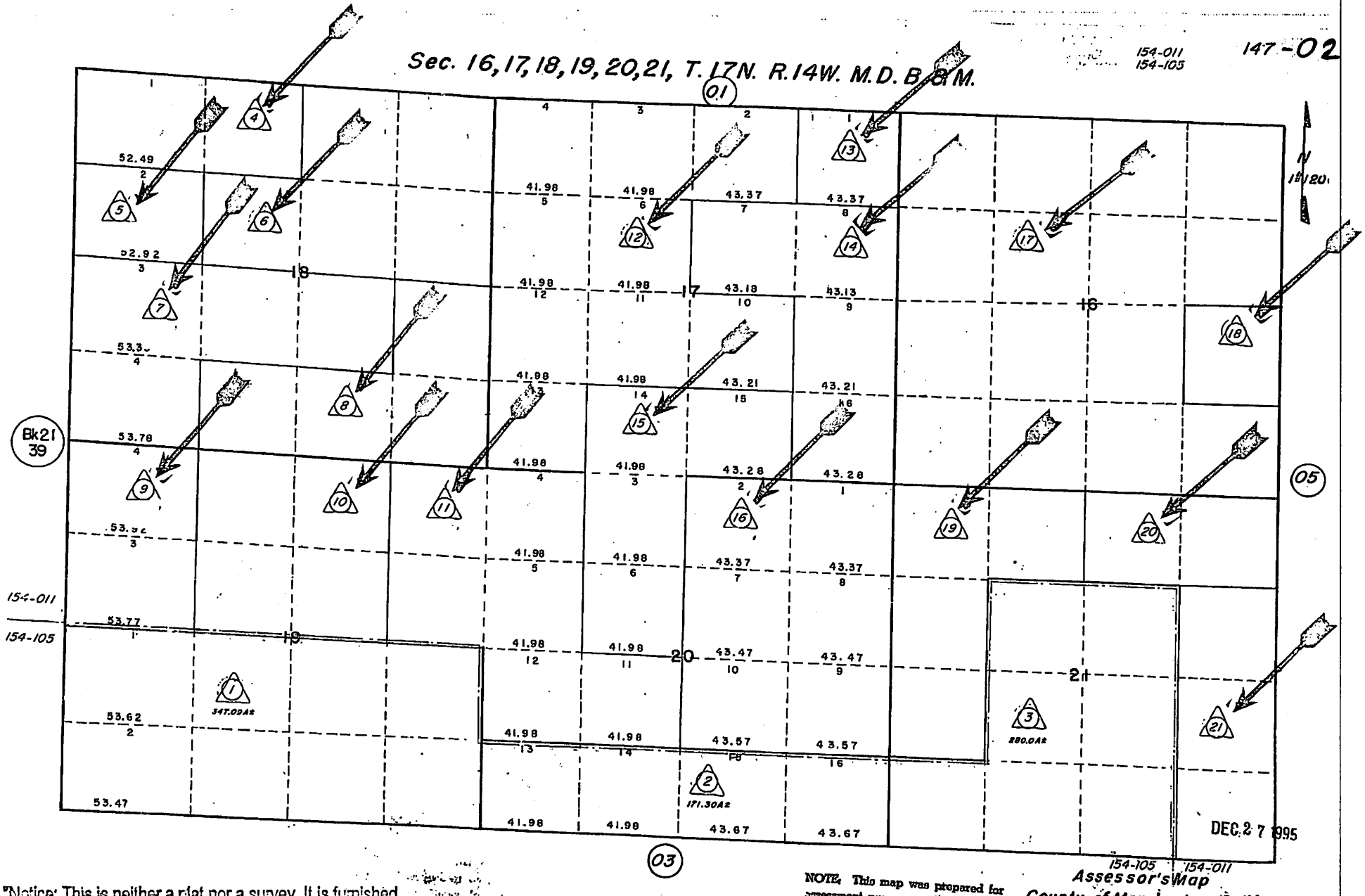


NOTE: This map was prepared for assessment purposes only. No liability is assumed for the data delineated hereon.

Assessor's Map
County of Mendocino, Calif.
March 1969

DEC 2 7 1995

Mendocino, CA , 2013-2014 - 147-020-04-00, Sheet: 1 of 1



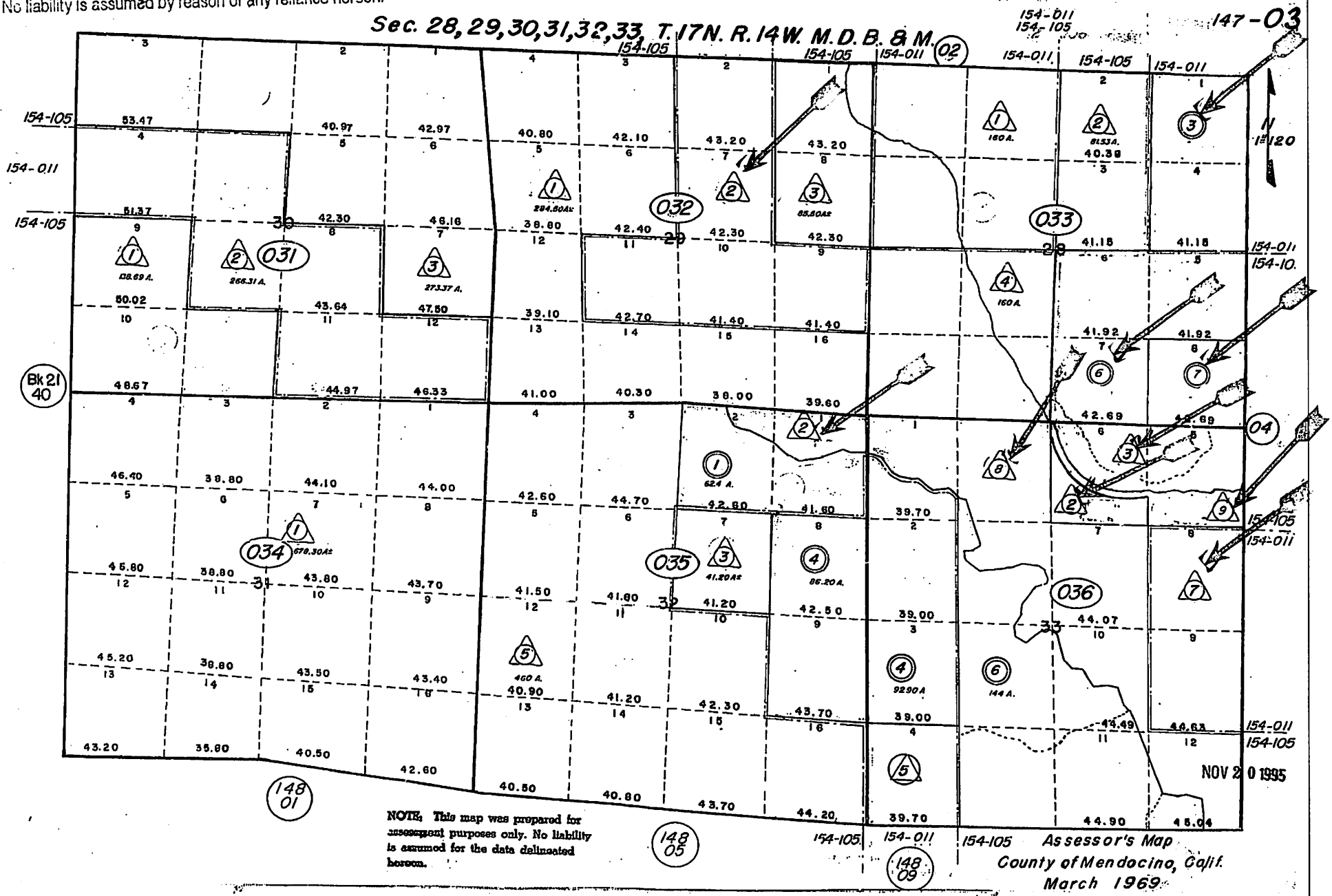
"Notice: This is neither a plat nor a survey. It is furnished merely as a convenience to aid you in locating the land indicated hereon with reference to streets and other land. No liability is assumed by reason of any reliance hereon."

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.
March 1969

Mendocino, CA , 2013-2014 - 147-032-02-00, Sheet 1 of 1

"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."



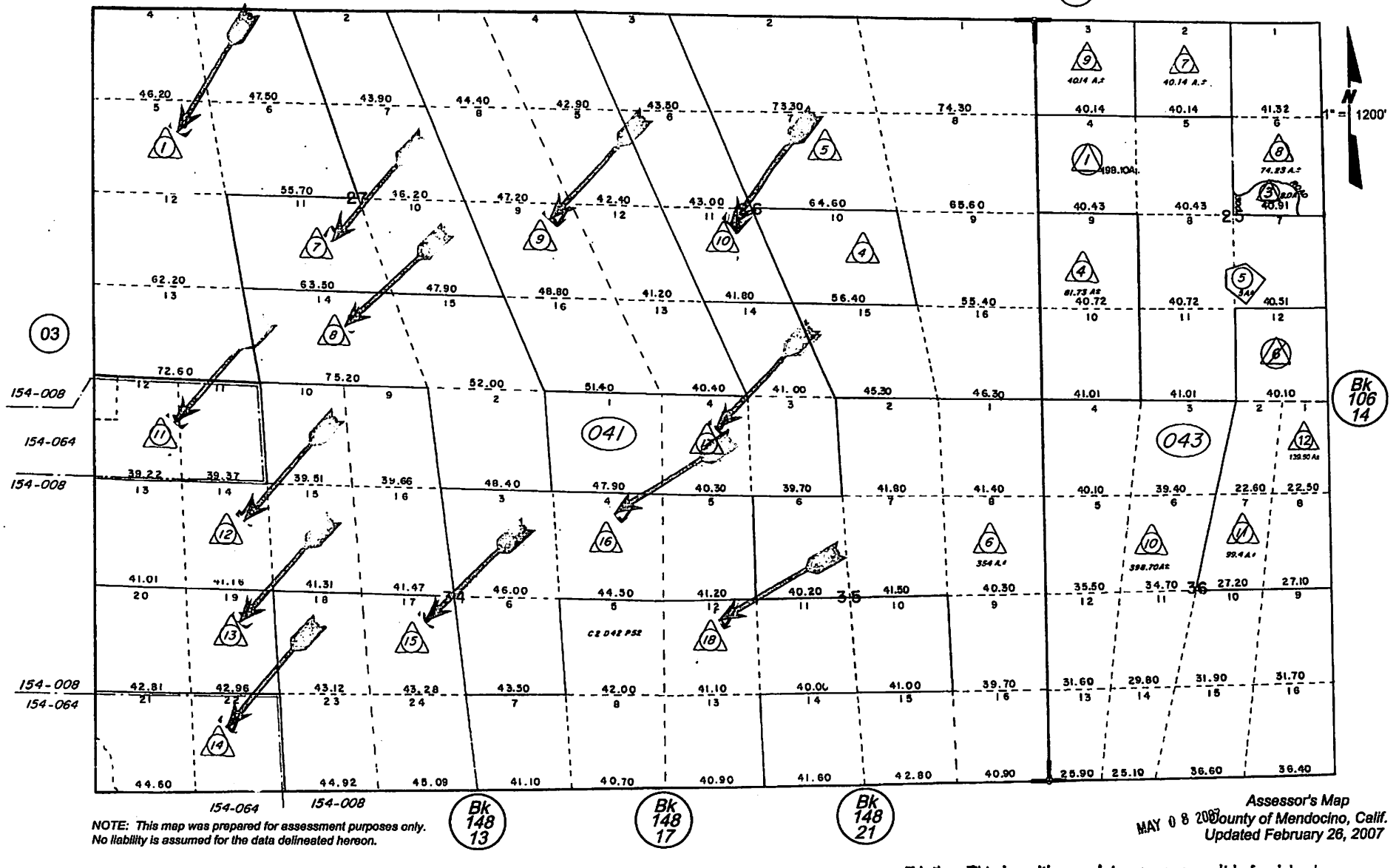
Mendocino, CA , 2013-2014 - 147-041-14-01, Sheet: 1 of 1

Sec. 25,26,27,34,35,36 T.17N. R.14W. M.D.B.& M.

05

154-008
154-064

147 - 04



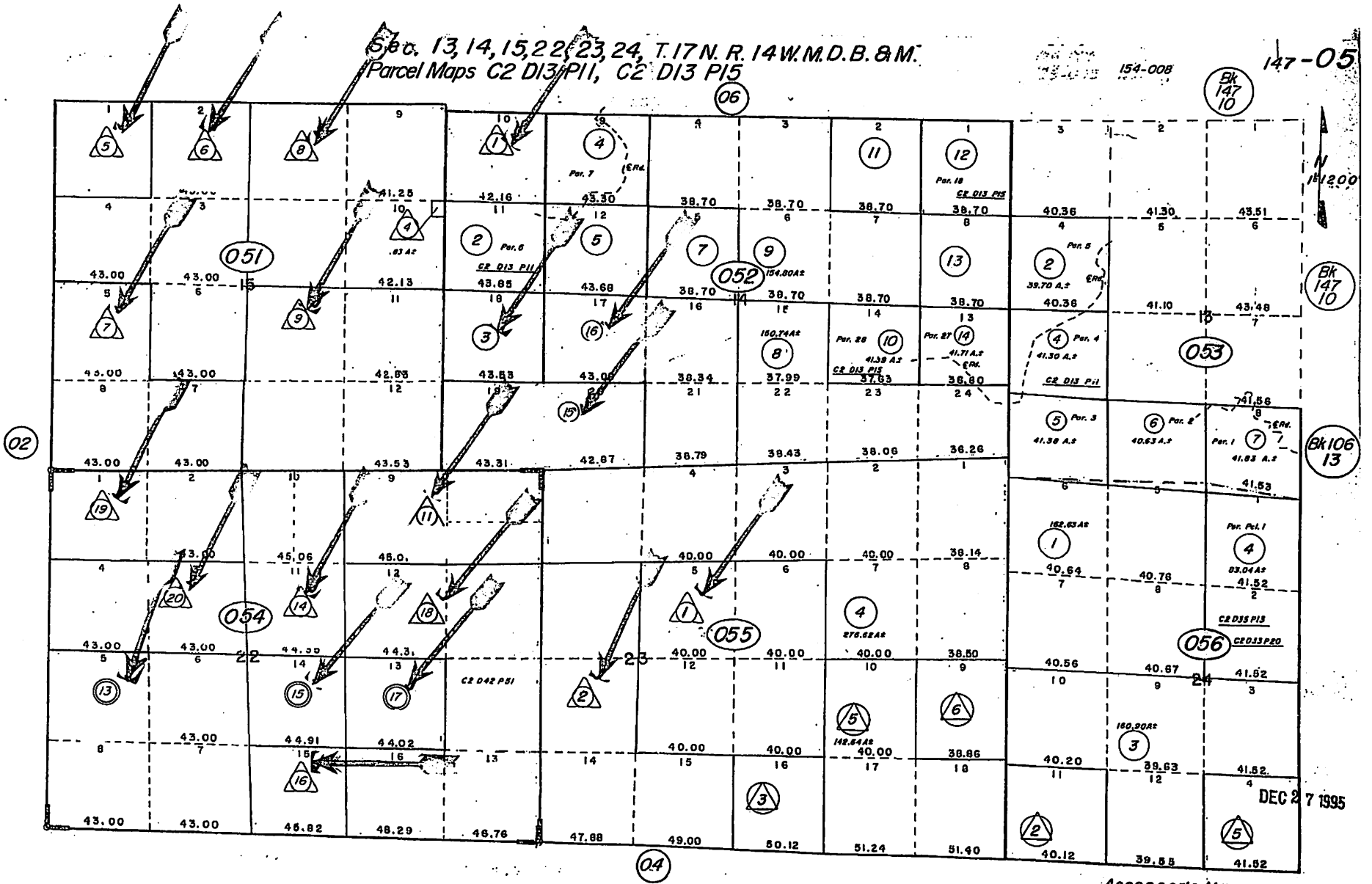
NOTE: This map was prepared for assessment purposes only.
No liability is assumed for the data delineated hereon.

Assessor's Map
County of Mendocino, Calif.
Updated February 26, 2007

MAY 0 8 2007

"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."

Mendocino, CA , 2013-2014 - 147-05, Sheet: 1 of 1



Assessor's Map
County of Mendocino, Calif.
March, 1969

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 hereon with reference to streets and other land. No liability is assumed by reason of any reliance hereon."

Mendocino, CA , 2013-2014 - 147-06, Sheet: 1 of 1

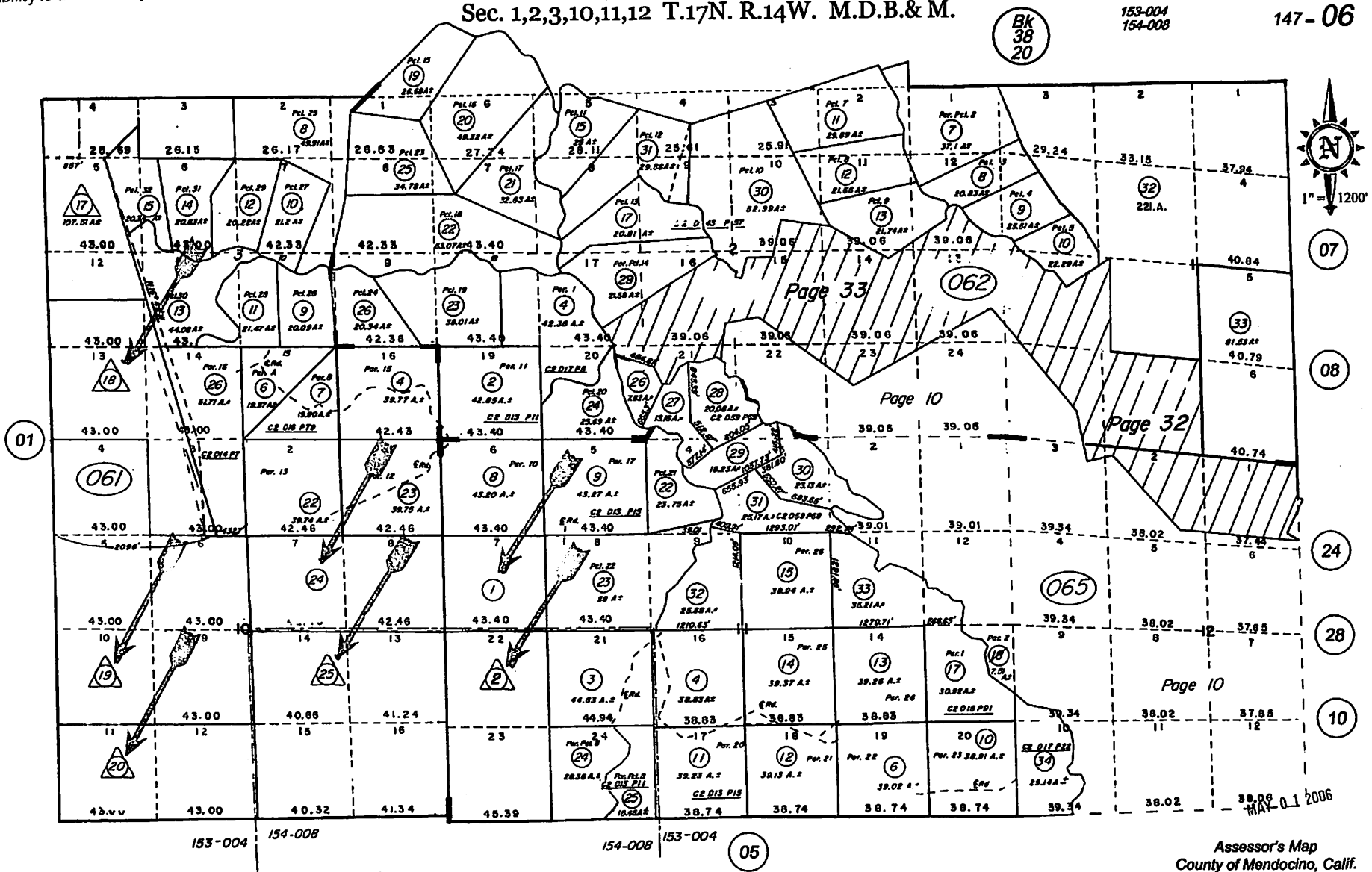
"Notice: This is neither a plat nor a survey. It is furnished merely as a convenience to aid you in locating the land indicated hereon with reference to streets and other land. No liability is assumed by reason of any reliance hereon."

Sec. 1,2,3,10,11,12 T.17N. R.14W. M.D.B.& M.

BK 38 20

153-004
154-008

147 - 06



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 December 20, 2005

MAY 01 2006

Mendocino, CA , 2013-2014 - 148-130-04-00, Sheet: 1 of 1

N.1/2 Sec. 4, T.16N. R.14W., MDB&M

104-021
104-031

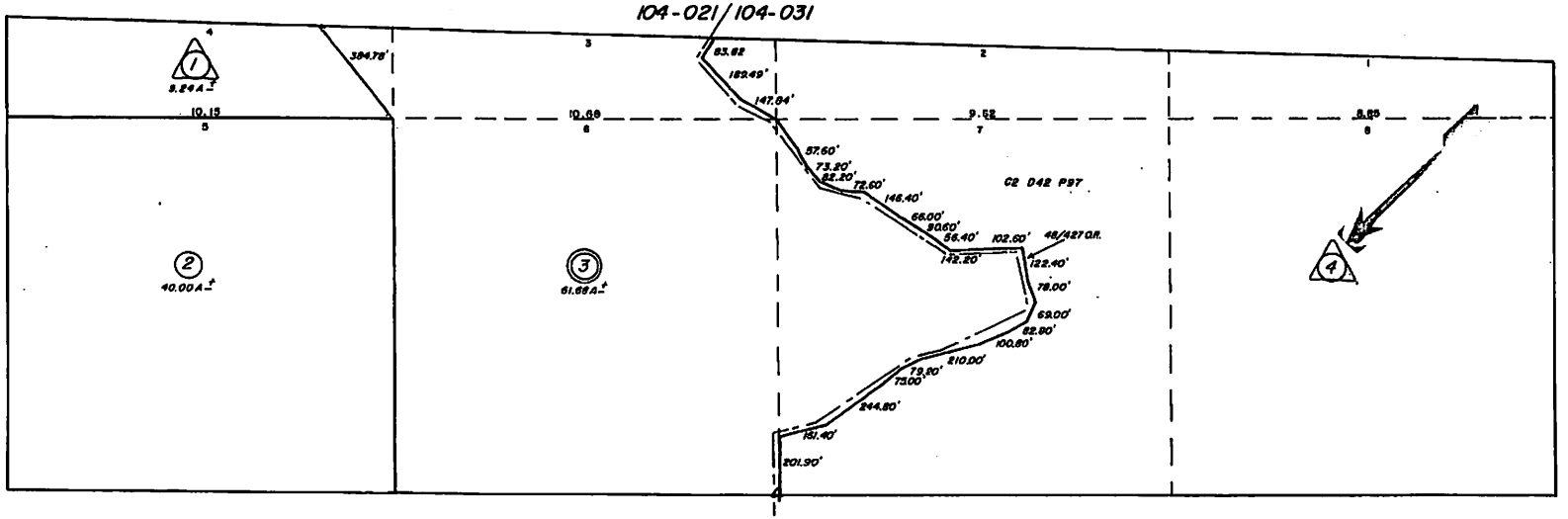
148-13

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

N
1" = 400'

Bk.147
03

104-021/104-031



104-021 104-031

14

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.
REVISED 5-20-85

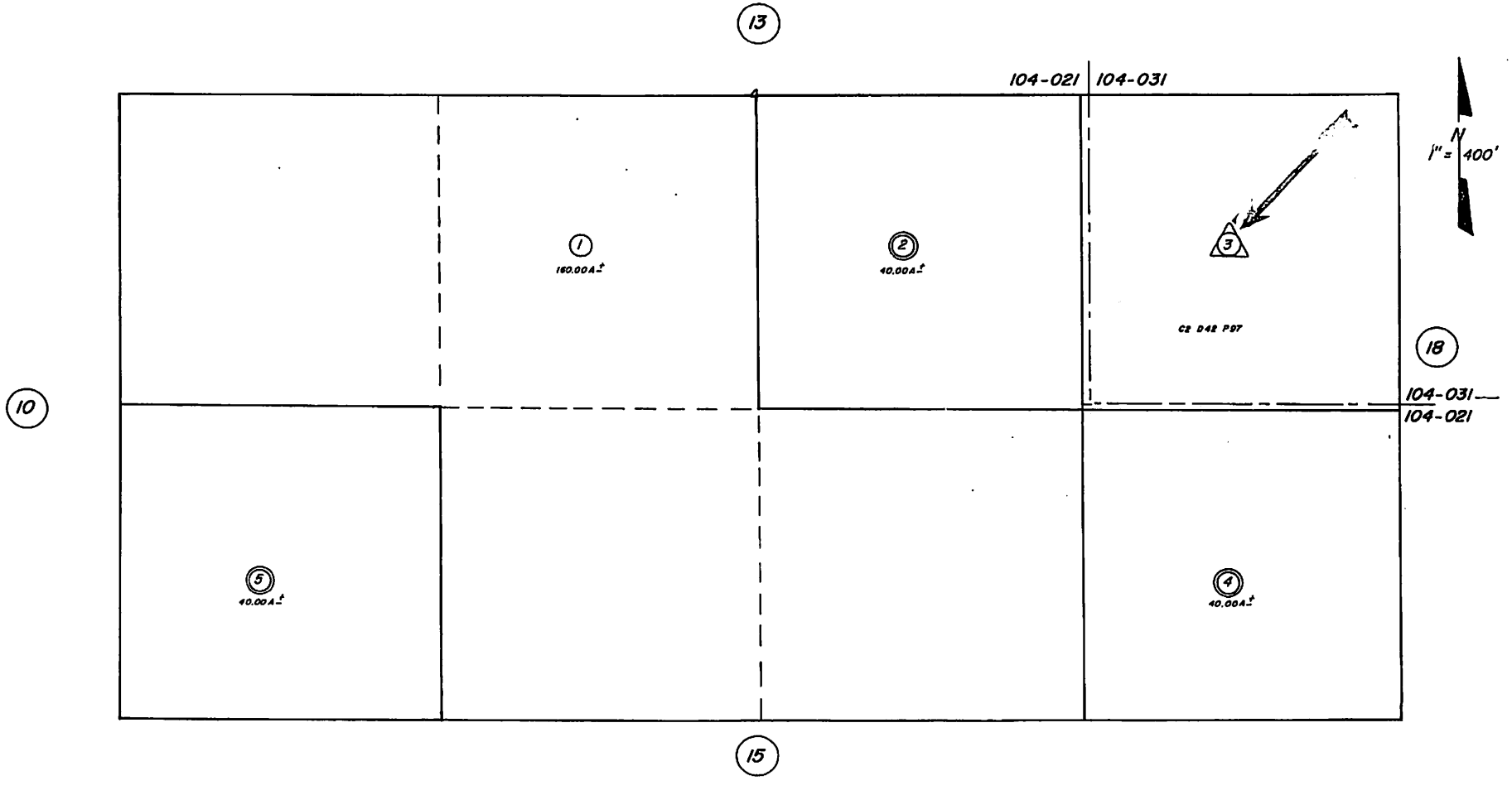
Mendocino, CA , 2013-2014 - 148-14, Sheet: 1 of 1

"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. 4, T.16N. R.14W., MDB&M

104-021
104-031

148-14



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.
REVISED 5-20-85

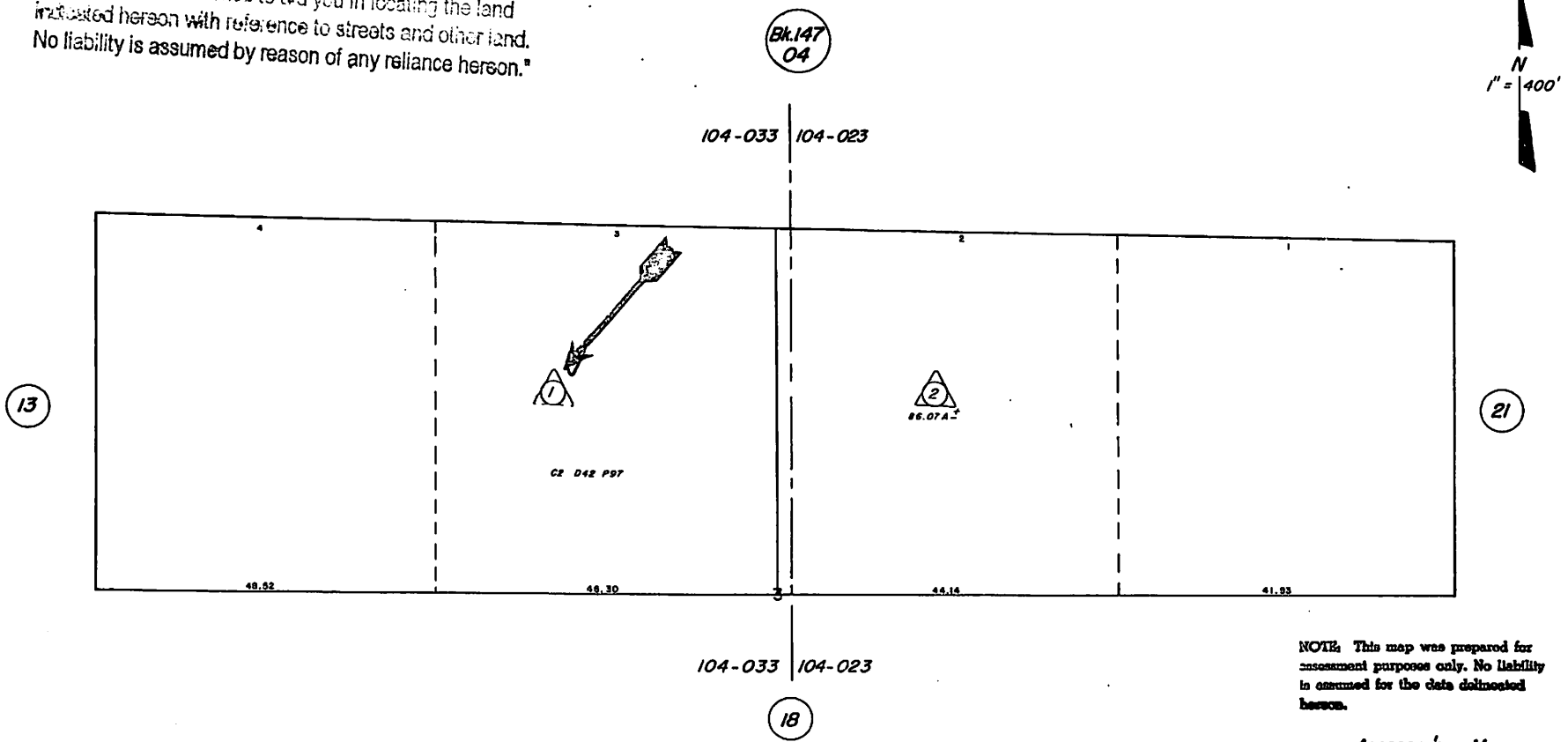
Mendocino, CA , 2013-2014 - 148-170-01-00, Sheet: 1 of 1

N.1/2 Sec. 3, T.16N. R.14W., MDB&M

104-023
104-033

148-17

"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."



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.
REVISED 5-20-85

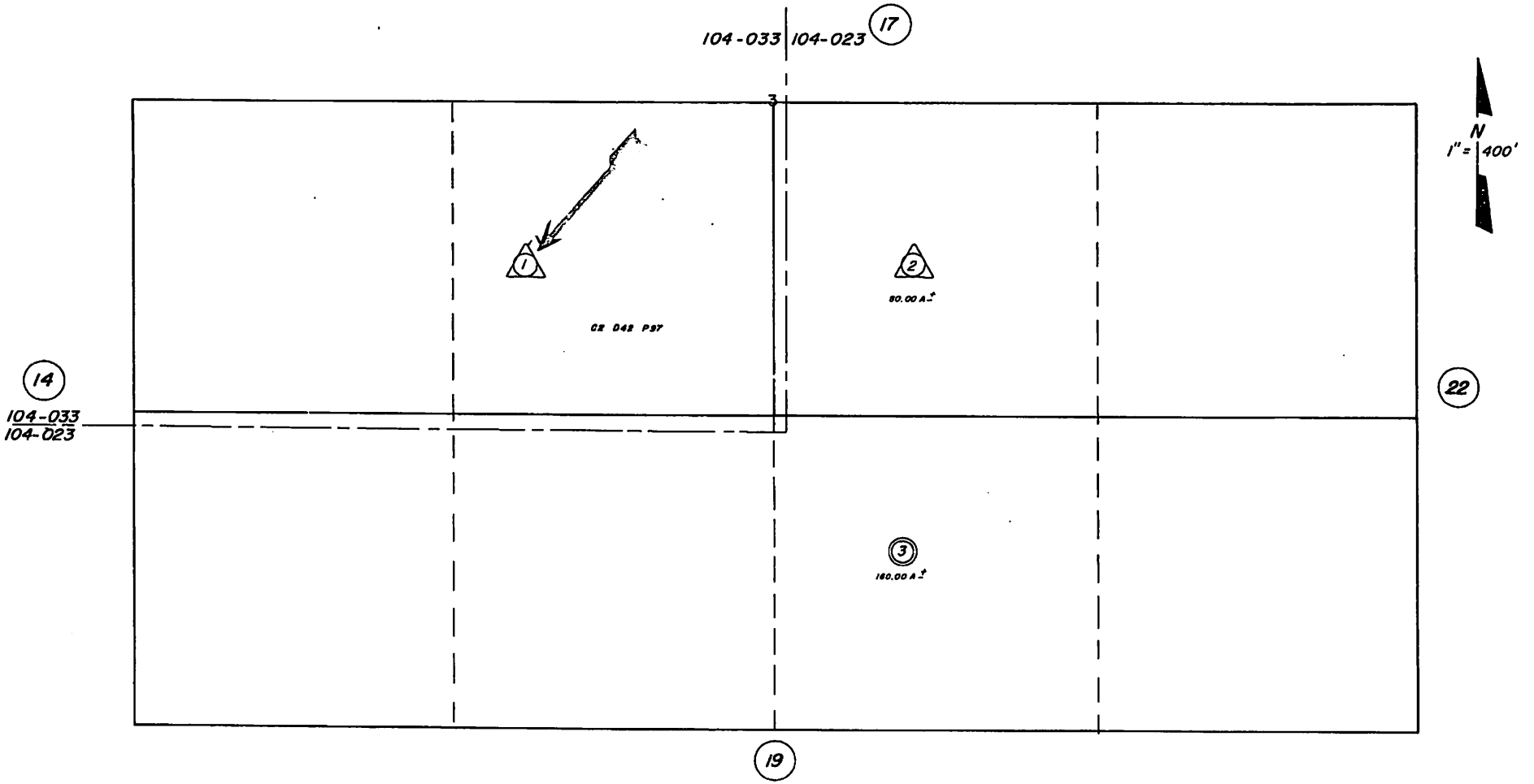
Mendocino, CA , 2013-2014 - 148-18, Sheet: 1 of 1

"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 lands. No liability is assumed by reason of any reliance hereon."

S.1/2 Sec. 3, T.16N. R.14W., MDB&M

104-023
104-033

148-18



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.
REVISED 5-20-85

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.

ATTACHMENT E

Willits Woods IFM
Improved Forest Management Project Map

Legend

- Property Boundary
- Forest Project Boundary
- Public Road
- Permanent Road
- Seasonal Road
- Watercourse
- Section Lines
- 40' Contour

Plotted Scale 1 : 28,800
1 inch = 2,400 feet

0 1,000 2,000 4,000 6,000 Feet

December 14, 2016
Version 1.1C

NCRM Inc.

R15W
R14W

T18N
T17N

ATTACHMENT F

Willits Woods

Improved Forest Management Project Map

Legend

- Property Boundary
- Non-Timberland
- Public Road
- Permanent Road
- Seasonal Road
- Watercourse
- Section Lines

Plotted Scale 1 : 28,800
1 inch = 2,400 feet

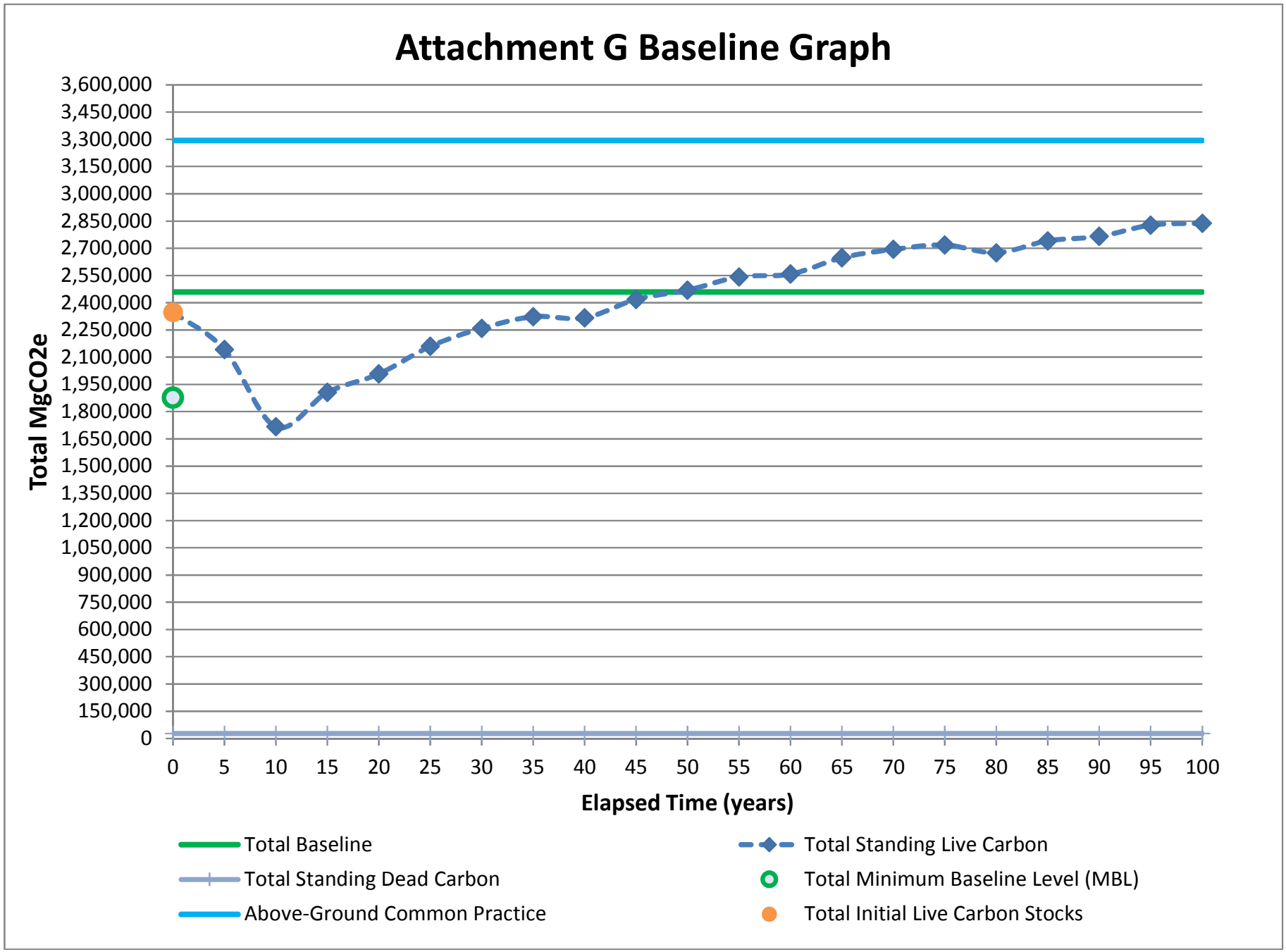
0 1,000 2,000 4,000 6,000 Feet

February 5, 2015
Version 1.0C

NCRM Inc.

R15W
R14W
T18N
T17N
T17N
T16N

ATTACHMENT G


Attachment G Baseline Graph
Total MgCO2e
3,600,000
3,450,000
3,300,000
3,150,000
3,000,000
2,850,000
2,700,000
2,550,000
2,400,000
2,250,000
2,100,000
1,950,000
1,800,000
1,650,000
1,500,000
1,350,000
1,200,000
1,050,000
900,000
750,000
600,000
450,000
300,000
150,000
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
Elapsed Time (years)
Total Baseline
Total Standing Live Carbon
Total Standing Dead Carbon
Total Minimum Baseline Level (MBL)
Above-Ground Common Practice
Total Initial Live Carbon Stocks

Baseline Carbon Stocks ($MgCO_2e$ Total)

Elapsed Time	Standing Live Carbon Pool IFM-1	Standing Live Above	Standing Live Below	Standing Dead Carbon	Baseline	MBL	Above-Ground Common	Initial Live Carbon Stocks
0	2,389,005	1,911,342	477,663	27,299	2,478,960	1,911,342	3,293,393	2,389,005
5	2,165,374	1,731,379	434,040	27,299	2,478,960		3,293,393	
10	1,735,206	1,375,186	360,085	27,299	2,478,960		3,293,393	
15	1,927,166	1,532,409	394,818	27,299	2,478,960		3,293,393	
20	2,029,862	1,615,146	414,778	27,299	2,478,960		3,293,393	
25	2,182,330	1,740,532	441,854	27,299	2,478,960		3,293,393	
30	2,281,545	1,820,877	460,723	27,299	2,478,960		3,293,393	
35	2,345,274	1,874,161	471,164	27,299	2,478,960		3,293,393	
40	2,337,529	1,866,925	470,658	27,299	2,478,960		3,293,393	
45	2,439,527	1,951,401	488,176	27,299	2,478,960		3,293,393	
50	2,489,587	1,991,736	497,900	27,299	2,478,960		3,293,393	
55	2,561,986	2,052,591	509,439	27,299	2,478,960		3,293,393	
60	2,576,371	2,064,006	512,411	27,299	2,478,960		3,293,393	
65	2,666,209	2,138,425	527,825	27,299	2,478,960		3,293,393	
70	2,710,973	2,174,283	536,732	27,299	2,478,960		3,293,393	
75	2,734,466	2,195,490	539,013	27,299	2,478,960		3,293,393	
80	2,689,663	2,158,738	530,963	27,299	2,478,960		3,293,393	
85	2,755,086	2,213,039	542,082	27,299	2,478,960		3,293,393	
90	2,778,519	2,231,215	547,340	27,299	2,478,960		3,293,393	
95	2,840,014	2,282,883	557,163	27,299	2,478,960		3,293,393	
100	2,849,186	2,289,997	559,222	27,299	2,478,960		3,293,393	
Average	2,451,661	1,962,465	489,240	27,299	2,478,960		3,293,393	

ATTACHMENT H

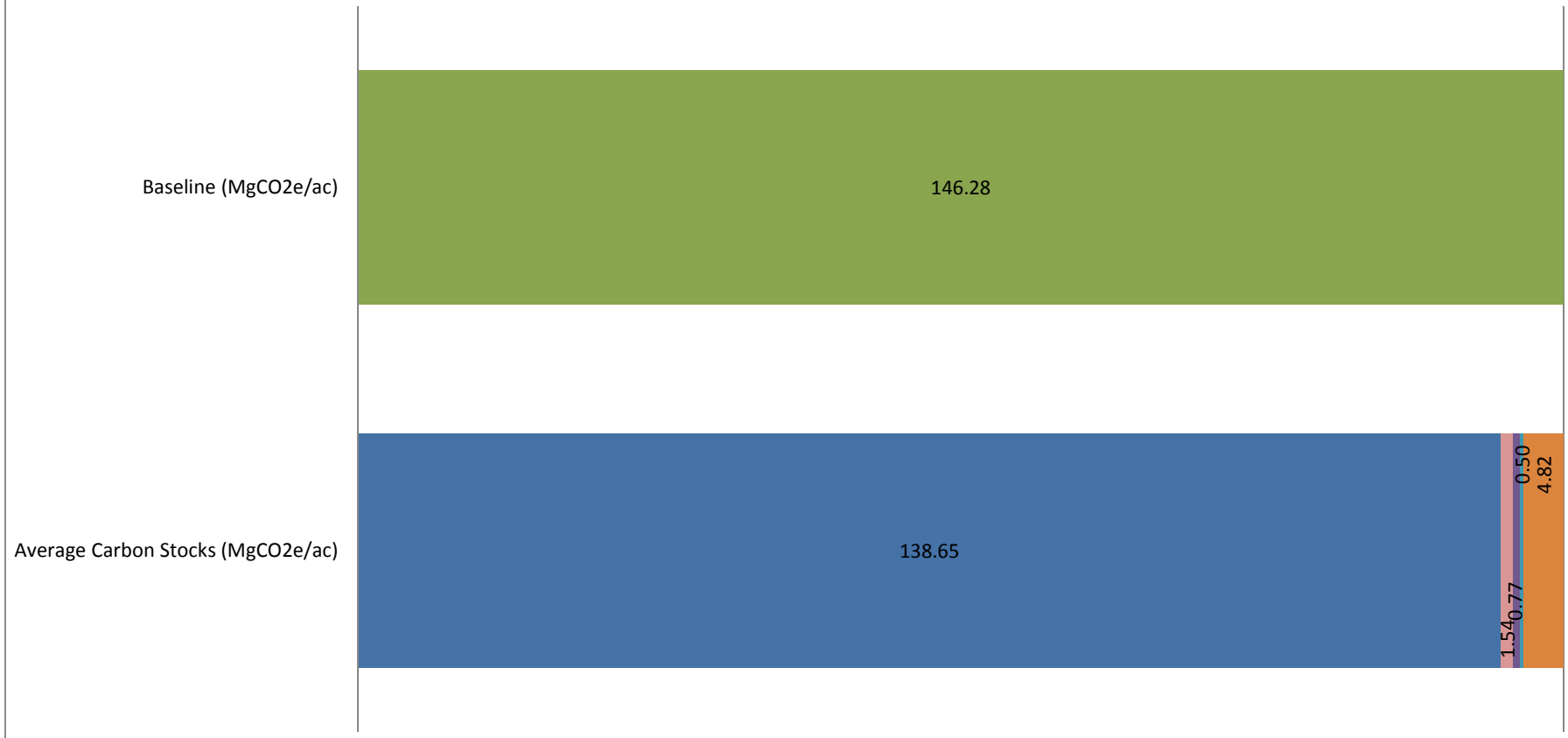
Attachment H

Baseline Carbon Stocks ($MgCO_2e$ per Acre)

Elapsed Time	Standing Live Carbon Pool IFM-1	Standing Dead Carbon Pool IFM-3	Baseline
0	135.11	1.54	140.19
5	122.46	1.54	140.19
10	98.13	1.54	140.19
15	108.99	1.54	140.19
20	114.80	1.54	140.19
25	123.42	1.54	140.19
30	129.03	1.54	140.19
35	132.63	1.54	140.19
40	132.20	1.54	140.19
45	137.96	1.54	140.19
50	140.80	1.54	140.19
55	144.89	1.54	140.19
60	145.70	1.54	140.19
65	150.78	1.54	140.19
70	153.32	1.54	140.19
75	154.64	1.54	140.19
80	152.11	1.54	140.19
85	155.81	1.54	140.19
90	157.14	1.54	140.19
95	160.61	1.54	140.19
100	161.13	1.54	140.19
Average	138.65	1.54	140.19

Carbon Pool	Mg C/ acre	Mg CO2e/acre	Total Mg CO2e
Average Standing Live and Standing Dead Pools	38.26	140.19	2,478,960
Average Annual Carbon 100-year In-Use	0.210	0.77	12,981.56
Average Annual Carbon 100-year Landfill	0.136	0.50	8,386.33
Average Annual Carbon in Harvested Trees Prior to Delivery to the Mill	1.316	4.82	81,418.23

Attachment H - Carbon Stocks and Baseline



ATTACHMENT I

Attachment I

Per section 9.2.1 of the protocol, the following table represents the projected actual harvesting volumes from the Project Area over 100 years.

Elapsed Time (Years)	Average Decadal Harvest (Board feet per acre)
10	500
20	600
30	600
40	700
50	900
60	1000
70	1000
80	1000
90	1000
100	1000

The baseline projection is provided in the Modeling plan included as Attachment M.

ATTACHMENT J

Carbon Stock Estimate Affidavit for the Purpose of Determining The High Stocking Reference

The carbon stock estimates for the 10-year period preceding the Project's commencement date are shown in the table and graph below. These values are derived through the calculation of annual percent stock change based on the Project's average annual percent stock change from the beginning of 2004 to the end of 2008 which was approximately 5.6% adjusted for annual harvested carbon stocks. Harvest records in the form of California Board of Equalization yield tax reports were used to calculate the carbon stocks delivered to the mill in each year of the ten year period for the portion of the Willits Woods owned by Coastal Forestlands (approximately 14,200 acres of the Project Area). Approximately 3,800 acres of the Project Area also known as the Williams Ranch was not owned by Coastal Forestlands, and no yield tax records exist. Based on knowledge regarding harvests from 1993 through 2003 on the Williams Ranch, it is estimated that ten million board feet of conifer volume was harvested over three years, with approximately 45% being harvested each year in 1994 and1995, and 10% in 1997. Hardwood harvests on the Williams Ranch were significantly lower than on the remainder of the Willits Woods; however, in order to be conservative the volume of hardwoods delivered to the mill for the Williams Ranch is based on the ratio of the conifer volume and hardwood volume delivered to the mill for the portion of the Project Area for which harvest records exist.

Harvested carbon was calculated using the "Harvested Wood Products Worksheet" developed by the Climate Action Reserve. The total MgCO2e in harvested wood delivered to the mill each year calculated using the worksheet was then multiplied by the ratio of carbon in wood delivered to the mill to carbon in trees harvested for wood products (prior to delivery to the mill) derived from the baseline harvested wood products values. This ratio is 1.86 for the Willits Woods Project.

Carbon Stocks for the 10-year period preceding the Project Start Date

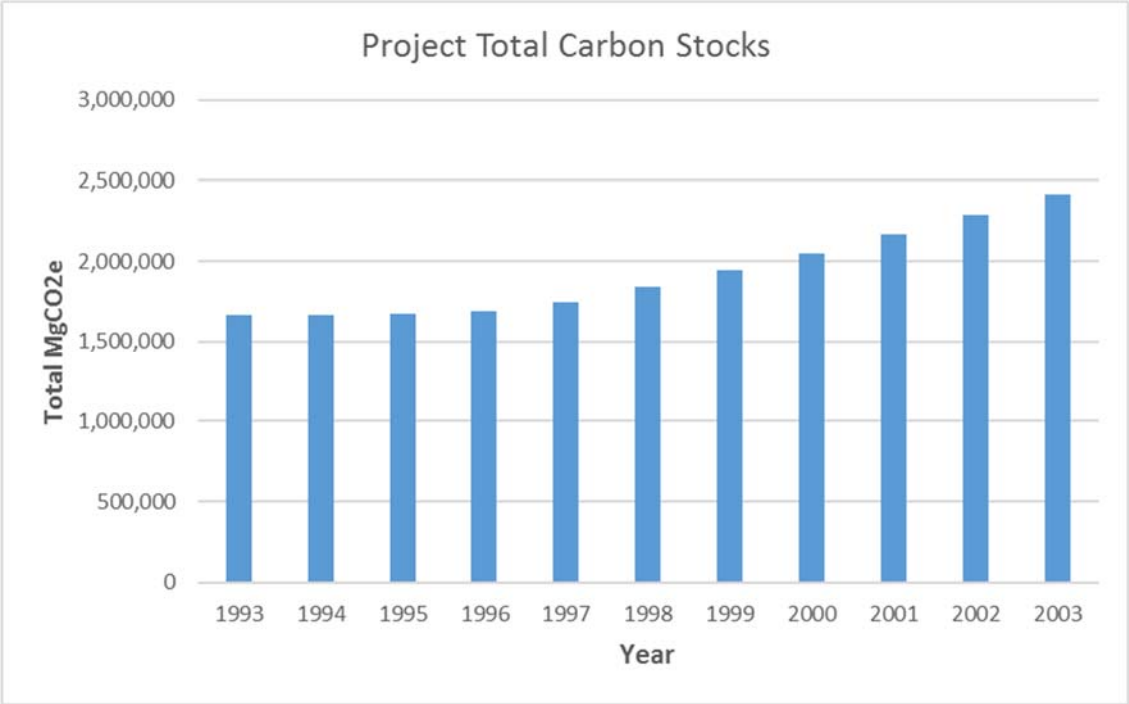
Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Total MgCO2e[1]	1,663,635	1,663,404	1,673,355	1,692,224	1,746,280	1,840,060	1,943,103	2,051,917	2,166,824	2,288,167	2,416,304
Annual Carbon Growth		88,211	88,739	89,739	92,606	97,579	103,043	108,814	114,907	121,342	128,137
Adjusted Harvested Carbon[2]		88,442	78,788	70,870	38,550	3,799	0	0	0	0	0
Harvest Carbon[3]		47,546	42,356	38,099	20,724	2,042	0	0	0	0	0
Net Stock Change		-0.01%	0.60%	1.13%	3.19%	5.37%	5.60%	5.60%	5.60%	5.60%	5.60%

[1]As of the end of the year

[2]Harvested Carbon times 2.01 Adjustment Factor

[3]Based on California Board of Equalization Records

Based on the information available to the Offset Project Operator at this time as presented above, the highest value for above-ground standing live carbon stocks per acre within the Project Area during the 10-year period preceding the Project commencement date was equal to the above-ground standing live carbon stocks at the end of the last year of this 10-year period (2003), which is equal to the Project's initial above-ground standing live carbon stocks (ICS). Therefore, the "High Stocking Reference" (HSR) is equal to 80% of the Project's ICS value of 108.09 MgCO2e per acre as reported in Part VIII.B.1 of this Initial OPDR, or 86.47 MgCO2e per acre.



The carbon stock inventory estimates presented above, including the summary of volume harvested over the 10-year period preceding the Project's commencement date are believed to be reasonably accurate and are based on the best available data including actual harvest records where available.

Signed,

James D. Clark
Authorized Project Designee

ATTACHMENT K

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.

ATTACHMENT L

Willits Woods IFM

This analysis is provided per section 6.2.1.3(1) of Compliance Offset Protocol U.S. Forest Projects, November 14, 2014, 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 finalcial feasibility. If herbicide treatments, tree planting and logging costs were significantly increased, the analysis would still demonstrate that the baseline growth and harvest is finalcially feasible. Delivered log values are below trended values based on Board of Equalization values, yet still demonstrate financial feasibility.

Model Inputs:

Discount Rate	10.0%	
Inflation	0.0%	
Real price appreciation for delivered log values	0.0%	
Yield Tax	2.9%	MBF

Production Costs:

Item	**Cost per acre**	**Quantity[1]**	**Total Cost**	**Cost per MBF**
THP Preparation	$150	16,890	$ 2,533,473	$32.62
Logging Supervision				$15.00
Property Management				$10.00
Logging and Hauling				$285.00
Total				**$342.62**

Herbicide Treatment of Hardwoods:

Period (10-year)	**Cost per acre**	**% of Acres Treated**	**Total Cost**	**Cost per MBF**
1	$ 175.00	100%	$2,955,719	$38.05
2	$ 175.00	33%	$975,387	$10.32
3	$ 175.00	33%	$975,387	$10.47
4	$ 175.00	33%	$975,387	$8.27
5	$ 175.00	33%	$975,387	$8.33
6	$ 175.00	33%	$975,387	$7.55
7	$ 175.00	33%	$975,387	$7.70
8	$ 175.00	33%	$975,387	$6.81
9	$ 175.00	33%	$975,387	$7.29
10	$ 175.00	33%	$975,387	$7.09

Tree Planting: ($1 per tree cost)

Period (10-year)	**Cost per acre**	**% of Acres Treated**	**Total Cost**	**Cost per MBF**
1	$ 135.00	100%	$2,280,126	$29.36
2	$ 100.00	25%	$422,246	$4.47
3	$ 100.00	25%	$422,246	$4.53
4	$ 100.00	25%	$422,246	$3.58
5	$ 100.00	25%	$422,246	$3.60
6	$ 100.00	25%	$422,246	$3.27
7	$ 100.00	25%	$422,246	$3.33
8	$ 100.00	25%	$422,246	$2.95
9	$ 100.00	25%	$422,246	$3.16
10	$ 100.00	25%	$422,246	$3.07

[1] Unconstrained timbered acreage.

Willits Woods IFM
Financial Analysis of Baseline Scenario
Calculation of Net Present Value of Harvest Stream

Assumptions: Harvest levels are based on Willits Woods IFM Baseline Harvest Scenario.
Logging sytem mix estimated as 80% tractor, 20% cable.
Production costs per MBF are estimates based upon logging system mix.
0% Real price appreciation applied to delivered log values.
All calculations in constant dollars without inflation.
Discount Rate 10% Real.

	Annual Harvest Volume				Delivered Log Values per MBF				Production	Herbicide	Tree	Yield	Net	Total	Present
	RW	DF	Pine	Totals	RW	DF	Pine	Camprun	Costs	Treatment	Planting	Taxes	Value	Net	Net
Year	MBF	MBF	MBF	MBF	$ / MBF	$ / MBF	$ / MBF	$ / MBF	$ / MBF	$ / MBF	$ / MBF	$ / MBF	$ / MBF	Value	Value
2004	3,556	4,038	173	7,767	900.00	500.00	400.00	680.92	342.62	38.05	29.36	19.75	251.14	1,950,635	1,773,304
2005	3,556	4,038	173	7,767	900.00	500.00	400.00	680.92	342.62	38.05	29.36	19.75	251.14	1,950,635	1,612,095
2006	3,556	4,038	173	7,767	900.00	500.00	400.00	680.92	342.62	38.05	29.36	19.75	251.14	1,950,635	1,465,541
2007	3,556	4,038	173	7,767	900.00	500.00	400.00	680.92	342.62	38.05	29.36	19.75	251.14	1,950,635	1,332,310
2008	3,556	4,038	173	7,767	900.00	500.00	400.00	680.92	342.62	38.05	29.36	19.75	251.14	1,950,635	1,211,191
2009	3,556	4,038	173	7,767	900.00	500.00	400.00	680.92	342.62	38.05	29.36	19.75	251.14	1,950,635	1,101,083
2010	3,556	4,038	173	7,767	900.00	500.00	400.00	680.92	342.62	38.05	29.36	19.75	251.14	1,950,635	1,000,984
2011	3,556	4,038	173	7,767	900.00	500.00	400.00	680.92	342.62	38.05	29.36	19.75	251.14	1,950,635	909,986
2012	3,556	4,038	173	7,767	900.00	500.00	400.00	680.92	342.62	38.05	29.36	19.75	251.14	1,950,635	827,260
2013	3,556	4,038	173	7,767	900.00	500.00	400.00	680.92	342.62	38.05	29.36	19.75	251.14	1,950,635	752,054
2014	3,316	5,913	226	9,455	900.00	500.00	400.00	637.88	342.62	10.32	4.47	18.50	261.98	2,476,972	868,164
2015	3,316	5,913	226	9,455	900.00	500.00	400.00	637.88	342.62	10.32	4.47	18.50	261.98	2,476,972	789,240
2016	3,316	5,913	226	9,455	900.00	500.00	400.00	637.88	342.62	10.32	4.47	18.50	261.98	2,476,972	717,491
2017	3,316	5,913	226	9,455	900.00	500.00	400.00	637.88	342.62	10.32	4.47	18.50	261.98	2,476,972	652,264
2018	3,316	5,913	226	9,455	900.00	500.00	400.00	637.88	342.62	10.32	4.47	18.50	261.98	2,476,972	592,968
2019	3,316	5,913	226	9,455	900.00	500.00	400.00	637.88	342.62	10.32	4.47	18.50	261.98	2,476,972	539,061
2020	3,316	5,913	226	9,455	900.00	500.00	400.00	637.88	342.62	10.32	4.47	18.50	261.98	2,476,972	490,056
2021	3,316	5,913	226	9,455	900.00	500.00	400.00	637.88	342.62	10.32	4.47	18.50	261.98	2,476,972	445,505
2022	3,316	5,913	226	9,455	900.00	500.00	400.00	637.88	342.62	10.32	4.47	18.50	261.98	2,476,972	405,005
2023	3,316	5,913	226	9,455	900.00	500.00	400.00	637.88	342.62	10.32	4.47	18.50	261.98	2,476,972	368,186
2024	3,299	5,964	55	9,318	900.00	500.00	400.00	641.04	342.62	10.47	4.53	18.59	264.83	2,467,855	333,483
2025	3,299	5,964	55	9,318	900.00	500.00	400.00	641.04	342.62	10.47	4.53	18.59	264.83	2,467,855	303,166
2026	3,299	5,964	55	9,318	900.00	500.00	400.00	641.04	342.62	10.47	4.53	18.59	264.83	2,467,855	275,605
2027	3,299	5,964	55	9,318	900.00	500.00	400.00	641.04	342.62	10.47	4.53	18.59	264.83	2,467,855	250,550
2028	3,299	5,964	55	9,318	900.00	500.00	400.00	641.04	342.62	10.47	4.53	18.59	264.83	2,467,855	227,773
2029	3,299	5,964	55	9,318	900.00	500.00	400.00	641.04	342.62	10.47	4.53	18.59	264.83	2,467,855	207,066
2030	3,299	5,964	55	9,318	900.00	500.00	400.00	641.04	342.62	10.47	4.53	18.59	264.83	2,467,855	188,242
2031	3,299	5,964	55	9,318	900.00	500.00	400.00	641.04	342.62	10.47	4.53	18.59	264.83	2,467,855	171,129
2032	3,299	5,964	55	9,318	900.00	500.00	400.00	641.04	342.62	10.47	4.53	18.59	264.83	2,467,855	155,572
2033	3,299	5,964	55	9,318	900.00	500.00	400.00	641.04	342.62	10.47	4.53	18.59	264.83	2,467,855	141,429
2034	4,708	7,052	34	11,794	900.00	500.00	400.00	659.40	342.62	8.27	3.58	19.12	285.81	3,370,734	175,611
2035	4,708	7,052	34	11,794	900.00	500.00	400.00	659.40	342.62	8.27	3.58	19.12	285.81	3,370,734	159,646
2036	4,708	7,052	34	11,794	900.00	500.00	400.00	659.40	342.62	8.27	3.58	19.12	285.81	3,370,734	145,133
2037	4,708	7,052	34	11,794	900.00	500.00	400.00	659.40	342.62	8.27	3.58	19.12	285.81	3,370,734	131,939
2038	4,708	7,052	34	11,794	900.00	500.00	400.00	659.40	342.62	8.27	3.58	19.12	285.81	3,370,734	119,945
2039	4,708	7,052	34	11,794	900.00	500.00	400.00	659.40	342.62	8.27	3.58	19.12	285.81	3,370,734	109,040
2040	4,708	7,052	34	11,794	900.00	500.00	400.00	659.40	342.62	8.27	3.58	19.12	285.81	3,370,734	99,128
2041	4,708	7,052	34	11,794	900.00	500.00	400.00	659.40	342.62	8.27	3.58	19.12	285.81	3,370,734	90,116
2042	4,708	7,052	34	11,794	900.00	500.00	400.00	659.40	342.62	8.27	3.58	19.12	285.81	3,370,734	81,924
2043	4,708	7,052	34	11,794	900.00	500.00	400.00	659.40	342.62	8.27	3.58	19.12	285.81	3,370,734	74,476
2044	5,255	6,432	29	11,716	900.00	500.00	400.00	679.17	342.62	8.33	3.60	19.70	304.93	3,572,453	71,757
2045	5,255	6,432	29	11,716	900.00	500.00	400.00	679.17	342.62	8.33	3.60	19.70	304.93	3,572,453	65,234
2046	5,255	6,432	29	11,716	900.00	500.00	400.00	679.17	342.62	8.33	3.60	19.70	304.93	3,572,453	59,304
2047	5,255	6,432	29	11,716	900.00	500.00	400.00	679.17	342.62	8.33	3.60	19.70	304.93	3,572,453	53,912
2048	5,255	6,432	29	11,716	900.00	500.00	400.00	679.17	342.62	8.33	3.60	19.70	304.93	3,572,453	49,011
2049	5,255	6,432	29	11,716	900.00	500.00	400.00	679.17	342.62	8.33	3.60	19.70	304.93	3,572,453	44,556
2050	5,255	6,432	29	11,716	900.00	500.00	400.00	679.17	342.62	8.33	3.60	19.70	304.93	3,572,453	40,505
2051	5,255	6,432	29	11,716	900.00	500.00	400.00	679.17	342.62	8.33	3.60	19.70	304.93	3,572,453	36,823
2052	5,255	6,432	29	11,716	900.00	500.00	400.00	679.17	342.62	8.33	3.60	19.70	304.93	3,572,453	33,475
2053	5,255	6,432	29	11,716	900.00	500.00	400.00	679.17	342.62	8.33	3.60	19.70	304.93	3,572,453	30,432
2054-2103															354,476
														Total	22,134,206

ATTACHMENT M

Willits Woods IFM
Modeling Plan

By James D. Clark, RPF #2528
November 18, 2016

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Introduction:

This Modeling Plan is intended to provide the information required by Appendix B of the Compliance Offset Protocol U.S. Forest Projects, November 14, 2014 (the "COP") with respect to the updating and forecasting of carbon stocks over the Project's initial crediting period. The baseline analysis described in this modeling plan is based on the analysis presented for the Early Action project CAR661 that was verified as a part of CAR661's initial reporting period, recalculated and remodeled so as to be in compliance with the COP.

CRYPTOS Emulator:

Prior to the recent development of FORSEE, the procedure for modeling individual plots using CRYPTOS, and tracking the resulting inventory, harvest, and growth was problematic due to the fact that the original CRYPTOS user interface is antiquated. The previous CRYPTOS interface was extremely difficult to manage in extended runs with many plots, while implementing various silvicultural prescriptions, multiple ingrowth files, and calibrations. To resolve these problems, Coastal Forestlands contracted with Jan Derksen, Ph.D. for the development of a timber growth and harvest modeling tool, which allows for management of the required complexity in a user-friendly manner, and for the comparison of various 100-year modeling scenarios. This tool has evolved over the years, and is currently referred to by the author as the CRYPTOS Emulator, which is listed in the COP as an approved model.

The CRYPTOS Emulator (Emulator) is substantively identical to CRYPTOS. The Emulator provides a user interface that facilitates complex growth and harvest modeling, the basis for the modeling relies entirely on the original CRYPTOS growth and harvest source code, which has been integrated into the Emulator model. Elsewhere in this document the discussion of CRYPTOS refers to results obtained using CRYPTOS, with the Emulator as the user interface.

The Emulator has at its core the Fortran CRYPTOS version 6 engine translated into Pascal. To the fullest extent possible the Emulator is an exact duplicate of the original CRYPTOS. As the Emulator is able to read CRYPTOS stand, calibration, and in-growth files a direct comparison between CRYPTOS and the Emulator is possible by running both programs on exactly the same stand files, with the same calibration, and the same in-growth files, and then comparing the results.

The Emulator allows users to load and maintain in a database:

1. The entire set of cruise plots for the ownership.

2. A program script used to drive the model logic.

To simplify the process of assigning silvicultural treatments to individual plots, a means for testing stand parameters such as basal area, or point count stocking has been developed and implemented through a series of commands contained in a scripting language. The introduction of testing of basal area, or point count stocking, etc., and acting on the outcome has allowed for the application of more intelligent silvicultural prescriptions. This more sophisticated harvesting strategy is compatible with CRYPTOS in that even though each plot receives a different prescription, the harvest actions performed are ordinary CRYPTOS harvest actions.

During an Emulator run, the program records each step (harvest, growth, or ingrowth) performed, and produces a list of the steps stored under the run name for later inspection. A run is performed by applying to each plot its assigned harvest prescription, growth routine, and inclusion of ingrowth.

Growth and Yield Modeling:

The growth and yield modeling described in this document is performed on an individual plot basis using the CRYPTOS Emulator model, and is based on the following:

Plot Data Pertaining to Previous Baseline Analysis:

The modeling presented in this document is based on cruise plots installed in the spring and summer of 2008 across Coastal Ridges' Willits Woods timberlands(. The 2008 plot data has been adjusted to 1/1/2004 which for all intents and purposes represents the Project stocks as of the 12/22/2003 project start date. These plots were installed systematically across the timbered portion of Coastal Ridges' property. The Willits Woods contains 281 plots installed as part of the 2008 inventory.

In addition to data based on this inventory, data has also been obtained from a series of 90 permanent plots Coastal Ridges maintains across its ownership. These plots were initially installed and measured in 1994 with the majority being measured in late 1994 and early 1995. In 2007 and 2008, 86 of these permanent plots were remeasured. Of these 86 plots, 67 had been

previously re-measured between 2000 and 2003. Data from these permanent plots has been used for the purpose of adjusting the 2008 inventory to 1/1/2004, and for the calculation of CRYPTOS basal area calibration factors as described below.

Updating the Inventory:

The inventory methodology included as Attachment N to the initial OPDR provides a detailed description of the methods that will be used to maintain and update the Willits Woods inventory. FORSEE or the CRYPTOS Emulator will be used to project inventory data either forward or backward as needed so that inventory plot data can be adjusted to the appropriate date for reporting of carbon stocks in future OPDRs. The following procedures will apply to inventory updates using average diameter and height increment data derived from 5-year FORSEE or CRYPTOS Emulator projections:

1. Inventory data gathered less than 3 months from the end of the reporting period will not be adjusted to the reporting period date.
2. Inventory data gathered between 3 months and 6 months from the end of the reporting period will be adjusted for one-half year's growth to represent the reporting period date.
3. Inventory data gathered between 6 months and 12 months from the end of the reporting period will be adjusted for one year's growth to represent the reporting period date.

Alternatively, if the inventory data needs to be adjusted in whole year increments, the inventory update feature of FORSEE or the CRYPTOS Emulator may be utilized.

Volume Calculations:

Reported volumes for the current crediting period are in board feet Scribner Scale for all conifers 6.5 inches DBH and larger. The FIA volume and biomass equations described in the Initial OPDR are used for the calculation of all carbon stock values.

Biomass Calculations:

Biomass calculations utilized in the modeling and reporting of current and future carbon stocks are described in detail in the Initial OPDR. The Initial

OPDR lists all of the species' specific volume and biomass equations utilized which are in compliance with the COP.

Volume Calculations:

Board foot volume calculations utilize the standard CRYPTOS volume equations taken from Bulletin 1907, by Krumland and Wensel (1983). Reported volumes are in board feet Scribner Scale for all conifers 6.5 inches DBH and larger to a 6" merchantable top. FIA cubic foot volume equations listed in the OPDR are used for the calculation of wood products cubic foot volumes delivered to the mill.

Biomass Calculations:

Biomass calculations utilized in the modeling are described in detail in the Initial OPDR. The Initial OPDR lists all of the species specific volume and biomass equations utilized; however, the growth and yield model CRYPTOS has a limited number of species which can be modeled. The baseline modeling described herein utilizes the following formulas for the calculation of cubic foot volumes and biomass:

Species	Bole Cubic Ft Volume	Bark Biomass	Live Crown Biomass
Redwood	Equation 24	Equation 17 if DBH >39.37 otherwise Equation 13	Equation 10
Douglas-fir	Equation 3	Equation 8	Equation 6
Other Conifer (Knobcone pine)	Equation 16	Equation 14	Equation 11
Tanoak	Equation 34	None	None
Other Hardwood (Madrone)	Equation 40	None	None

Adjusting the 2008 Inventory Data to 1/1/2004:

In order to adjust the 2008 plot data to 1/1/2004, the 2008 dataset was grown five years forward using the CRYPTOS Emulator. For each tree in the 2008 inventory database, average one-year height and diameter increment was calculated.

As Coastal Ridges' 2008 inventory was installed in the middle of the 2008 growing season, a growth adjustment of 4.5 years is applied to the 2008 data in order to approximate the 1/1/2004 inventory date. The annual diameter and height increments were applied to the 2008 dataset for a 4.5 year period

in order to estimate the tree diameters and heights in 2004. Trees recorded in 2008 that were less than 1" DBH were not included in the 2004 dataset.

There has been no conifer timber harvesting since 2004; however, approximately 991 acres of the timbered portion of the property have been treated with herbicides to kill hardwoods since Coastal Ridges acquired the property in 2003. This treatment occurred in October 2006. The area treated contains mainly standing dead hardwoods.

In order to ensure that the plot data as of 1/1/2004 reflected these hardwood treatments, the plot data was adjusted in the following way. All recorded dead hardwoods on plots within areas treated for hardwood reduction were added back into the 1/1/2004 dataset as live trees.

In addition to the treatment of hardwoods, a small portion of the Willits Woods Tract burned during the 2008 Mendocino Lightning Complex. Two fires were started by the lightning storm. The first fire burned approximately 2 acres in the northern portion of the ownership adjacent to the Two Rock Lookout. A second fire approximately 423 acres in size burned in the southern portion of the tract adjacent to the headwaters of Big River. Both of these fires were characterized primarily as slow burning ground fires that crept through the understory. These fires did not consume a significant portion of vegetation in the 3.5" DBH and larger diameter classes. The burned areas were cruised after the fires had been suppressed. The cruise plots indicate that very little of the measured trees were burned. Accordingly, no adjustment to the 2008 plot data has been made to account for the 2008 fires.

Projecting the 2008 Inventory Data to 12/31/2015:

As a part of the Project's original verification under Early Action, the 2008 plot data was grown in the CRYPTOS Emulator with calibration for two and a half years to estimate the inventory as of 12/31/2010. After that, the inventory was updated one year at a time with calibration to 12/31/2011, 12/31/2012, 12/31/2013, 12/31/2014 and finally to the end of the initial reporting period under the COP of 12/31/2015.

Calibration:

CRYPTOS computes increments in basal area and height for each individual tree in a stand list. Increments are based, among other factors, on current dbh, height, live crown, position of the crown of the individual tree in the canopy, and basal area per acre of the stand.

CRYPTOS' growth increments can be calibrated, that is, adjusted for local conditions. By comparing local growth measurements with growth increments predicted by CRYPTOS for the same trees in the same stands, a basal area growth calibration factor can be computed. CRYPTOS allows both basal area growth and height growth to be calibrated.

Tree measurements from the 67 remeasured permanent plots has been used to develop CRYPTOS basal area calibrations for conifers and tanoak. These calibrations were created by dividing the measured basal area growth over a given time period for a given tree by the CRYPTOS predicted basal area growth for the same tree over the same time period. If a tree's remeasured DBH was less than its previously measured DBH, it was assumed to be measurement error, and all such trees were therefore excluded from the analysis.

Successive measurements of trees on these 67 permanent plots show that CRYPTOS underestimates diameter growth rates for larger trees and overestimates diameter growth on smaller diameter trees on Coastal Ridges' property.

Table 1 shows the CRYPTOS basal area calibrations derived from a comparison of the first permanent plot remeasurement (2000-2003) and the most recent remeasurement (2007-2008). This analysis includes all trees 3.5 inches DBH and larger that were measured at the time of the first remeasurement.

Table 1: Basal Area Calibration Factors

DBH	Basal Area Calibration Factor			
Class	Redwood	Douglas-fir	Sugar P	Tanoak
0-5	0.27	0.76	0.49	1.50
6-10	0.68	0.91	1.22	1.61
11-15	0.78	1.05	1.77	2.11
16-20	1.07	1.56	2.13	2.24
21+	1.86	1.88	2.85	1.50
Average	0.88	1.09	1.90	1.65

DBH	Sample Size			
Class	Redwood	Douglas-fir	Sugar Pine	Tanoak
0-5	13	28	2	50
6-10	31	54	4	70
11-15	128	111	26	18
16-20	62	33	18	3
21+	14	10	5	2
Total	248	236	55	143

These calibration factors will be utilized for the first two periods of the 100-year planning period, and during future inventory updates utilizing the

CRYPTOS Emulator model to estimate stand growth. Coastal Ridges will continue to develop appropriate calibration factors based upon remeasurement of its permanent plots over time. The use of updated calibration factors will be fully described in future option A updates.

Ingrowth:

The amount of ingrowth added to each plot during each decade of the planning period is calculated from several factors. The maximum number of ingrowth trees added is determined by the silvicultural prescription under which the plot is being harvested. The species composition of ingrowth is determined by calculating the species composition of the pre-harvest plot by basal area, and then adjusting the percentage of redwood seedlings to a minimum of 25% percent. Adding ingrowth at the same rates as the pre-harvest species composition of the plots results in the species composition of the property shifting from approximately 43% redwood in 2010 to less than 30% redwood species composition at the end of the 100 year planning period. Increasing the component of redwood ingrowth to a minimum of 25 percent maintains the current level of redwood stocking throughout the baseline and project modeling scenarios.

Table 2: Regeneration (Ingrowth) Assumptions

Prescription	Regeneration Assumption
Selection	Natural regeneration and planted seedlings are assumed for this treatment. Conifer regeneration is 45 seedlings per acre. Hardwood regeneration is 8 seedlings per acre.
Selection (WLPZ)	Natural regeneration and planted seedlings are assumed for this treatment. Conifer regeneration varies from 10 to 20 seedlings per acre. Hardwood regeneration is 3 seedlings per acre.
Transition	Natural regeneration and planted seedlings are assumed for this treatment. Conifer regeneration is 60 seedlings per acre. Hardwood regeneration is 10 seedlings per acre.
Group Opening	Natural regeneration and planted seedlings are assumed for this treatment. Conifer regeneration is 100 seedlings per acre. Hardwood regeneration is 18 seedlings per acre.
Rehabilitation	Natural regeneration and planted seedlings are assumed for this treatment. Conifer regeneration is 100 seedlings per acre. Hardwood regeneration is 18 seedlings per acre.
Non-Commercial (Release)	As these stands are well stocked prior to harvest, only a minimal amount of natural regeneration is assumed for this treatment. Conifer regeneration is 8 seedlings per acre. Hardwood regeneration is 3 seedlings per acre.
Even-Aged	Natural regeneration and planted seedlings are assumed for this treatment. Conifer regeneration is 50 seedlings per acre. Hardwood regeneration is 10 seedlings per acre.

Each decade ingrowth in the form of 10-year old trees was added to the CRYPTOS stand description as per the regeneration assumptions shown in Table 2 above. This addition was done before the harvest and before further growth. These ingrowth assumptions are based on an analysis of the inventory data, comparisons with other data sources and professional experience. These 10-year old trees are assumed to be 2.0 inches in diameter, and 15 feet tall for conifers, and 1.5 inches in diameter, and 12 feet tall for hardwoods.

Site Index:

In order to conduct growth modeling for the property, it was necessary to develop an estimate of average 50-year base age site index by species for each project area. Redwood site index is Wensel and Krumland 50-year breast height age, and Douglas-fir is King 50-year breast height age.

Site index is derived from data collected as part of a site index study conducted on Coastal Ridges' lands in late 1996 and early 1997. The study was based on a methodology agreed to by the California Department of Forestry and Fire Protection. The site tree study involved the collection of site tree data from plots systematically installed on Coastal Forestlands' approximate 70,000 acres of timberland. The methodology involved searching for candidate trees in a systematic manner on each sample plot in order to minimize bias. The final site tree sampling protocol as well as correspondence between NCRM and Tim Robards (CDF biometrician at the time) are included as Appendix A to this modeling plan. These correspondences indicate that CDF approved of the sample design, as well as the selection of sample plots.

The average site index by species for the property is shown in Table 3 below and is detailed in a report in Appendix A. Only the site indices for trees twenty-five years or older were used in the calculation of site index for the purpose of growth and yield modeling.

The following 50-year base age average site indices were used during the growth and yield analysis:

Table 3a: Site Index by Ownership Block

Willits Woods

Species	**Site Index**
Douglas-fir	120
Redwood	119

Project Acreage:

The Willits Woods Improved Forest Management Project (the "Willits Woods Project") is comprised of 17,682 acres of timberland on the larger 18,662 acre ownership block. The topographic map included in Attachment A of the Project Design Document shows the Project Area boundary.

Baseline Modeling:

The baseline modeling utilizes the above-described 2004 plot dataset, and an unevenaged management harvesting strategy employing selection and transition combined with small group openings not exceeding 2.5 acres in size. Portions of Coastal Ridges' 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. Since 2003, Coastal Ridges has treated approximately 991 acres on the Project Area for the purpose of reducing hardwood stocking (primarily tanoak), and releasing existing conifer regeneration. The baseline harvest scenario assumes a continuation of this intensive hardwood reduction program.

The baseline modeling scenario assumes that Coastal Ridges would demonstrate Maximum Sustained Production of High Quality Timber Products (MSP) through Option "A". Under the baseline scenario Coastal's stands will not contain sufficient basal area per acre of conifer trees 18" and larger to satisfy MSP using Option "C" during the early decades of the planning period; however, by the 5th decade of the baseline scenario, MSP could be demonstrated by either Option "A" or Option "C".

At the Project's initiation on 12/22/2003 there we no approved Timber Harvest Plans (THPs) on the Project Area. Since 2006, Coastal Ridges has obtained approval of eighteen THPs on the Project Area, which cover approximately 45% of the timberstands available for harvest during the first decade.

Baseline Harvest Strategy:

The group-selection harvest strategy results in the eventual harvest in small groups of those areas of the property located outside of WLPZs within an 80-year period. Once a plot is harvested as either a small group, or under a rehabilitation prescription, the plot is grown for 20 years without harvest, subsequent silvicultural treatments are transition, or selection prior to the plot being harvested under a group selection treatment in 80 years. Plots, which are harvested utilizing selection prior to their first group selection treatment, must continue under selection following the 20-year period of no harvest.

Silvicultural treatments under the baseline scenario in the first decade of the 100-year planning period are dominated by transition harvests (39%),

selection harvests (17%), rehabilitation of understocked areas (25%), and release of well stocked conifer stands through hardwood control (7%). Only a limited number of small group openings (2%) are created in the first period, as the level of hardwood reduction under rehabilitation treatments is extensive.

Beginning in the second decade, approximately 12% on average of the property outside of WLPZ areas is harvested as small groups each decade. Plots were selected for harvest based on conifer stocking level, with those plots with the highest stocking levels being harvested as small groups first.

Silvicultural prescriptions on individual THPs are designed to best accommodate local timber stand conditions, while complying with the Forest Practice Rules. 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 3a-3c 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 (Guldin 1991). 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.

General Harvest Constraints:

Harvest on Coastal Ridges' ownership 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. The Willits Woods 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. Based on the size of the timber found on the Willits Woods, the sustained yield rules

referred to as 'Option A' rules are used to meet sustained yield requirements. The pertinent rules include the following:

- 14 CCR 913.11(a): Maximum Sustained Production of High Quality Timber Products;
- 913.2: minimum basal area retention standards for Unevenaged Regeneration Methods;
- 913.2 (a)(2)(B): Group selection harvest limitations;
- 913.2 (b)(6): Minimum post-harvest residual basal area retention standards;
- 913.3; minimum basal area retention standards for Intermediate Treatments;
- 913.4 (b): standards for rehabilitation of Understocked Areas;
- 913.1 (c): standards for Seed Tree Seed Step;
- 916.9: details harvest limitations for Watercourse and Lake Protection Zones around Class 1, 2 and 3 streams;

Attachment K contains a detailed list of legal constraints affecting forest management activities on the Project Area. The method by which the Forest Practice Rule constraints listed above as well as other legally binding constraints is described in the following sections.

Coastal Ridges is also committed to restoring riparian function, and has instituted a 25' no-harvest zone on either side of all class I watercourses. No-harvest zones have also been established around all Northern Spotted Owl (NSO) activity sites.

These constraints are modeled by calculating the acreage of each identified constraint, to determine the combined constrained area of 792.51 acres. The plot data is run with a 100-year no-harvest regime utilizing Coastal's basal area calibration factors for the first two ten-year periods, and a 0.75 basal area calibration for the 3rd through 10th ten-year periods. The yield stream from this no-harvest regime is weighted by the constrained acreage and combined with the baseline harvest regime weighted by the unconstrained acreage to determine the final baseline carbon stocks through the 100-year analysis period.

Class I no Harvest Zone:

Utilizing Coastal Ridges GIS, it is estimated that 153.77 acres are located within 25' of either side of a class I watercourse.

Harvesting WLPZ Plots:

Utilizing Coastal's GIS the locations of the 281 plots in relation to class I and II WLPZs were determined. There are 31 plots located within class I or II WLPZs. This represents over 11% of the plots, and by extension over 11% of the Project Area. These plots are harvested using the selection silvicultural prescription depending on basal area stocking (please see tables 4a-4c below). 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 given the basal area retention standards applied in the model.

An analysis of the potential distribution of WLPZ areas by slope class was performed. Based on this analysis, it was determined that the greatest horizontal distance for a Class II WLPZ would be approximately 85 feet, and approximately 150 feet for a Class I WLPZ. Given a reasonable distribution of slope classes within any one of the watercourse class designations, the average WLPZ buffer distance would be less than the calculated maximum. The baseline modeling has been revised to include an 85 foot WLPZ buffer on Class II watercourses, and a 150 foot buffer on Class I watercourses. These buffer distances are felt to meet the definition of "Conservative" per Section 95802 of the Regulation in that these modeled buffer distances meet the largest potential buffer that would need to be applied per the Forest Practice Rules.

Northern Spotted Owl:

NSO activity centers are given a 1,000 foot no harvest buffer. There are approximately 626 acres of no-harvest NSO buffers associated with the Willits Woods.

Hardwood Harvest:

Coastal's hardwood reduction program calls for the manipulation of hardwood stocking levels through commercial harvest, manual or mechanical treatments, or basal herbicide treatments as appropriate.

Non-Commercial Treatments:

Portions of Coastal'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. 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, Coastal 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.

No Harvest Area:

In sections 27 and 26, T17N, R14W MDB&M, there exists an approximate 60-acre area for which timber harvesting is prohibited by deed restriction. The deed describes the restricted area as approximately 80 acres; however, the area depicted on the map, Exhibit "D" of the recorded document, represents a 60-acre area. This 60-acre area has been treated as a no-harvest area in the baseline analysis.

Small Tree Mortality Adjustment:

Mortality of conifer and hardwood trees between 1" to 3" DBH beyond any mortality applied by CRYPTOS is modeled in the baseline harvest scenario by reducing the number of trees per acre in each decade of the 100-year analysis. Plots with >3000 TPA in trees 1" to 3" DBH have 85% of the trees per acre removed; plots with between 2000 to 3000 TPA have 75% of the trees per acre removed; and plots with between 1000 to 2000 TPA have 60% of the trees per acre removed.

This mortality adjustment is designed to more accurately reflect small tree mortality on plots with excessive numbers of small trees. Past observations of CRYPTOS growth and harvest with regard to plots with excessive numbers of small trees indicate that CRYPTOS does no realistically reduce tree numbers over time. This small tree mortality assumption also serves to account for logging damage in areas subject to high small tree stocking.

Table 3b: 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 for site class III timberlands of 75 square feet per acre for selection silviculture, and 50 square feet per acre for transition silviculture.

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 932.7(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 § 933.2(b)(1). Unless the plan submitter demonstrates how the proposed harvest will achieve MSP pursuant to 14 CCR § 933.11(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 § 933.1(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.

Rehabilitation of Understocked Areas:

14 CCR 913.3: Special Prescriptions:

The following special harvesting methods are appropriate under certain conditions:

a) 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 (l) 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(a)(1) through (5):

(1) Producing the yield of timber products specified by the landowner, taking into account biologic and economic factors, while accounting for limits on productivity due to constraints imposed from consideration of other forest values, including but not limited to, recreation, watershed, wildlife, range and forage, fisheries, regional economic vitality, employment and aesthetic enjoyment.

(2) Balancing growth and harvest over time, as explained in the THP for an ownership, within an assessment area set by the timber owner or timberland owner and agreed to by the Director. For purposes of this subsection the sufficiency of information necessary to demonstrate the balance of growth and harvest over time for the assessment area shall be guided by the principles of practicality and reasonableness in light of the size of the ownership and the time since adoption of this section using the best information available. The projected inventory resulting from harvesting over time shall be capable of sustaining the average annual yield achieved during the last decade of the planning horizon. The average annual projected yield over any rolling 10-year period, or over appropriately longer time periods for ownerships which project harvesting at intervals less

frequently than once every ten years, shall not exceed the projected long-term sustained yield.

(3) Realizing growth potential as measured by adequate site occupancy by species to be managed and maintained given silvicultural methods selected by the landowner.

(4) Maintaining good stand vigor.

(5) Making provisions for adequate regeneration.

This overall constraint is emulated in the baseline by requiring that the harvest schedule never harvests more than growth in any 10-year period, and that all harvests meet the minimum stocking standards of the Forest Practice Rules.

Standing Dead:

The standing dead carbon pool represents approximately 0.4% of the total carbon found on the Project Area. The standing dead carbon pool is treated as a static pool. 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 estimated level. 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 4a: Silvicultural Prescriptions used by Coastal

Prescription		Description
Uneven-Aged Management		
	Single Tree Selection	The goal of this prescription is to create and maintain, multistoried, uneven-aged stands with varied diameter classes.
	Single Tree Selection (WLPZ)	The goal of this prescription is to create and maintain dense, multistoried, uneven-aged stands with varied diameter classes.
	Group Selection	The goal of this prescription is to create and maintain, multistoried, uneven-aged stands with varied diameter classes. Groups are 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.
Even-Aged Management		
	Even-aged	The goal of this prescription is to perform the final step in rotating the stand that proceeded the current stand. Successive harvests will utilize uneven-aged silviculture.
	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.

Table 4b: Pre-harvest Stand Conditions by Silvicultural Prescription

Prescription	Pre-Harvest Conifer Basal Area (Square Feet per Acre)		Other Pre-Harvest Considerations
	Lower Limit	Upper Limit	
Uneven-Aged Management			
Single Tree Selection	125	None	
Single Tree Selection Low Stocking (WLPZ)	150	225	
Single Tree Selection Medium Stocking (WLPZ)	225	275	
Single Tree Selection High Stocking (WLPZ)	275	None	
Group Selection	125	None	
Transition	50	125	
Even-Aged Management			
Even-aged	15	60	Greater than 50% of conifer basal area in trees larger than 18" DBH
Rehabilitation	0	50	Less than 300 point count
Hardwood Release	0	50	

Table 4c: Post-harvest Stocking by Silvicultural Prescription

Prescription		Stocking Considerations	Conifer Basal Area Retention (sq. ft. per acre)	Hardwood Basal Area Retention (sq. ft. per acre)	Time to Next Treatment
Uneven-Aged Management					
	Single Tree Selection	All age, evenly distributed	>75	8	At Least 10 Years
	Single Tree Selection Low Stocking (WLPZ)	All age, evenly distributed	>140	30	At Least 10 Years
	Single Tree Selection Medium Stocking (WLPZ)	All age, evenly distributed	>175	25	At Least 10 Years
	Single Tree Selection High Stocking (WLPZ)	All age, evenly distributed	>225	20	At Least 10 Years
	Group Selection	Less than 20% of stand in group openings	>75	5	At Least 10 Years
	Transition	Less than 20% of stand in group openings, at least 15 sq. ft. >12" DBH	>50	8	Selection within 10-20 Years
Even-Aged Management					
	Even-aged	Retain/recruit 2-3 snags per acre	>8	8	Selection within 20-40 Years
	Rehabilitation	Retain/recruit 2-3 snags per acre	>8 where conifer >8 pre-harvest	8	Selection within 30-40 Years
	Hardwood Release	No Commercial Conifer Harvest	No Commercial Conifer Harvest	8	Selection within 20-40 Years

Growth and Yield Analysis:

The baseline growth and yield analysis was modeled using the CRYPTOS Emulator model utilizing the above described harvest strategy. The calibration factors shown in Table 1 were applied during the first two decades of the 100-year planning period. The maximum retention diameter was set at 18.5" for the first decade, and was increased by two inches per decade until the 4th decade and was thereafter held at 24.5 inches for the remainder of the planning period. 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 per Acre Conifer Growth and Yield through the Planning Horizon

Elapsed Time (year)	Beginning Inventory (board feet)	Average Decadal Growth (board feet)	Average Decadal Harvest (board feet)	Ending Inventory (board feet)
10	6,296	568	439	7,588
20	7,588	750	535	9,740
30	9,740	774	527	12,213
40	12,213	811	667	13,650
50	13,650	824	663	15,268
60	15,268	833	731	16,289
70	16,289	843	716	17,558
80	17,558	835	810	17,811
90	17,811	834	757	18,589
100	18,589	843	778	19,237

Table 5b: Average per Acre Total Live Carbon Growth and Yield through the Planning Horizon

Elapsed Time (year)	Beginning Inventory (Mg Carbon)	Average Decadal Growth (Mg Carbon)	Average Decadal Harvest (Mg Carbon)	Ending Inventory (Mg Carbon)
10	37.80	2.15	3.21	27.25
20	27.25	2.05	1.58	31.87
30	31.87	1.80	1.40	35.82
40	35.82	1.76	1.67	36.70
50	36.70	1.73	1.49	39.09
60	39.09	1.71	1.57	40.45
70	40.45	1.71	1.50	42.57
80	42.57	1.68	1.71	42.23
90	42.23	1.67	1.53	43.63
100	43.63	1.68	1.57	44.74

Table 5c: Average Annual Total Live Carbon Growth and Yield through the Planning Horizon (Total Mg C)

Elapsed Time (year)	Beginning Inventory (Mg	Average Decadal Growth (Mg	Average Decadal Harvest (Mg	Ending Inventory (Mg Carbon)
10	668,452	38,056	56,727	481,765
20	481,765	36,174	27,993	563,574
30	563,574	31,825	24,837	633,451
40	633,451	31,111	29,556	648,995
50	648,995	30,534	26,313	691,213
60	691,213	30,248	27,840	715,308
70	715,308	30,239	26,501	752,679
80	752,679	29,730	30,320	746,762
90	746,762	29,599	27,132	771,432
100	771,432	29,725	27,766	791,052

Table 6: Average Basal Area per Acre through the Planning Horizon

Elapsed Time (years)	0	10	20	30	40	50	60	70	80	90	100
Conifer	68	74	82	92	95	100	101	105	103	106	107
Hardwood	74	27	26	24	20	19	19	20	20	20	21
Total	141	100	101	107	103	106	107	110	108	110	111

Table 7 presents the estimated percentage of each silvicultural prescription modeled by decade for the entire baseline modeling analysis.

Table 7: Application of Silviculture through the 100-year Planning Horizon

	Silviculture						
Decade	Selection	Transition	Group Select	Rehabilitation	Release	Even-aged	No Harvest
1	17%	39%	2%	25%	7%	1%	9%
2	17%	39%	11%	0%	15%	0%	19%
3	42%	21%	14%	0%	0%	0%	23%
4	40%	23%	10%	0%	0%	0%	27%
5	51%	13%	11%	0%	0%	0%	26%
6	65%	1%	12%	0%	0%	0%	22%
7	67%	0%	8%	0%	0%	0%	24%
8	65%	0%	14%	0%	0%	0%	21%
9	70%	0%	7%	0%	0%	0%	23%
10	67%	0%	11%	0%	0%	0%	22%

The growth and yield modeling presented here includes variations of seven silvicultural prescriptions: Selection, Group openings associated with selection or transition, Transition, Rehabilitation, Even-aged, Release, and Non-Commercial. These reflect the principle silvicultural prescriptions

currently being applied on Coastal Ridges' timberlands. The application of these silvicultural prescriptions is guided by the stocking standards contained in Forest Practice Rules.

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, November 14, 2014.

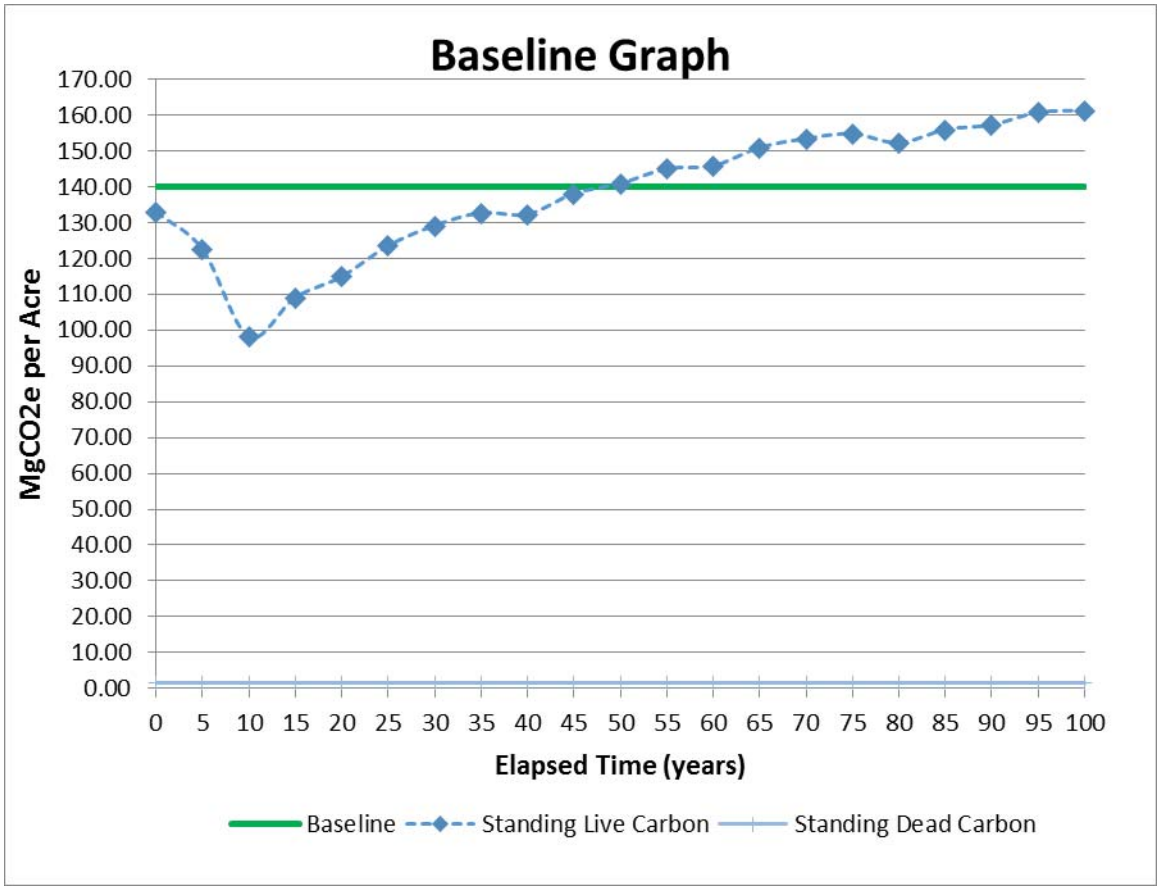
Key components of the calculated baseline are as follows:

1. Initial Project live carbon stocks are below 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.

Elapsed Time	Standing Live Carbon Pool IFM-1	Standing Live Above Ground	Standing Live Below Ground	Standing Dead Carbon Pool IFM-3	Baseline
0	135.11	108.09	27.01	1.54	140.19
5	122.46	97.92	24.55	1.54	140.19
10	98.13	77.77	20.36	1.54	140.19
15	108.99	86.66	22.33	1.54	140.19
20	114.80	91.34	23.46	1.54	140.19
25	123.42	98.43	24.99	1.54	140.19
30	129.03	102.98	26.06	1.54	140.19
35	132.63	105.99	26.65	1.54	140.19
40	132.20	105.58	26.62	1.54	140.19
45	137.96	110.36	27.61	1.54	140.19
50	140.80	112.64	28.16	1.54	140.19
55	144.89	116.08	28.81	1.54	140.19
60	145.70	116.73	28.98	1.54	140.19
65	150.78	120.94	29.85	1.54	140.19
70	153.32	122.96	30.35	1.54	140.19
75	154.64	124.16	30.48	1.54	140.19
80	152.11	122.08	30.03	1.54	140.19
85	155.81	125.16	30.66	1.54	140.19
90	157.14	126.18	30.95	1.54	140.19
95	160.61	129.11	31.51	1.54	140.19
100	161.13	129.51	31.63	1.54	140.19
Average	138.65	110.98	27.67	1.54	140.19

Figure 1: Baseline Carbon Stocks



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.

Woods Products	Mg C/ acre	Total Mg CO2e
Average Annual Carbon 100-year In-Use	0.210	12,981.56
Average Annual Carbon 100-year Landfill	0.136	8,386.33
Average Annual Carbon in Harvested Trees Prior to Delivery to the Mill	1.316	81,418.23

Attachments

Exhibit A – Site Index Study Documentation

Literature Cited

Guldin, James M., 1991. Uneven-Aged BDq Regulation of Sierra Nevada Mixed Conifers. Journal of Forestry, Vol. 6, No. 2, p. 27-32.

Oliver, W.W., J.L. Lindquist, and R.O. Strothman. 1994. Young-growth redwood stands respond well to various thinning intensities. West. J. Appl. For. 9(4): 106-112.

Wensel, Lee C., and Krumland, Bruce. Volume and Taper Relationships for Redwood, Douglas Fir, and Other Conifers in California's North Coast, University of California, Division of Agricultural Sciences Bulletin 1907, 1983.

Exhibit A

Site Index Study Documentation

Average Site Index - Entire Ownership

Species	Avg Site Index	Sample Size
Douglas-fir	118	157
Redwood	114	80
Sugar-Pine	116	104

Property Wide Site Index for trees >24:

Species	*Site Index*	*Sample Size*
Douglas-fir	113	118
Redwood	111	62
Sugar-Pine	107	82

Property Wide Site Index for trees <25:

Species	*Site Index*	*Sample Size*
Douglas-fir	126	39
Redwood	129	18
Sugar-Pine	152	22

Willits Woods Average Site

Species	*Site Index*	*Sample Size*
Douglas-fir	126	80
Redwood	123	47

Average Site Index for trees >24:

Species	*Site Index*	*Sample Size*
Douglas-fir	120	62
Redwood	119	31

Average Site Index for trees <25:

Species	*Site Index*	*Sample Size*
Douglas-fir	139	18
Redwood	128	16

Longview Average Site

Species	*Site Index*	*Sample Size*
Douglas-fir	110	77
Redwood	103	33
Sugar-Pine	116	104

Average Site Index for trees >24:

Species	*Site Index*	*Sample Size*
Douglas-fir	106	56
Redwood	102	31
Sugar-Pine	107	82

Average Site Index for trees <25:

Species	*Site Index*	*Sample Size*
Douglas-fir	117	21
Redwood	133	2
Sugar-Pine	152	22

NORTH COAST RESOURCE MANAGEMENT
P.O. Box 509 Redwood Valley, CA 95470-0509 707-485-7211
Forestry-Archaeology-Computer Consulting

#35

March 4, 1997

Mr. Tim Robards
California Department of Forestry and Fire Protection
1416 Ninth St., Room 1516-4
Sacramento, California 94244-2460

Re: CFL Site Tree Study

Dear Mr. Robards,

The collection of field data for this project is complete. Attached please find a listing of all the site trees collected as a part of this project. Also please find my calculation of site index dated 2/12/97. I have also attached a copy of the letter by Mr. Glen Zane of MB&G, detailing their conclusions regarding the site tree study.

Data Summary:

The site trees measured have been entered into an Access database, from which the data can be manipulated or sorted to provide desired calculations. The site tree data is available in digital format for calculation or modeling purposes, and will be provided if requested.

Site tree data can be summarized in different manners to reflect different analysis requirements. The attached table presents the site index calculation for the entire property, for the Willits Woods and Longview Fiber separately, while also calculating a site index with all trees, and differentiating between trees twenty five years of age and older, and those younger than twenty five. It is understood that final calculation of site index will be performed by Mason, Bruce, and Girard, Inc..

Discussion of Site Tree Measurements and Results.

The site tree protocols agreed to by the CDF require that trees be selected within a plot not exceeding 2 acres in size, located in a systematic manner across the entire ownership. Within the plot, dominant and codominant trees meeting the selection criteria were required to be selected as site trees. In general, if the trees show evidence of consistent growth, without suppression, they are required to be selected. In both site tree studies conducted on CFL lands (current study and 1995 study) several issues have become apparent that have never been fully resolved. First, due to the harvest history of CFL

stands, most of the older candidate site trees are codominants or intermediate trees from previous stands. Current protocols require that emphasis be given towards selecting trees as close to the Index Age (50 years) as possible. Unfortunately, many of the trees approaching this age are of low vigor, or are of questionable status. A portion of CFL's older site tree candidate trees were likely codominant or intermediate trees in the native stand. For a variety of reasons these older trees have been retained in the stand, and the timber site potential they express may be below actual as they have not truly grown at full potential throughout their life span. As a case in point, in both site studies the average timber site index calculated for both Douglas-fir and redwood increases as site tree age decreases. It is likely that the younger site trees measured are expressing full growth potential, and may be acting as true dominants. Given the composition of CFL's timber stands, these younger trees may present the best evidence as to actual timber site potential.

During discussions with you, the issue of minimum site tree age was discussed at length. It was your position that site trees should be no less than 25 years of age. The dominant argument presented in favor of this notion is the fact that a majority of the sample trees in the original site tree studies were older than 25 years of age. While this may be a correct statement, the data sets of original studies do contain trees less than 25 old, and these trees were used to construct height/age curves beginning at ages less than 25 years of age (breast high age). While differences between site index curves may be small at young ages, it does not seem logical to exclude young trees from our calculated average.

Most of the historic site tree studies were derived from stands with significantly different characteristics than the CFL lands. For example, most of the stands sampled to construct the original studies were single aged, and did not have recent harvest activity or hardwood competition. For the most part, trees measured were dominant trees. In both of the CFL studies to date site trees available for measurement are mostly codominant trees, in multi-aged stands, with varying levels of harvest activity and hardwood competition.

Estimating timber site index on CFL is a challenging task, as the stand conditions differ significantly from stands used historically to model site. The methods employed in historic studies to measure site potential are difficult to apply to CFL's lands. This fact became very clear to all of us when we were working with you to adopt protocols for this round of plots. For example, on CFL you cannot measure the largest 20% of the trees present and assume

that you have captured the dominant trees on site, as has been done in other site tree studies. Instead, we have built protocols that roughly follow the "classic" approach while allowing us to pay attention to dominance of individual trees. The growth of the young dominants measured is the best available, and may be our best indicator of timber site potential. The estimate of site provided by the current study while unbiased, may be unduly conservative due to the general pressure to "find" site trees on plots where only marginal codominant trees exist.

All other factors aside, I feel that the inclusion of all trees measured that are fifteen years of age or older in our site tree study is reasonable.

Do not hesitate to call if you have any further questions.

Sincerely,

Mark D. Edwards
Registered Professional Forester #2039

cc: Coastal Forestlands, LTD.

NORTH COAST RESOURCE MANAGEMENT
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#27

January 10, 1997

Mr. Tim Robards
California Department of Forestry and Fire Protection
1416 Ninth St., Room 1516-4
Sacramento, California 94244-2460

Re: CFL Site Tree Protocols

Dear Mr. Robards,

Pursuant to our telephone conversations yesterday, and as per your letter dated 1/9/97, attached please find the "final" site tree protocols that we propose for the upcoming CFL site tree study. I believe that these revised protocols incorporate the revisions requested in your 1/9/97 letter.

Site Tree Plot Location

All site tree plots will be installed on CFL grid locations. Prior to starting field activities 198 site tree plot locations have been established on a systematic manner across the entire property. In general, plots were located at every thirty fifth key plot location throughout the ownership. Adjustments to this spacing were required to ensure that plots sampled only strata used for modeling purposes- CH33, HC33, HWDCON, RCRH, and CONHWD. No plots will be installed on non-modeled strata - SG, HARDWOOD, and NONVEG.

It is anticipated that not all of the 198 plots will be reachable due to time or access problems. For reasons of access, no plots are allotted to the Brandt Tract. This study will install at least 180 site tree plots out of the 198 plots indicated on the site tree plot map. In addition, no less than 90% of the plots allotted within either the Willits Woods or Longview Tracts will be installed.

Following the installation of the 180 minimum plots, additional plots will be installed if required within specific strata to ensure adequate sampling. The location of plots added to provide for appropriate strata sampling will be reviewed with CDF staff prior to their installation.

Plot Installation

At each plot location a 167 foot radius plot will be installed. Plots will be installed at key plot locations and fully monumented as per CFL's timber

FILE: Strobards 4

cruise key plot standards. Each plot will be divided into four quadrants (NE (0°-89°), SE (90°-179°), SW (180°-269°), & NW (270°-359°)) with the NW quadrant sampled initially for site trees. The protocols below call for locating up to five site trees per species, per plot. If less than five measurable site trees per species are encountered in the first quadrant (NE), then the second quadrant may be entered (SE). In turn, the third quadrant (SW) and then the fourth quadrant (NW) may be visited to obtain up to five site trees per species. The number of site trees to be chosen is cumulative through the four quadrants. That is, up to five site trees per species will be selected, beginning in the NE quadrant, and progressing in a clockwise manner through the other three quadrants. All candidate trees will be identified within the individual quadrant, and trees meeting all of the site tree selection criteria will be measured. In instances where excess site trees are available following review of the entire quadrant, only that number of trees required to meet the "five" limitation shall be selected as site trees. In this instance, priority will be given to trees with:

1) the largest DBH
2) DBH age nearest Index age (50 years)
3) All other factors being the same, the first tree encountered (lowest azimuth).

Data for site trees not chosen due to the "five" limitation shall be retained on the plot card, and the reason for not choosing these candidate trees shall be noted.

Individual site trees selected will be numbered with an appropriate tag at DBH, as well as paint marked with "ST" on two sides to indicate their status as site trees. The approximate location of each site tree will be shown on a field map, and for each site tree the approximate distance and azimuth from plot center will be recorded. Next, the plot center will be mapped, and its location recorded via GPS (2 meter accuracy)

Site Tree Selection Criteria

Candidate site trees must meet the following guidelines:

1) All trees selected must be either dominant or codominant trees, and must have maintained this crown position throughout their life.
2) They must display a past history of uniform and consistent leader growth.
3) They must have a full, healthy crown, or nearly so.

4) Analysis of radial increment for candidate trees must indicate that the candidate tree has not been suppressed in its past.
5) Trees should not be selected that show signs of damage or disease, are residual type old-growth, or are "wolf" trees.
6) Site trees must be chosen as close to the index age as possible (50 years). Priority shall be given to selecting site trees 25 years of age or older, and no site trees will be selected with a breast high age less than fifteen years. When selecting between candidate trees meeting 1-4 above, and exhibiting otherwise similar characteristics, preference will be given to the tree nearest the index age. Up to five site trees 25 years or older at breast height will be selected. Site trees between 15 and 25 years of age will be collected only after trees older than 25 are collected. If five site trees older than 25 are found on the plot, any trees between 15 and 25 years of age may be measured and included on the plot card as supplemental data.
7) Site trees must be located within plot boundaries.

Douglas-fir Site Index Sampling

At each location identify candidate site trees prior to beginning final selection. Candidate site trees meeting all the criteria set out above, shall be selected whenever possible from trees of the largest 20% by DBH present in the plot. In the event no suitable site trees exist in the plot from within the largest 20%, smaller trees may be selected. At each plot record data from up to five Douglas-fir site trees, only if they comply with all of provisions 1-6 above. No Douglas-fir site trees shall be selected that are joined at their butt. For each site tree selected, record the plot information as indicated below.

Redwood Site Index Sampling

At each location identify candidate trees within the plot area prior to beginning final selection. Candidate site trees meeting all the criteria set out above, shall be selected whenever possible from trees of the largest 20% by DBH present in the plot, and shall be selected primarily from dominant sprouts. In the event insufficient dominant sprouts exist on the plot, site trees may be selected from codominant trees within the largest 20% of trees present. At each plot record up to five site trees, only if they comply with all of provisions 1-6 above.

Sugar Pine Site Index Sampling

Sugar Pine site trees shall be measured as a part of this site tree project. The Douglas-fir Sampling procedures shall be followed for this species.

Field Procedures

All data will be recorded on the "Site Tree Form" provided. Grid intersect points are to be located by GPS, and mapped and located on the ground as per the CFL timber cruise manual. Previously prepared maps showing CFL inventory grid intersect points for plots to be sampled will be provided to field crews. Site tree plots will be a 167 foot radius plot centered on preselected grid intersect points.

For each plot record the following data:

1) Crew Members
2) Date
3) Line start and reference tree information.
4) Locate plot at grid point and record appropriate plot number on card.
5) GPS plot center (2m accuracy). If offsets to plot center are required, note offsets on plot card.
6) Comments - access, etc.
7) Map location of plot and approximate location of site tree.

At each plot, install plot as follows, and record the following data:

8) Proceed from plot center due north for up to 167 feet and cover the plot area by moving clockwise through the NE quadrant, and into additional quadrants if required as is described above. Refer to Site Trees Selection Criteria above to determine if the potential site trees encountered meet site tree criteria.
9) Upon locating a potential site tree, using your increment borer, extract an increment core from a boring taken at breast height. Examine the increment core to determine whether the tree shows signs of having been suppressed. If the tree shows signs of having been suppressed, exclude that tree from your sample and continue the site tree search. If the tree does not show signs of suppression, determine and record the breast height age of the site tree, and the five and ten year increment (in 1/20th inch) from the increment core.

10) Number each site tree sequentially in the plot. Each site tree will have a two part number - the plot number followed by a "-" and the tree number.
11) Record the azimuth and approximate distance from the plot center to the site tree.
12) Record the species of the site tree.
13) Record the DBH to the nearest 1/10th inch.
14) Measure and record total height of the site tree to the nearest two feet.
15) Estimate and record the live crown ratio of the site tree to the nearest 5 percent.
16) Record if the tree is dominant or codominant.
17) For each tree, at DBH place an aluminum tack and tag containing the plot intersect and tree number (the two part number described in #10 above). Tie flagging around the tree just above the aluminum tag. Paint the letters "ST" for site tree on the bole of the site tree just below the aluminum tag, and facing plot center.

I hope that you will look these over if you have time. You should receive the plot map early next week. Do not hesitate to contact me if you have additional comments. I would appreciate it if you would send me a memo indicating your approval of the site tree protocols above.

Sincerely,

Mark D. Edwards
RPF #2039

STATE OF CALIFORNIA-THE RESOURCES AGENCY PETE WILSON, Governor

DEPARTMENT OF FORESTRY AND FIRE PROTECTION
1416 Ninth Street
Sacramento California 95814
(916) 657-4778

#28

R 27

Mr. Mark Edwards
North Coast Resource Management
P.O. Box 509
Redwood Valley, CA 95470

January 13, 1997

Dear Mr. Edwards,

Thank you for the final site tree sampling protocols dated January 10, 1997. Most of the concerns that I have discussed with you in previous memos and conversations are incorporated as revisions in the final protocol. It is my understanding that all 198 plots will be visited. CDF believes, for reasons stated in earlier correspondence, that an unbiased sampling protocol shall consider only trees at least 25 years old for site trees. Given the two items above, this protocol is believed by CDF to be an unbiased sampling protocol to quantify the site productivity of CFL's property.

Sincerely,

Timothy A. Robards
Forest Biometrician
RPF 2521

TE OF CALIFORNIA-THE RESOURCES AGENCY PETE WILSON, Governor

ARTMENT OF FORESTRY AND FIRE PROTECTION
1416 Ninth Street
Sacramento California 95814
(916) 657-4778

R 27

Mr. Mark Edwards
North Coast Resource Management
P.O. Box 509
Redwood Valley, CA 95470

January 27, 1997

Dear Mr. Edwards,

I received a fax from Jim Mehrwein at Mason, Bruce, and Girard on Friday, January 24, 1997. I also spoke with Mr. Mehrwein this morning for some additional clarification. The plots were selected moving from north to south, when at the bottom of a column the column to the east was moved to and then the count proceeded north. This pattern was continued across the property. This accounts for why there is no pattern to the plot numbers as they are sequential from west to east. Mr. Mehrwein states that only grid points and timber strata were used when plots were allocated.

Given the information provided by Mr. Mehrwein, the plot locations should provide an unbiased sample.

Sincerely,

Timothy A. Robards
Forest Biometrician
RPF 2521

ATTACHMENT N

WILLITS WOODS CARBON PROJECT INVENTORY METHODOLGY

This document contains specifications for the collection of data in the field for the Willits Woods Inventory, as well as the data to be collected and the standards for data collection and processing. The Willits Woods Carbon Project includes approximately 17,682 acres of timberland characterized by redwood, Douglas-fir, Black Oak, Interior live oak, Ponderosa Pine, Pacific Madrone, 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 Willits Woods Project. Sampling was conducted through the installation of sampling points on a square systematic plot grid 25.4 chains on a side utilizing a random starting location. A map of the sampling grid is attached. 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 Initial OPDR 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 Willits Woods 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 Initial OPDR 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 Willits Woods Inventory Plot Data Entry Procedures (Appendix C). Plot data within the database is extensively sorted and queried to look for data entry errors. This process results 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 and during future inventory updates.

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 Initial OPDR 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

For the current inventory, the Willits Woods IFM Project Area was not stratified. Future inventory updates may utilize stratification based on species composition and relative stocking.

Quality Assurance/Quality Control (QA/QC)

Procedures for ensuring quality control are explained in the attached Willits Woods Carbon Project Inventory Specifications document under the “Check Cruising” heading. Procedures in verifying the integrity of inventory data are described above.

Updating the Inventory

As timber management activities take place on the Willits Woods IFM Project Area or disturbance such as fire or mortality resulting from pathogens or other factors occurs, cruise plots installed in 2008 will be relocated and remeasured within areas that have been harvested, treated for hardwood reduction, or subject to disturbance. By 2021, all of the plots installed in 2008 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, Willits Woods IFM 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.
2. Existing inventory plots that are 12 years old or less will be updated using the CRYPTOS Emulator or FORSEE. Plot data will then be exported to FORSEE for the calculation of the final carbon stock values as described in the modeling plan.
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 a 6.35 x 6.35 chain grid tied to the initial 25.4 chain inventory plot 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 following the update process.

Identification of Known or Potential Diseases:

Known or potential diseases that may affect the health of the project's inventory, specifically above-ground standing live and dead trees are listed below:

In Douglas-fir the most prevalent disease is Phellinus pini, known as white pocket rot, white speck or red ring rot. This is the most damaging wood rot in the western states. The presence of fruiting bodies or "conks" is the best indicator of infection. The size and frequency of the conks present may provide an indication of the amount of decay, but caution must be exercised until local conditions can be assessed. Infections associated with white speck become established through living and dead branches or branch stubs. The best way to reduce risk of white speck infection is to avoid damaging trees within the stand. This disease does not usually result in the imminent death of the infected tree.

Fomes annosus root rot can attack Douglas-fir present on the project. The sapwood and inner bark of small to medium sized roots and the heartwood of larger roots is infested when the fungus attacks. Frequently, the infection spreads through the roots and into the lower trunk of the host, causing butt rot of the heartwood. Heartwood and root rots often predispose fir trees to wind throw and/or fatal insect attack. Within 2 to 6 years, the disease moves to the tree's root crown and girdles it, thereby killing the tree. The Fomes fungus subsequently acts as a wood decay organism and may remain viable in surrounding soil for as long as fifty years. The disease is spread by spores that colonize freshly cut stumps, growing into the root system and spreading to surrounding areas via root contacts with adjacent trees. Fomes annosus has not been observed during fieldwork on the property. Group killing of trees, with the oldest deaths at the center and more recently dead trees on the periphery, is a common symptom of infection within pine stands. The presence of fruiting bodies on infected trees is the best evidence of disease. These vary in size, but are usually found around the base of the tree just below the duff, or within the hollow of infected stumps. Examination of roots or root crowns can also indicate the presence of the disease.

Another disease present in the Douglas fir is Leptographium wageneri var. pseudotsugae, black stain root disease. Black stain is recognizable by weakening symptoms in the trees such as declining vigor, reduced needle retention, and dull gray/green foliage discoloration. Black stain will occur in the sapwood of the roots, root crown and lower bole. The stain in cross section follows the annual rings in circular pattern and not radially as typical of other stains. Since black stain spreads by root graft (as well as by spores), the disease can be partially controlled by removing all the infected trees from the area of infection as well as adjacent trees not yet displaying symptoms.

Sudden Oak Dealth (SOD) is a plant disease caused by the pathogen Phytophthora ramorum. This disease may be transported to new areas when infected plants, infested soil, or contaminated water are moved. Although not detected on the property to date, the Project Area is within the SOD zone of infestation. Tanoak would be the primary species affected by this pathogen but a variety of other species, both hardwood and conifer, can be infected. Information about ongoing research and up to date regulations are available at www.suddenoakdeath.org, a site operated by the California Oak Mortality Taskforce.

Appendices:

A. Inventory Change Log
B. Willits Woods Carbon Project Inventory Specification from 2008 Inventory
C. Willits Woods Carbon Project Inventory Specification for Future Inventory
D. Willits Woods Inventory Plot Data Entry Procedures
E. Plot Map
F. CAR Harvested Wood Products Worksheet

Appendix A

Willits Woods Carbon Project Inventory Change Log

Date of Change	Note (changes made)
2/1/2016	A subsample of standing dead trees is conducted.
5/1/2016	A revised Willits Woods Carbon Project Inventory Specification dated May 2016 is included.
5/1/2016	Stratification of the Project Area has been included.
5/1/2016	DBH will be measured to the nearest $1/10^{th}$ inch.
5/1/2016	Total height to the nearest foot will be recorded for all trees.
5/1/2016	Plot center reference tags with distance and direction to plot center are now included.
5/1/2016	Tree numbers will be painted on trees on the $1/50^{th}$ acre and $1/5^{th}$ acre plot.
5/1/2016	A line will be painted at DBH for all trees, or a dot on small trees in order to mark the point at which DBH was measured.
5/1/2016	The collection of data on missing tree volume has been added to the inventory specification.
5/1/2016	The snag class definitions have been revised to be consistent with Research Paper NRS-15, Harmon et al. (2011).
5/1/2016	Additional plots may be installed into one or more stratum either in a systematic or random manner in order to achieve the desired inventory confidence of plus or minus 5% at the 90% confidence level.
5/1/2016	Guidance on the measurement of leaning trees has been included.
11/29/2016	A discussion of “Known or Potential Diseases” has been included.

Appendix B

Willits Woods Carbon Project
Inventory Specification for 2008 Inventory

Willits Woods Carbon Project
Inventory Specification

The 2008 initial inventory of the Willits Woods timber stands included a total of approximately 17,682 acres. The emphasis of the cruise was 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 does not include stratification. The cruise design installed 281 plots on a square systematic plot grid 25.4 chains on a side. This inventory specification utilized a set of nested fixed-area plots, described below in the "Sampling Method" section.

Plot Documentation and Location: Cruisers were supplied with maps that show the locations of the plots and plot numbers, air photo maps, and a list of coordinates for the existing plot centers (UTM).

It is the cruiser's responsibility to accurately locate plots within the accuracy tolerances specified (one chain). Plots were located via a combination of GPS take-off points established by Coastal, and field measurement (hip chain, or electronic device). Resource grade GPS equipment will be used to establish plot take-off points where cruise lines cross or are adjacent to traveled roads. Plot take-off points were 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 navigated from the take-off point to the plot in question using a hand compass, hip-chain or electronic distance device approved by Coastal. Where it was not possible or practical to establish a road take-off point for a given plot, the plot was located based on the last plot cruised on the cruise line. When navigating between plots, or between the take-off point and the plot, cruisers hung flags (glow lime green) at one-chain intervals. Flags were hung in such a manner that they assist relocation of cruise plots by check cruisers. Where cruise lines cross roads, cruisers hung a long flag with the distance and direction to the next plot, plot number of the next plot, date, and cruiser initials.

Plot centers were documented with a 50p ferrule nail and vinyl flag with the plot number written in rain proof ink. A long vinyl flag (at least 24" in length) with the plot number, date, and cruiser initials written in rain proof ink were hung on trees stems or branches over, or nearly over the plot center. The plot number was painted on the nearest tree to plot center of sufficient size with orange spray paint. Flagging to establish plot center was glow lime green.

Plot Card Format: Paper field data forms followed the format of the sample card attached to the proposal letter From William Kliener dated January 15, 2008. The only exception is that the "Tree Defect%" column was replaced with "Merch. Height" and an additional column was added for recording dib at 17.5 feet (Form Class). Cruisers filled out all appropriate information on cruise cards while in the field. All cruise cards produced within any day were completed and "proofed" by the cruiser the same day. Cruisers were responsible for generating the cruise report, providing copies of the field data cards, and providing the cruise data in a digital format. Cruise reports were provided at the tract level.

Sampling Method: All plots are circular fixed plots; plot radius distances are horizontal distances.

The cruise will consist of three nested circular plots:

1. $1/5^{th}$ acre (52.67') – Conifers 10.5" DBH and larger.
2. $1/50^{th}$ acre (16.65') – Conifers 3.5" DBH to 10.4" DBH and hardwoods 3.5" DBH and larger.
3. $1/250^{th}$ acre (7.45') – Conifers and hardwoods 1.0" DBH to 3.4" DBH.

Data collected:

1. Tree number were recorded clockwise from north
2. Plot size
3. Species
4. DBH in 1" DBH classes
5. Crown position
6. Live crown ration (LCR) to the nearest 10%
7. Visible defect was recorded by log position for all conifers and hardwoods which contain at least one 16.5' x 6" dib log.
8. Total height to the nearest foot, and merchantable height to a 6" top (dib) to the nearest foot for conifer trees where form class is recorded.
9. Total height to the nearest foot for the first conifer and hardwood tree from north on each sub-plot.
10. Status Code
11. Conifer snag trees if they were at least 10.5" DBH and 20' in height with height recorded to the nearest five feet.
12. Hardwood snags at least 10.5" DBH and 20' in height had DBH recorded
13. Form classes were measured on the first merchantable conifer tree of each species present on the plot, selected clockwise from north ($1/5^{th}$ acre plot).

Standing Dead Subsampling:

To comply with the Compliance Offset Protocol (2014) additional standing dead tree data was collected in early 2016 for snags on a subsample of every fifth cruised plot with a random starting plot. Snags were sampled within the following parameters:

1. $1/5^{th}$ acre (52.67') – Conifers 10.5" DBH and larger with height 15-19 feet.
2. $1/50^{th}$ acre (16.65') – Conifers and hardwoods 5" DBH to 10.4" DBH with height at least 15 feet. Hardwoods 10.5" DBH and larger with height 15-19 feet.

DBH was recorded to the nearest $1/10^{th}$ inch and height was recorded to the nearest foot. Broken top trees were measured to the break and "BT" was noted in the "Status" field. Percent missing volume was estimated for the entire remaining portion of the tree, not including any missing volume resulting from a broken top.

Blank Plots

If there are no trees located on any of nested plots, the plot is considered a Blank Plot.

Species Codes:

RW	Redwood	TO	Tanoak
DF	Douglas-fir	PM	Madrone
SP	Sugar Pine	BO	Black Oak
PP	Ponderosa Pine	WO	White Oak
GF	Grand Fir	LO	Live Oak
IC	Incense Cedar	BM	Bigleaf Maple
WH	Western Hemlock	CL	California Laurel
CX	Other Conifer	HX	Other Hardwood
NM	Nutmeg	XX	Blank Plot

*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 have 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 class ranges from 0.5” below the midpoint of the class, and 0.4” above the midpoint. As an example, the 10” DBH class runs from 9.5” to 10.4”.

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.

Visible Defect:

Visible defect for all merchantable conifer and hardwood trees by 16-foot log segment was estimated. A merchantable conifer tree is any tree that will make at least one 16.5’ x 6” dib log.

Missing Volume:

Missing volume was calculated from log defect codes as described below:
9 – Cull Log, 5% deduction for the log.
10 – Goose pen, deduct the defect recorded on the card for the log.
11 – Cull with sucker, 5% deduction for the log.
12 – Missing Log, 100% deduction for the log.

Total Height:

Total height to the nearest foot was measured for all conifers on the plots, and to the nearest five feet for all hardwoods. Merchantable conifers had merchantable height to a 6” top (dib) recorded.

Trees with broken tops had the condition of the top noted (broken, broken and recovered, dead). In those instances where breakage occurred above 6” dib, no further information was required. For trees where breakage occurred below 6” dib, cruisers recorded appropriate visible defect codes to reflect loss of tree volume >6” dib.

Status Codes:

BT	Broken top
FT	Forked top
RL	Recovered leader
DT	Dead top
SN	Snag

Snag Decay Class:

Class 0 Tree has recently died with leaves intact.
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 fifteen percent of plots were check cruised. Each plot check cruised received either a pass or fail grade. The basis for pass or fail was individual plot measurements for a given plot as compared to the check cruiser. Plot data was proofed daily and provided to Coastal Ridges for check cruising within 3 days of cruising. Coastal Ridges randomly select plots to be checked as plot data was received from cruisers. All check cruise reports were 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 1/5th, and 1/50th acre plots including snags	None.
Species	None.
Total height	±10% or 10' whichever is less, on each tree.
DBH	±1 for trees less than 24" DBH ±2 for trees 24" DBH or greater
Live crown ratio	20%.
Plot location	Within one chain of mapped location
Tree count on 1/250th – acre plot	±30% within each species class

The cruiser's work is 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 failed 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 were remeasured in their entirety.

Remarks:

Descriptive information for particular trees was recorded here, notes about measurements, or other observations.

Maps of the location of the plot relative to known landmarks such as roads and streams were drawn and directions to the plot were recorded.

Special Circumstances:

DBH: Trees with irregularities at DBH shall be measured just above the irregularity. For trees with a fork near DBH, the tree shall be treated as two trees if the fork occurs below DBH, and as a single tree if the fork occurs above DBH. As the plots are fixed area plots, trees were 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.

The reference for determining if a tree is off or on the plot is the point where the tree meets the ground. Trees leaning away from plot center are on the plot in question if the center of the base of the tree, and not the tree's DBH is within the plot radius.

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.

Appendix C

Willits Woods Carbon Project
Inventory Specification for Future Inventory*

*Changes from the previous inventory specification have been included in the Change Log

Willits Woods Carbon Project
Inventory Specification

May 2016

The inventory of the Willits Woods timber stands includes a total of approximately 17,682 acres. The emphasis of this inventory 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.

This inventory is based on a systematic sample of the ownership, and does not include stratification. The cruise design will install approximately 281 plots on a square systematic plot grid 25.4 chains on a side. This inventory specification utilizes a set of nested fixed-area plots, described below in the "Sampling Method" section. Following measurement of the initial 281 plot locations, it may be necessary to install additional plots either randomly or systematically in order to achieve the desired inventory confidence of plus or minus 5% at the 90% confidence level.

Plot Documentation and Location: Cruisers will be supplied with maps that show the locations of the plots and plot numbers, air photo maps, and a list of coordinates for the existing plot centers (UTM NAD83).

Plots will be located via a systematic list of GPS coordinates as supplied by Coastal Ridges and if necessary, due to lack of adequate GPS satellite reception, road take-off points established by Coastal Ridges, and field measurement (hip chain, or electronic device). Handheld GPS equipment will be used to establish or locate 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.

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.

It is the cruiser's responsibility to accurately locate plots within the accuracy tolerances specified (one chain). In the event the plot location cannot be established with the handheld GPS device, plots shall be located via a combination of GPS take-off points established by Coastal, and field measurement (hip chain, or electronic device). Resource grade GPS equipment will be used to establish plot take-off points where cruise lines cross or are adjacent

to traveled roads. Plot take-off points are 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 shall navigate from the take-off point to the plot in question using a hand compass, hip-chain or electronic distance device approved by Coastal. 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 between plots, or between the take-off point and the plot, cruisers hung flags (glow lime green) at one-chain intervals. Flags were hung in such a manner that they assist relocation of cruise plots by check cruisers. Where cruise lines cross roads, cruisers hung a long flag with the distance and direction to the next plot, plot number of the next plot, date, and cruiser initials. As needed and where it is not possible or practical to establish a road take-off point for a given plot, and location with a handheld GPS device is not possible, the plot shall be located based on the last plot cruised on the cruise line.

Plots are measured where they fall on the systematic grid regardless of roads, watercourses, or unmapped non-timbered areas. The cruise is based on all acres within the timbered strata including roads and small non-timbered areas.

Plot centers are to be documented with a 3/8" rebar stake at least 16 inches in length (provided by Costal Ridges) and flagging (tied to the spike) with the plot number written in rain proof ink. The plot center stake shall be inserted at least 12 inches into the ground, with the protruding portion being painted with glo-orange paint. 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 tree 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 with orange spray paint. Flagging to establish plot center shall be glow lime green and provided by Costal Ridges. A GPS coordinate of the actual plot center shall be recorded. GPS coordinates shall be clearly written on the plot card.

At each plot center, two plot reference trees will be established for the purpose of relocating the plot center. 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 from the reference tree to the plot center shall be recorded with the plot data. Reference trees shall be at least 3.5" in diameter and should be located as close as possible at right angles to plot center. A ring shall be painted around the circumference of the reference trees at DBH to identify these trees and the plot in the future. Paint color shall be glo-orange.

Plot Card Format: Paper field data forms will follow the format of the attached sample cruise card (to be provided by Coastal Ridges on Rite-In-The-Rain paper). 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. Cruiser will be responsible for providing copies of the field data cards to Coastal Ridges within 1 day of cruising.

Sampling Method: All plots are circular fixed plots; plot radius distances are horizontal distances.

The cruise will consist of three nested circular plots:

1. 1/5th acre (52.67') – Conifers 10.5" DBH and larger.
2. 1/50th acre (16.65') – Conifers 3.5" DBH to 10.4" DBH and hardwoods 3.5" DBH and larger.
3. 1/250th acre (7.45') – Conifers and hardwoods 1.0" DBH to 3.4" DBH.

Data 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
3. DBH to the nearest 1/10th inch (paint a horizontal line at DBH location on the uphill side of the tree).
4. Live crown ration (LCR) to the nearest 10%
5. Missing volume by 1/3rd segment of the tree as described below.
6. Total height to the nearest foot for all trees.
7. Status Code
8. 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.

Each tree shall be recorded on an individual line of the plot card.

Blank Plots

Blank Plots are noted on the plot card by including "XX" in the Species column, and no other tree data.

Species Codes:

RW	Redwood	TO	Tanoak
DF	Douglas-fir	PM	Madrone
SP	Sugar Pine	BO	Black Oak
PP	Ponderosa Pine	WO	White Oak
GF	Grand Fir	LO	Live Oak
IC	Incense Cedar	BM	Bigleaf Maple
WH	Western Hemlock	CL	California Laurel
CX	Other Conifer	HX*	Other Hardwood
NM	Nutmeg	XX	Blank Plot
KP	Knobcone hybrid		

*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 above mineral soil) is beneath any branches or forest litter that may have accumulated on the uphill side. Diameter is recorded to the nearest 0.1 inch. 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 Attachment 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.

For suppressed trees, reduce the live crown ratio recorded on the card. If a tree is severely suppressed, record a 5% live crown ratio.

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. 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
RL	Recovered leader
DT	Dead top
SN	Snag

Snag Decay Class:

Each snag recorded on a given plot shall have its decay class recorded consistent with the definitions in Research Paper NRS-15, Harmon et al. (2011). These decay classes are generally described as follows:

Code	Description	Description of Condition of Standing Dead Wood
1	Snag 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.
2	Snag 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.
3	Snag 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.
4	Snag 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.
5	Snag Class 5	No evidence of branches remains; the top is broken; <20 percent of the bark remains; sapwood is gone; heartwood is sloughing throughout.

Check Cruising: A minimum of five percent of plots shall be check cruised. Each plot check cruised receives either a pass or fail grade. The basis for pass or fail is individual plot measurements for a given plot as compared to the check cruiser. Plot data shall be proofed daily and provided to Coastal Ridges for check cruising within 3 days of cruising. Coastal Ridges will randomly select plots to be checked as plot data is received from cruisers. All check cruise reports shall 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 1/5th, and 1/50th acre plot only including snags	None.
Species	None.
Total height	±10% or 10' whichever is less, on each tree.
DBH 1/5th 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 1/50th and 1/250th acre plots	±0.3" for all trees
Live crown ratio	10%.
Plot location	Within one chain of mapped location
Tree count on 1/250th – acre plot	±20% within each species class

The cruiser's work is 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 failed 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 were remeasured in their entirety.

Remarks:

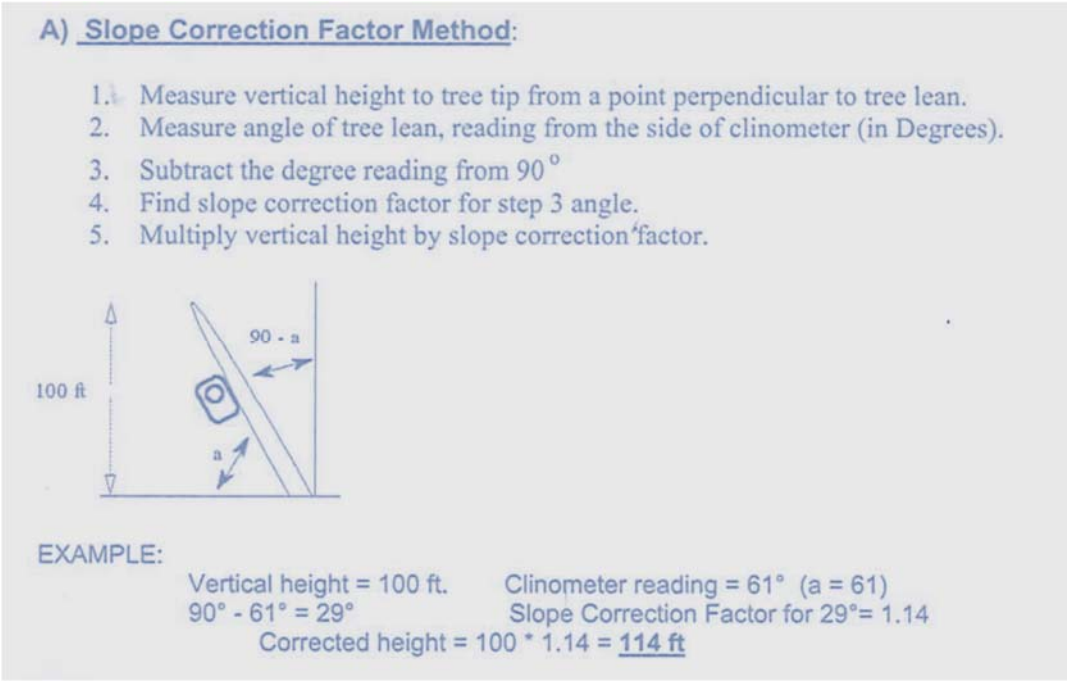
Descriptive information for particular trees shall be recorded here, notes about measurements, or other observations.

Maps of the location of the plot relative to known landmarks such as roads and streams are drawn and directions to the plot are recorded here if deemed necessary.

Special Circumstances:

The reference for determining if a tree is off or on the plot is the point (geometric center of tree) where the tree meets the ground. Trees leaning away from plot center are on the plot in question if the center of the base of the tree, and not the tree's DBH is within the plot radius. If the pith intersection of two forked trees is above 1 foot and below 4.5 feet, use the center of the combined tree below the pith intersection where it meets the ground line. If the pith intersection is below 1 foot, use the center of each individual tree, and project to ground line.

Leaning Trees: Total height on slightly leaning trees (less than 15 degrees) shall be measured perpendicular to the lean of the tree. Severely leaning trees (15 degrees or more) shall be measured perpendicular to the lean with the vertical distance from the ground to the tip of the tree, and the angle of the tree lean to the nearest 5 degrees recorded in the "Remarks" column. 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. Severely leaning tree heights are not subject to penalties by check cruisers.



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.

Attachment A – Special Instructions for DBH measurements

The attached special instructions for DBH measurement are adapted from the FIA National Core Field Guide, Version 6.1 dated October, 2014 section 5.9.2. Not all instructions apply to the Willits Woods 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 Willits Woods 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^{o} 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:

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.

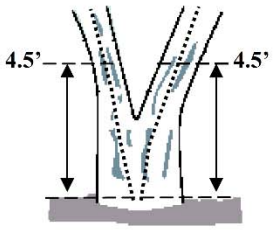


Figure 23. Forked below 1.0 ft.

- 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.

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).

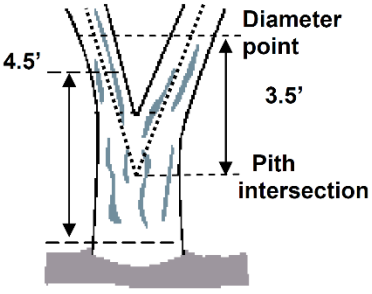


Figure 24. Forked between 1.0-4.5 ft.

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).

- 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.

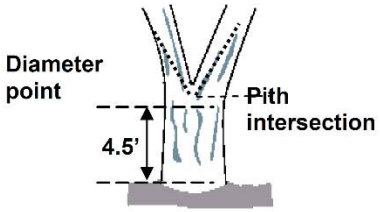


Figure 25. One tree.

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,

   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.

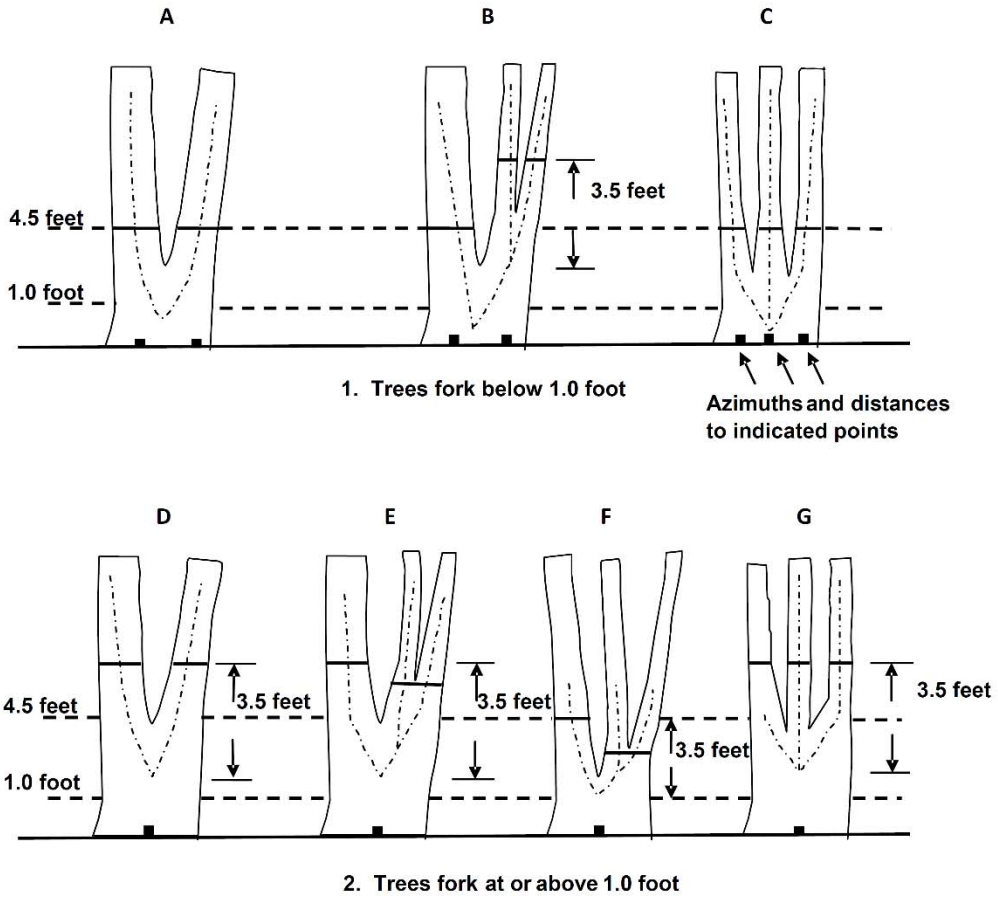


Figure 26. Summary of where to measure DBH, distance, and azimuth on forked trees.

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).

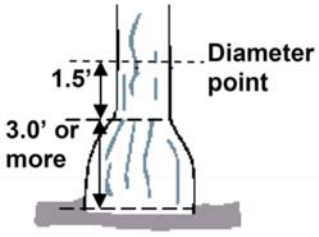


Figure 27. Bottleneck tree.

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.

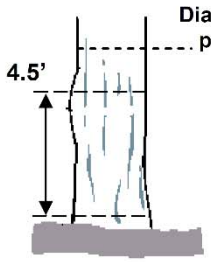


Figure 28. Tree with swelling.

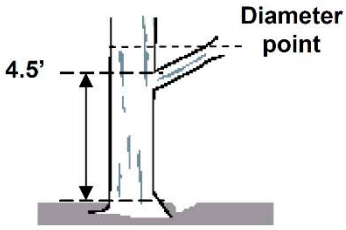


Figure 29. Tree with branch.

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).

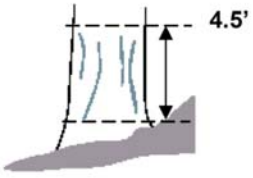


Figure 30. Tree on a slope.

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).

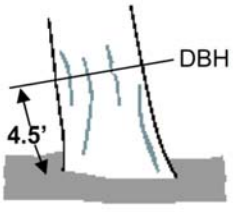


Figure 31. Leaning tree.

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. Set 2 aluminum nails at the half-way points, paint them, then measure the distance between them and double the measurement to determine DBH. 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).

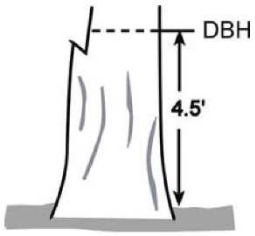


Figure 32. Tree with part of stem missing.

10. Live windthrown tree: Measure from the top of the root collar along the length to 4.5 feet (fig. 33).

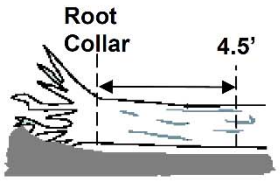


Figure 33. Tree on the ground.

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.

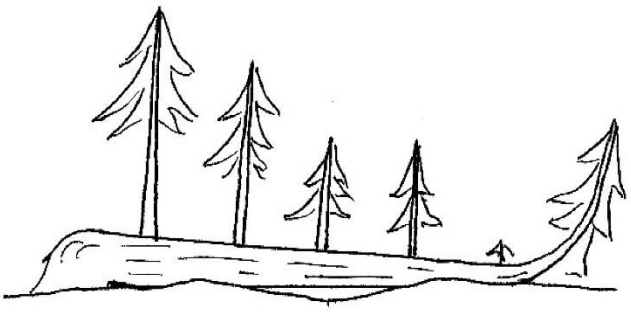


Figure 34. Down tree above duff.

- 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.

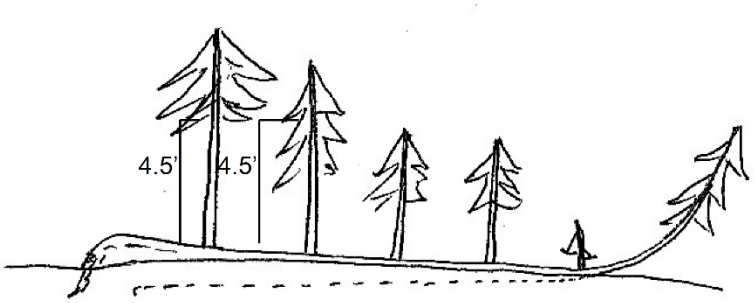


Figure 35. Down tree below duff.

12. Tree with curved bole (pistol butt tree): Measure along the bole on the uphill side (upper surface) of the tree (fig. 36).

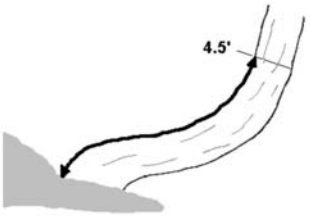


Figure 36. Tree with curved bole (pistol butt tree).

Appendix D

Willits Woods Inventory
Plot Data Entry Procedures

Willits Woods Inventory
Plot Data Entry Procedures

The following data entry procedures indicate 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 "Willits_Woods_2016.mdb" Access database found at L:\CFL\Coastal Ridges\ARB\Inventory2016.
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:\CFL\Coastal Ridges\ARB\Inventory2016\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.

Appendix E

Plot Map

Willits Woods
Cruise Plot Location Map

Legend

- Property Boundary
- Public Road
- Permanent Road
- Seasonal Road
- Class I Watercourse
- Class II Watercourse
- Cruise Plot

0 250 500 1,000 1,500 2,000 Meters

0 1,000 2,000 4,000 6,000 Feet

October 24, 2016
Version 1.1A

THREE CHOP RD
JAMES CREEK RD
GROUSE RIDGE RD
MAIN RD
LOWER RD
LOOKOUT RD
TURKEY TRACK JUNCTION
TWO ROCK LOOKOUT
RANCH HOUSE RD
CUT OFF RD
LOWER CUT OFF RD
UPPER LOOP RD
EAST BRANCH LOOP
McELHANEY RD
WILLIAMS MTN PEAK RD
WILLIAMS RANCH RD
BIG BAKER RD
WILLIAMS RANCH
REC CREEK RD
VALENTINE CREEK RD
LOWER EAST BRANCH RD
EAST BRANCH RD
NORTH FORK RD
LOWER BIG PINE RD
EAST BRANCH RD
T18N
T17N
T16N
R15W
R14W

Appendix F

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

The key below provides a color-coded reference to cells in this worksheet. User action is required wherever a 'Step' is mentioned.

Step Guidance	
Project data entered by Project Developer	
Assumptions and/or data populated automatically	
Default Values	
Data calculated automatically for input into the Calculation Worksheet	

Table 2. Project Characteristics

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.

Region*:	Pacific Southwest (PSW)
Reporting Period:	
Hardwood Harvest Units:	Cubic Feet
Softwood Harvest Units:	MBF-Scribner ("Large" or "Long")

***From the Reserve's Assessment Area Data File.**

Table 3. Default Wood Products Classes; Volume Totals

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**.

Softwood Lumber	Hardwood Lumber	Plywood	Oriented Strandboard	Non Structural Panels	Miscellaenous	Paper
0%	0%	0%	0%	0%	0%	0%

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	
Total	0	Total	
%	#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	***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
Gross Total:		-	-	-	-		-	-	-	-	-	-	-		-
Net Total:		-	-	-	-		-	-	-	-	-	-	-		-

Section 2. Estimates of Carbon Storage in Wood Products and Emissions Associated with Harvested Trees

Table 5. Estimates of CO_2-equivalent (CO_2-e) in Harvested Wood Products associated with Project Activities

	Hardwood					Softwood						
Units	Lumber	Oriented Strandboard	Non Structural Panels	Misc Products	Paper	Lumber	Plywood	Oriented Strandboard	Non Structural Panels	Misc Products	Paper	Sum
Project carbon in harvested wood delivered to mills (Cubic Feet)	-	-	-	-	-	-	-	-	-	-	-	-
Project carbon in harvested wood delivered to mills (tCO_2e)	-	-	-	-	-	-	-	-	-	-	-	-
Project carbon transferred to wood products (Cubic Feet)	-	-	-	-	-	-	-	-	-	-	-	-
Project carbon transferred to wood products (tCO_2e)	-	-	-	-	-	-	-	-	-	-	-	-
% Product												0%
Long-term storage in in-use wood products (tCO_2e)	-	-	-	-	-	-	-	-	-	-	-	-
Long-term storage in wood products in landfills (tCO_2e)	-	-	-	-	-	-	-	-	-	-	-	-

Table 6. Estimates of CO_2-equivalent (CO_2-e) in Harvested Wood Products associated with Baseline Activities

	Hardwood					Softwood						
Units	Lumber	Oriented Strandboard	Non Structural Panels	Misc Products	Paper	Lumber	Plywood	Oriented Strandboard	Non Structural Panels	Misc Products	Paper	Sum
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

Calculation Sheet Inputs (for Current Reporting Period)		Row Location in Calculation Worksheet
Actual Project Carbon in Harvested Wood Delivered to Mill (tCO2e)	-	11 (Excel 22)
Actual Project Carbon in Trees Harvested for Wood Products (tCO2e)	-	9 (Excel 20)
Actual Project Carbon Stored Long-term in Wood Products (tCO2e) - Excl Landfill	-	13 (Excel 24)
Actual Project Carbon Stored Long-term in Wood Products (tCO2e) - Incl Landfill	-	14 (Excel 25)
Baseline Carbon Stored Long-term in Wood Products (tCO2e) - Excl Landfill	-	15 (Excel 26)
Baseline Carbon Stored Long-term in Wood Products (tCO2e) - Incl Landfill	-	16 (Excel 27)

Table 8. Ratio of Harvested Wood Carbon to Harvested Tree Carbon

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.

Baseline Carbon in Trees Harvested for Wood Products (tCO_2e) (from Excel Row 21 of the Monitoring Calculation Worksheet)	
Baseline Carbon in Harvested Wood Delivered to Mill (tCO_2e) (from Row 23 of the Monitoring Calculation Worksheet)	
Multiplier of Carbon in Wood Delivered to Mill to Carbon in Trees Harvested for Wood Products	**0.00**

Section 3. Conversion Assumptions

Table 9. Volume multipliers for converting timber and chip units to Cubic Feet

Unit	Factor
Bone Dry Tons	71.3
Bone Dry Units	82.5
Cords	75
Cubic Feet	1
Cubic Meters	35.3
Cunits-Chips (CCF)	100
Cunits-Roundwood	100
Cunits-Whole tree chip	126
Green tons	31.5
MBF-Doyle	222
MBF-International 1/4"	146
MBF-Scribner ("C" or "Small")	165
MBF-Scribner ("Large" or "Long")	145
MCF-Thousand Cubic Feet	1000
Oven Dried Tonnes	75.8

Source: American Forest & Paper Association, Sustainable Forestry Initiative Program Annual Progress Reporting Form

Table 10. Conversion Factors: to convert volume estimates to CO2-e

		Source
Cubic Feet / Hardwood Harvest Unit	1	Table 9.
Cubic Feet / Softwood Harvest Unit	145	Table 9.
SG of Softwoods by Region	0.399	Table 12.
SG of Hardwoods by Region	0.51	Table 12.
Tree Carbon:Wood Carbon	0.00	Table 8.
Pounds to Metric Tons	0.0004535970	-
Portion of Carbon in Biomass	0.5	-
Carbon to CO2-e	3.67	Reserve FPP
Density of water (lbs/cf)	62.43	-

Table 11. 100-year average storage factors

Wood Product Class	In-Use	Landfills
Softwood Lumber	0.463	0.298
Hardwood Lumber	0.250	0.414
Softwood Plywood	0.484	0.287
Oriented Strandboard	0.582	0.233
Non Structural Panels	0.380	0.344
Miscellaneous Products	0.176	0.454
Paper	0.058	0.178

Source: Reserve Forest Project Protocol, Appendix C.3 & C.4

Table 12. Average regional factors: specific gravity (SG) and mill efficiencies (ME)

	Hardwoods			Softwoods		
Region	**SG**	**Saw Log ME**	**Pulp ME**	**SG**	**Saw Log ME**	**Pulp ME**
Northeast (NE)	0.518	0.614	0.650	0.371	0.569	0.513
Northern Lake States (NLS)	0.473	0.585	0.685	0.360	0.630	0.514
Northern Prairie States (NPS)	0.537	0.585	0.685	0.434	0.630	0.514
Pacific Northwest, East (PWE)	0.424	0.568	0.568	0.396	0.637	0.637
Pacific Northwest, West (PWW)	0.415	0.531	0.531	0.426	0.740	0.500
Pacific Southwest (PSW)	0.510	0.568	0.568	0.399	0.675	0.675
Rocky Mountain, North (RMN)	0.389	0.568	0.568	0.394	0.704	0.704
Rocky Mountain, South (RMS)	0.353	0.568	0.568	0.369	0.704	0.704
Southeast (SE)	0.508	0.609	0.591	0.462	0.636	0.553
South Central (SC)	0.529	0.587	0.581	0.463	0.629	0.570

Sources: USDA Forest Service, Forest Inventory and Analysis Program database of forest surveys (SG) and *Technical 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 O

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)

Type of Volume	Calculated on trees with a DIA of:	Volume name in equations
All softwoods and hardwoods:		
Volume of the total stem, ground to tip	>= 1”	CVTS
Volume from a 1-foot stump to the tip	>= 1”	CVT
Volume from a 1-foot stump to a 4-inch top	>= 5”	CV4
Softwood sawlog volume:		
Volume from a 1-foot stump to a 6-inch top	>= 9”	CV6
Hardwood sawlog volume:		
Volume from a 1-foot stump to an 8-inch top	>= 11”	CV8

BOARD FOOT VOLUME (square feet)

Type of Volume	Calculated on trees with a DIA of:	Volume name in equations
Softwoods:		
Scribner volume, 16-foot log rule, 1-foot stump to a 6-inch top (Eastern OR; Eastern WA; CA)	>= 9”	SV616
Scribner volume, 32-foot log rule, 1-foot stump to a 6-inch top (Western OR; Western WA)	>= 9”	SV632
International 1/4" volume, 16-foot log rule, 1-foot stump to a 6-inch top (all states)	>= 9”	XINT6
Hardwoods:		
Scribner volume, 16-foot log rule 1-foot stump to an 8-inch top (all states)	>=11”	SV816
International 1/4" volume, 8-foot log rule, 1-foot stump to an 8-inch top (all states)	>= 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:

RATIO	Used to convert:
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

		Halfstate				
Species Code	**Species**	**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

EQUATION 1	DOUGLAS-FIR	(Brackett, 1973; DNR RPT # 24,1977)
EQUATION 2	DOUGLAS-FIR	(DNR MEMO--SUMMERFIELD,11/7/80)
EQUATION 3	DOUGLAS-FIR	(USDA-FS RES NOTE PNW-266)
EQUATION 4	PONDEROSA PINE	(DNR MEMO--SUMMERFIELD,11/7/80)
EQUATION 5	PONDEROSA PINE	(USDA-FS RES NOTE PNW-266)
EQUATION 6	W.HEMLOCK	(DNR NOTE 27,4/79)
EQUATION 7	W.HEMLOCK	(BROWNE (1962) BC FOREST SERV,P33)
EQUATION 8	REDCEDAR	(REDCEDAR INTERIOR--DNR RPT # 24,1977)
EQUATION 9	REDCEDAR	(REDCEDAR COAST--DNR RPT # 24,1977)
EQUATION 10	TRUE FIRS	(INTERIOR BALSAM--DNR RPT # 24,1977)
EQUATION 11	TRUE FIRS	(COAST BALSAM--DNR RPT # 24,1977)
EQUATION 12	SPRUCE	(SITKA SPRUCE INTERIOR--DNR RPT # 24,1977)
EQUATION 13	SPRUCE	(SITKA SPRUCE MATURE--DNR RPT # 24,1977)
EQUATION 14	Other junipers	(Chojnacky, 1985)
EQUATION 14.1	Singleleaf pinyon	(Chojnacky, 1985)
EQUATION 14.2	Rocky mountain juniper	(Chojnacky, 1985)
EQUATION 15	LODGEPOLE PINE	(LODGEPOLE PINE--DNR RPT # 24,1977)
EQUATION 16	LODGEPOLE PINE	(USDA-FS RES NOTE PNW-266)
EQUATION 17	MTN.HEMLOCK	(BELL, OSU RES.BULL 35)
EQUATION 18	SHASTA RED FIR	(USDA-FS RES NOTE PNW-266)
EQUATION 19	INCENSE CEDAR	(USDA-FS RES NOTE PNW-266)
EQUATION 20	SUGAR PINE	(USDA-FS RES NOTE PNW-266)
EQUATION 21	W.JUNIPER	(CHITTESTER,1984)
EQUATION 22	W.LARCH	(LARCH--DNR RPT # 24,1977)
EQUATION 23	WHITE FIR	(USDA-FS RES NOTE PNW-266)
EQUATION 24	REDWOOD	(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

$$\mathbf{CVTSL} = -3.21809 + 0.04948 \times \log(HT) \times \log(DBH) - 0.15664 \times (\log(DBH))^2 + 2.02132 \times \log(DBH) + 1.63408 \times \log(HT) - 0.16185 \times (\log(HT))^2 \quad (1)$$

CVTS=10**CVTSL (2)

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

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 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 2

$$\mathbf{CVTSL} = -6.110493 + 1.81306 \times ln(DBH) + 1.083884 \times ln(HT) \quad (1)$$

$$\mathbf{CVTS} = exp(CVTSL) \quad (2)$$

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

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 DBH^2

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

$$\mathbf{CVTSL} = -8.521558 + 1.977243 \times \ln(DBH) - 0.105288 \times (\ln(HT))^2 + \frac{136.0489}{HT} + 1.99546 \times \ln(HT) \quad (1)$$

$$\mathbf{CVTS} = exp(CVTSL) \quad (2)$$

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{((1.033 \times (1.0 + 1.382937 \times exp(-4.015292 \times DBH))) \times (BA + 0.087266) - 0.174533)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

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 DBH^2

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

$$\mathrm{CVTSL} = -2.72170 + 2.00857 \times \log(DBH) + 1.08620 \times \log(HT) - 0.00568 \times (DBH) \quad (1)$$

CVTS=10**CVTSL

(2)

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

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 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

$$\mathbf{CVTSL} = -2.663834 + 1.79023 \times log(DBH) + 1.124873 \times log(HT) \quad (1)$$

CVTS=10**CVTSL

(2)

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

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 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

$$\mathrm{CVTSL} = -2.464614 + 1.701993 \times \log(DBH) + 1.067038 \times \log(HT) \quad (1)$$

CVTS=10**CVTSL

(2)

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

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 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 9

$$\mathbf{CVTSL} = -2.379642 + 1.682300 \times log(DBH) + 1.039712 \times log(HT) \quad (1)$$

(2)

CVTS=10**CVTSL

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

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 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

$$\mathbf{CVTSL} = -2.502332 + 1.864963 \times log(DBH) + 1.004903 \times log(HT) \quad (1)$$

CVTS=10**CVTSL

(2)

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

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 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

$$\mathbf{CVTSL} = -2.575642 + 1.806775 \times log(DBH) + 1.094665 \times log(HT) \quad (1)$$

CVTS=10**CVTSL

(2)

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

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 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 12

$$\text{CVTSL} = -2.539944 + 1.841226 \times \log(DBH) + 1.034051 \times \log(HT) \quad (1)$$

CVTS=10**CVTSL

$$\textbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\textbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\textbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

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 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

$$\mathbf{CVTSL} = -2.700574 + 1.754171 \times log(DBH) + 1.164531 \times log(HT) \quad (1)$$

CVTS=10**CVTSL

(2)

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

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 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;

VOLUME = (0.02434 + (0.119106 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)

DRC (inches) = Diameter at the root collar

HT (feet) = Total height of the tree

No boardfoot equation is available

Equation 15

$$\mathrm{CVTSL} = -2.615591 + 1.847504 \times \log(DBH) + 1.085772 \times \log(HT) \quad (1)$$

CVTS=10**CVTSL

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

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 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 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

$$\mathbf{CVTS} = 0.001106485 \times (DBH)^{1.8140497} \times (HT)^{1.2744923} \tag{1}$$

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \tag{2}$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \tag{3}$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \tag{5}$$

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 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 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

$$\mathbf{CVTS} = 0.005454154 \times \left[0.30708901 + 0.0008615762\ 2 \times HT\text{-}0.0037255243 \times DBH \times \frac{HT}{HT - 4.5} \right] \times DBH^2 \times HT \times \left(\frac{HT}{HT - 4.5} \right)^2 \quad (1)$$

$$\mathbf{TARIF} = \frac{\left(CVTS \times 0.912733 \right)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0} \right) \right) \right) \right) \times \left(BA + 0.087266 \right) - 0.174533 \right)} \quad (2)$$

$$\mathbf{CV4} = \frac{\left(CVTS + 3.48 \right)}{\left(1.18052 + 0.32736 \times exp\left(-0.1 \times DBH \right) \right)} - 2.948 \quad (3)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5} \right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0} \right) \right) \right) \right) \times \left(BA + 0.087266 \right) - 0.174533 \right)}{0.912733} \quad (5)$$

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 x 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

$$\mathbf{CVTSL} = -2.624325 + 1.847123 \times log(DBH) + 1.044007 \times log(HT) \quad (1)$$

$$\mathrm{CVTS} = 10.0^{CVTSL} \quad (2)$$

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \quad (3)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (4)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \quad (5)$$

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 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 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

$$\mathbf{CVTS} = exp\left(-6.2597 + 1.9967 \times ln(DBH) + 0.9642 \times ln(HT)\right) \tag{1}$$

$$\mathbf{TARIF} = \frac{\left(CVTS \times 0.912733\right)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)} \tag{2}$$

$$\mathbf{CV4} = \frac{TARIF \times \left(BA - 0.087266\right)}{0.912733} \tag{3}$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)}{0.912733} \tag{4}$$

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 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

SOFTWOOD BOARDFOOT VOLUME EQUATIONS

$$\textbf{RC6} = 0.993 - \left(0.993 \times 0.62^{(DBH - 6.0)}\right)$$

$$\textbf{CV6} = RC6 \times CV4$$

IF CV6 > CV4 THEN CV6 =CV4

$$\textbf{CUBUS} = CV4 - CV6$$

$$\textbf{B4} = \frac{TARIF}{0.912733}$$

$$\textbf{RS616L} = 0.174439 + 0.117594 \times log(DBH) \times log(B4) - \frac{8.210585}{DBH^2} + 0.236693 \times log(B4) - 0.00001345 \times (B4)^2 - 0.00001937 \times DBH^2$$

$$\textbf{RS616} = 10.0^{RS616L}$$

$$\textbf{RS632} = 1.001491 - \frac{6.924097}{TARIF} + 0.00001351 \times DBH^2$$

$$\textbf{SV616} = RS616 \times CV6$$

$$\textbf{SV632} = RS632 \times SV616$$

$$\textbf{SCRIB} = SV632$$

note: West-side Scribner conifer volumes are based on 32 foot logs, for areas other than western Oregon and western Washington SCRIB = sv616

$$\textbf{RI6} = -2.904154 + 3.466328 \times log(DBH \times TARIF) - 0.02765985 \times DBH - 0.00008205 \times TARIF^2 + \frac{11.29598}{DBH^2}$$

$$\textbf{XINT6} = RI6 \times CV6$$

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 ¼ INCH 6-INCH TOP
XINT6 =INTERNATIONAL ¼ INCH VOLUME--6-INCH TOP (IN 16-FT LOGS)

HARDWOOD CUBIC VOLUME EQUATIONS

Volume equation numbers

		Halfstate				
Species Code	**Species**	**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)

		Halfstate				
Species Code	**Species**	**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
Brackett, 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.

HARDWOOD CUBIC VOLUME EQUATIONS

EQUATION 25

If HT < 18 then set HT = 18

$$\mathbf{F} = 0.3651 \times Z^{2.5} - 7.9032 \times Z^{2.5} \frac{DBH}{1000.0} + 3.295 \times Z^{2.5} \times \frac{HT}{1000.0}$$
$$- 1.9856 \times Z^{2.5} \times HT \times \frac{DBH}{100000.0} - 2.9668 \times Z^{2.5} \times \frac{HT^2}{1000000.0}$$
$$+ 1.5092 \times Z^{2.5} \times \frac{HT^{0.5}}{1000.0} + 4.9395 \times Z^{4} \times \frac{DBH}{1000.0}$$
$$- 2.05937 \times Z^{4} \times \frac{HT}{1000.0} + 1.5042 \times Z^{33} \times HT \times \frac{DBH}{1000000.0}$$
$$- 1.1433 \times Z^{33} \times \frac{HT^{0.5}}{10000.0} + 1.809 \times Z^{41} \times \frac{HT^2}{10000000.0} \quad (1)$$

Where: $$Z = \frac{\left(HT - 0.5 - \frac{DBH}{24.0}\right)}{HT - 4.5}$$

$$\mathbf{CVT} = 0.00545415 \times (DBH)^2 \times (HT - 4.5) \times F \quad (2)$$

$$\mathrm{TARIF} = \frac{(CVT \times 0.912733)}{\left(\left(0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)}\right) \times \left(\left(\left(1.0330 \times \left(1.0 + 1.382937 \times \exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)\right)} \quad (3)$$

$$\mathbf{CVTS} = TARIF \times \frac{\left(\left(\left(1.0330 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)\right)}{0.912733} \quad (4)$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \quad (5)$$

$$\mathbf{RC8} = 0.983 - \left(0.983 \times 0.65^{(DBH-8.6)}\right)$$

$$\mathbf{CV8} = RC8 \times CV4 \quad (6)$$

$$\mathbf{CV4X} = CV4$$

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 26

$$\mathbf{CVTSL} = -2.672775 + 1.920617 \times log(DBH) + 1.074024 \times log(HT) \quad (1)$$

CVTS=10**CVTSL

(2)

$$\mathbf{TARIF} = \frac{\left(CVTS \times 0.912733\right)}{\left(\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)\right)} \quad (3)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)\right)}{0.912733} \quad (4)$$

$$\mathbf{CV4} = \frac{TARIF \times \left(BA - 0.087266\right)}{0.912733} \quad (5)$$

$$\mathbf{RC8} = 0.983 - \left(0.983 \times 0.65^{(DBH - 8.6)}\right)$$

$$\mathbf{CV8} = RC8 \times CV4 \quad (6)$$

$$\mathbf{CV4X} = CV4$$

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

$$\mathbf{CVTSL} = -2.945047 + 1.803973 \times log(DBH) + 1.238853 \times log(HT) \quad (1)$$

CVTS=10**CVTSL (2)

$$\mathbf{TARIF} = \frac{\left(CVTS \times 0.912733\right)}{\left(\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)\right)} \quad (3)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)\right)}{0.912733} \quad (4)$$

$$\mathbf{CV4} = \frac{TARIF \times \left(BA - 0.087266\right)}{0.912733} \quad (5)$$

$$\mathbf{RC8} = 0.983 - \left(0.983 \times 0.65^{(DBH - 8.6)}\right)$$

$$\mathbf{CV8} = RC8 \times CV4 \quad (6)$$

$$\mathbf{CV4X} = CV4$$

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 DBH^2

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

$$\mathbf{CVTSL} = -2.635360 + 1.946034 \times log(DBH) + 1.024793 \times log(HT) \quad (1)$$

CVTS=10**CVTSL (2)

$$\mathbf{TARIF} = \frac{\left(CVTS \times 0.912733\right)}{\left(\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)\right)} \quad (3)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)\right)}{0.912733} \quad (4)$$

$$\mathbf{CV4} = \frac{TARIF \times \left(BA - 0.087266\right)}{0.912733} \quad (5)$$

$$\mathbf{RC8} = 0.983 - \left(0.983 \times 0.65^{(DBH - 8.6)}\right)$$

$$\mathbf{CV8} = RC8 \times CV4 \quad (6)$$

$$\mathbf{CV4X} = CV4$$

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 DBH^2

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

$$\mathbf{CVTSL} = -2.757813 + 1.911681 \times log(DBH) + 1.105403 \times log(HT) \quad (1)$$

CVTS=10**CVTSL (2)

$$\mathbf{TARIF} = \frac{\left(CVTS \times 0.912733\right)}{\left(\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)\right)} \quad (3)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)\right)}{0.912733} \quad (4)$$

$$\mathbf{CV4} = \frac{TARIF \times \left(BA - 0.087266\right)}{0.912733} \quad (5)$$

$$\mathbf{RC8} = 0.983 - \left(0.983 \times 0.65^{(DBH - 8.6)}\right)$$

$$\mathbf{CV8} = RC8 \times CV4 \quad (6)$$

$$\mathbf{CV4X} = CV4$$

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 DBH^2

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

$$\mathbf{CVTSL} = -2.770324 + 1.885813 \times log(DBH) + 1.119043 \times log(HT) \quad (1)$$

CVTS=10**CVTSL (2)

$$\mathbf{TARIF} = \frac{\left(CVTS \times 0.912733\right)}{\left(\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)\right)} \quad (3)$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(BA + 0.087266\right) - 0.174533\right)\right)}{0.912733} \quad (4)$$

$$\mathbf{CV4} = \frac{TARIF \times \left(BA - 0.087266\right)}{0.912733} \quad (5)$$

$$\mathbf{RC8} = 0.983 - \left(0.983 \times 0.65^{(DBH - 8.6)}\right)$$

$$\mathbf{CV8} = RC8 \times CV4 \quad (6)$$

$$\mathbf{CV4X} = CV4$$

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 DBH^2

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

$$\mathbf{CVTS} = 0.0016144 \times DBH^2 \times HT \tag{1}$$

$$\mathbf{TARIF} = \frac{(CVTS \times 0.912733)}{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)} \tag{2}$$

$$\mathbf{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{0.912733} \tag{3}$$

$$\mathbf{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \tag{4}$$

$$\mathbf{RC8} = 0.983 - \left(0.983 \times 0.65^{(DBH - 8.6)}\right)$$

$$\mathbf{CV8} = RC8 \times CV4 \tag{5}$$

$$\mathbf{CV4X} = CV4$$

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 DBH^2

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

$$\text{CVTS} = 0.0120372263 \times DBH^{2.02232} \times HT^{0.68638} \quad (1)$$

$$\textbf{CV4} = 0.0055212937 \times DBH^{2.07202} \times HT^{0.77467} \quad (2)$$

$$\textbf{CV8} = 0.0018985111 \times DBH^{2.38285} \times HT^{0.77105} \quad (3)$$

$$\text{CVT} = CVTS * RTS \quad (4)$$
$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH - 1.5)}$$

$$\textbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\textbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH - 8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

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 DBH^2

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

$$\mathbf{CVTS} = 0.0057821322 \times DBH^{1.94553} \times HT^{0.88389} \quad (1)$$

$$\mathbf{CV4} = 0.0016380753 \times DBH^{2.05910} \times HT^{1.05293} \quad (2)$$

$$\mathbf{CV8} = 0.0007741517 \times DBH^{2.23009} \times HT^{1.03700} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$
$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)}$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

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 DBH^2

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

$$\mathbf{CVTS} = 0.0058870024 \times DBH^{1.94165} \times HT^{0.86562} \quad (1)$$

$$\mathbf{CV4} = 0.0005774970 \times DBH^{2.19576} \times HT^{1.14078} \quad (2)$$

$$\mathbf{CV8} = 0.0002526443 \times DBH^{2.30949} \times HT^{1.21069} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$
$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)}$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

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 DBH^2

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

$$\mathbf{CVTS} = 0.0042870077 \times DBH^{2.33631} \times HT^{0.74872} \quad (1)$$

$$\mathbf{CV4} = 0.0009684363 \times DBH^{2.39565} \times HT^{0.98878} \quad (2)$$

$$\mathrm{CV8} = 0.0001880044 \times DBH^{1.87346} \times HT^{1.62443} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$

$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH - 1.5)} \quad (4)$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH - 8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

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 DBH^2

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

$$\mathbf{CVTS} = 0.01914531910 \times DBH^{2.40248} \times HT^{0.28060} \quad (1)$$

$$\mathbf{CV4} = 0.00538663530 \times DBH^{2.61268} \times HT^{0.31103} \quad (2)$$

CV8 =CV4 (3)

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$

$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)} \quad (4)$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

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 DBH^2

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

$$\mathbf{CVTS} = 0.0101786350 \times DBH^{2.22462} \times HT^{0.57561} \quad (1)$$

$$\mathrm{CV4} = 0.0034214162 \times DBH^{2.35347} \times HT^{0.69586} \quad (2)$$

$$\mathbf{CV8} = 0.0004236332 \times DBH^{2.10316} \times HT^{1.08584} \times FC^{0.40017} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$

$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)} \quad (4)$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

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 DBH^2

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

$$\mathbf{CVTS} = 0.0070538108 \times DBH^{1.97437} \times HT^{0.85034} \quad (1)$$

$$\mathbf{CV4} = 0.0036795695 \times DBH^{2.12635} \times HT^{0.83339} \quad (2)$$

$$\mathbf{CV8} = 0.0012478663 \times DBH^{2.68099} \times HT^{0.42441} \times FC^{0.28385} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$

$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)} \quad (4)$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

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 DBH^2

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

$$\mathbf{CVTS} = 0.0125103008 \times DBH^{2.33089} \times HT^{0.46100} \quad (1)$$

$$\mathbf{CV4} = 0.0042324071 \times DBH^{2.53987} \times HT^{0.50591} \quad (2)$$

$$\mathbf{CV8} = 0.0036912408 \times DBH^{1.79732} \times HT^{0.83884} \times FC^{0.15958} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$

$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)} \quad (4)$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

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 DBH^2

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

$$\mathbf{CVTS} = 0.0067322665 \times DBH^{1.96628} \times HT^{0.83458} \quad (1)$$

$$\mathbf{CV4} = 0.0025616425 \times DBH^{1.99295} \times HT^{1.01532} \quad (2)$$

$$\mathrm{CV8} = 0.0006181530 \times DBH^{1.72635} \times HT^{1.26462} \times FC^{0.37868} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$

$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)} \quad (4)$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

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 DBH^2

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

$$\mathbf{CVTS} = 0.0072695058 \times DBH^{2.14321} \times HT^{0.74220} \quad (1)$$

$$\mathbf{CV4} = 0.0024277027 \times DBH^{2.25575} \times HT^{0.87108} \quad (2)$$

$$\mathbf{CV8} = 0.0008281647 \times DBH^{2.10651} \times HT^{0.91215} \times FC^{0.32652} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$

$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)} \quad (4)$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

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 DBH^2

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

$$\mathbf{CVTS} = 0.0097438611 \times DBH^{2.20527} \times HT^{0.61190} \quad (1)$$

$$\mathbf{CV4} = 0.0031670596 \times DBH^{2.32519} \times HT^{0.74348} \quad (2)$$

$$\mathbf{CV8} = 0.0006540144 \times DBH^{2.24437} \times HT^{0.81358} \times FC^{0.43381} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$

$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)} \quad (4)$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

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 DBH^2

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

$$\mathbf{CVTS} = 0.0065261029 \times DBH^{2.31958} \times HT^{0.62528} \quad (1)$$

$$\mathbf{CV4} = 0.0024574847 \times DBH^{2.53284} \times HT^{0.60764} \quad (2)$$

$$\mathbf{CV8} = 0.0006540144 \times DBH^{2.24437} \times HT^{0.81358} \times FC^{0.43381} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$

$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)} \quad (4)$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

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 DBH^2

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

$$\mathbf{CVTS} = 0.0136818837 \times DBH^{2.02989} \times HT^{0.63257} \quad (1)$$

$$\mathbf{CV4} = 0.0041192264 \times DBH^{2.14915} \times HT^{0.77843} \quad (2)$$

$$\mathbf{CV8} = 0.0006540144 \times DBH^{2.24437} \times HT^{0.81358} \times FC^{0.43381} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$

$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)} \quad (4)$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

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 DBH^2

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

$$\mathbf{CUBUS} = CV4 - CV8 \quad (1)$$

$$\mathbf{RC6} = 0.993 - 0.993 \times 0.62^{(DBH-6.0)} \quad (2)$$

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:

$$\mathrm{CV4X} = \mathrm{CVT} \times 0.99875 - \frac{43.336}{\mathrm{DBH}^3} - \frac{124.717}{\mathrm{DBH}^4} + \frac{0.193437 \times \mathrm{HT}}{\mathrm{DBH}^3} + \frac{479.83}{\mathrm{DBH}^3 \times \mathrm{HT}}$$

$$\mathrm{TARIFX} = \frac{\mathrm{CV8} \times 0.912733}{0.983 - 0.983 \times 0.65^{\mathrm{DBH}-8.6} \times \mathrm{BA} - 0.087266}$$

If TARIF or TARIFX are <0 then set them to .01

$$\mathrm{CV6} = RC6 \times CV4X \quad (3)$$

$$\mathrm{B4} = \frac{TARIFX}{0.912733}$$

$$\mathrm{RS616L} = 0.174439 + 0.117594 \times \log(DBH) \times \log(B4) - \frac{8.210585}{DBH^2} + 0.236693 \times \log(B4) - 0.00001345 \times (B4)^2 - 0.00001937 \times DBH^2 \quad (4)$$

$$\mathrm{RS616} = 10.0^{RS616L} \quad (5)$$

$$\mathrm{SV616} = RS616 \times CV6$$

$$\mathrm{RI6} = -2.904154 + 3.466328 \times \log(DBH \times TARIFX) - 0.02765985 \times DBH - 0.00008205 \times TARIFX^2 + \frac{11.29598}{DBH^2} \quad (6)$$

$$\mathrm{XINT6} = RI6 \times CV6 \quad (7)$$

$$RS616 = 0.990 - 0.58 \times (0.484^{DBH-9.5}) \quad (8)$$

$$SV816 = RS816 \times SV616 \quad (9)$$

Calculated on hardwood species only:

$$RI8 = 0.990 - 0.55 \times (0.485^{DBH-9.5}) \quad (10)$$

$$XINT8 = XINT6 \times RI8 \quad (11)$$

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.

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 torreya	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	Subablpine 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

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 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

$$\mathrm{BB} = \frac{\exp\left(2.1069 + 2.7271 \times \log(DBH)\right)}{1000}$$

EQUATION 2 BIOPAK EQUATION 887

$$\mathrm{BB} = 0.6 + 16.4 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 3 BIOPAK EQUATION 917

$$\mathrm{BB} = 1.0 + 17.2 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 4 BIOPAK EQUATION 382

$$\mathrm{BB} = \frac{\exp\left(1.47146 + 2.8421 \times \log(DBH)\right)}{1000}$$

EQUATION 5 BIOPAK EQUATION 251

$$\mathrm{BB} = \frac{\exp\left(2.79189 + 2.4313 \times \log(DBH)\right)}{1000}$$

EQUATION 6 BIOPAK EQUATION 845

$$\mathrm{BB} = 1.3 + 12.6 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 7 BIOPAK EQUATION 875

$$\mathrm{BB} = 4.5 + 9.3 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 8 BIOPAK EQUATION 5

$$\mathrm{BB} = \exp\left(-4.3103 + 2.4300 \times \log\left(DBH\right)\right)$$

EQUATION 9 BIOPAK EQUATION 705

$$\mathrm{BB} = \exp\left(-3.6263 + 1.34077 \times \log\left(DBH\right) + 0.8567 \times \log\left(HT\right)\right)$$

EQUATION 10 BIOPAK EQUATION 391

$$\mathrm{BB} = \frac{\exp\left(2.183174 + 2.6610 \times \log(DBH)\right)}{1000}$$

EQUATION 11 BIOPAK EQUATION 899

$$\mathrm{BB} = 1.2 + 11.2 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 12 (updated) BIOPAK EQUATION 385

$$\mathrm{BB} = \frac{\exp\left(-13.3146 + 2.8594 \times \log(DBH)\right) * 1000}{}$$

EQUATION 13 BIOPAK EQUATION 461

$$\mathrm{BB} = 0.336 + 0.00058 \times DBH^2 \times HT$$

EQUATION 14 BIOPAK EQUATION 904

$$\mathrm{BB} = 3.2 + 9.1 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 15 BIOPAK EQUATION 174

$$\mathrm{BB} = \exp\left(-4.371 + 2.259 \times \log\left(DBH\right)\right)$$

EQUATION 16 BIOPAK EQUATION 54

$$\mathrm{BB} = \exp\left(-10.175 + 2.6333 \times \log\left(DBH \times \pi\right)\right)$$

EQUATION 17 BIOPAK EQUATION 394

$$\mathrm{BB} = \frac{\exp\left(7.189689 + 1.5837 \times \log(DBH)\right)}{1000}$$

EQUATION 18 BIOPAK EQUATION 942

$$\mathrm{BB} = 1.3 + 27.6 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 19

$$\mathrm{BB} = 0.0$$

EQUATION 20 BIOPAK EQUATION 275

$$\mathrm{BB} = \exp\left(-4.6424 + 2.4617 \times \log\left(DBH\right)\right)$$

EQUATION 21 BIOPAK EQUATION 911

$$\mathrm{BB} = 0.9 + 27.4 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 22 BIOPAK EQUATION 881

$$\mathrm{BB} = 1.0 + 15.6 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 23 BIOPAK EQUATION 923

$$\mathrm{BB} = 1.8 + 9.6 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 24 BIOPAK EQUATION 893

$$\mathrm{BB} = 2.4 + 15.0 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 25 BIOPAK EQUATION 857

$$\mathrm{BB} = 3.6 + 18.2 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 26 BIOPAK EQUATION 455

$$\mathrm{BB} = -0.025 + 0.00134 \times DBH^2 \times HT$$

EQUATION 27 BIOPAK EQUATION 948

$$\mathrm{BB} = -1.2 + 29.1 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 28 BIOPAK EQUATION 930

$$\mathrm{BB} = 1.2 + 15.5 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 29 (Bigleaf maple)

$$ADBH = \frac{(DBH - 0.21235)}{0.94782} \quad 1$$

$$OUTERVOL = 0.0000246916 \times \left(ADBH^{2.354347} \left(HT^{0.69586} \right) \right) \quad 2$$

$$INNERVOL = 0.0000246916 \times \left(DBH^{2.354347} \left(HT^{0.69586} \right) \right) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 30 (California Black Oak)

$$ADBH = \frac{(DBH + 0.68133)}{0.95767} \quad 1$$

$$OUTERVOL = 0.0000386403 \times \left(ADBH^{2.12635}\left(HT^{0.83339}\right)\right) \quad 2$$

$$INNERVOL = 0.0000386403 \times \left(DBH^{2.12635}\left(HT^{0.83339}\right)\right) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 31 (Canyon Live Oak)

$$ADBH = \frac{(DBH + 0.48584)}{0.96147} \quad 1$$

$$OUTERVOL = 0.0000248325 \times \left(ADBH^{2.32519}\left(HT^{0.74348}\right)\right) \quad 2$$

$$INNERVOL = 0.0000248325 \times \left(DBH^{2.32519}\left(HT^{0.74348}\right)\right) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 32 (Golden Chinkapin)

$$ADBH = \frac{(DBH - 0.39534)}{0.90182} \quad 1$$

$$OUTERVOL = 0.000056884 \times \left(ADBH^{2.07202}\left(HT^{0.77467}\right)\right) \quad 2$$

$$INNERVOL = 0.000056884 \times \left(DBH^{2.07202}\left(HT^{0.77467}\right)\right) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 33 (California Laurel)

$$ADBH = \frac{(DBH + 0.32491)}{0.96579} \quad 1$$

$$OUTERVOL = 0.0000237733 \times \left(ADBH^{2.05910}\left(HT^{1.05293}\right)\right) \quad 2$$

$$INNERVOL = 0.0000237733 \times \left(DBH^{2.05910}\left(HT^{1.05293}\right)\right) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 34 (Pacific Madrone)

$$ADBH = \frac{(DBH + 0.03425)}{0.98155} \quad 1$$

$$OUTERVOL = 0.0000378129 \times \left(ADBH^{1.99295}\left(HT^{1.01532}\right)\right) \quad 2$$

$$INNERVOL = 0.0000378129 \times \left(DBH^{1.99295}\left(HT^{1.01532}\right)\right) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 35 (Oregon White Oak)

$$ADBH = \frac{(DBH + 0.78034)}{0.95956} \quad 1$$

$$OUTERVOL = 0.0000236325 \times \left(ADBH^{2.25575}\left(HT^{0.87108}\right)\right) \quad 2$$

$$INNERVOL = 0.0000236325 \times \left(DBH^{2.25575}\left(HT^{0.87108}\right)\right) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 36 (Tanoak)

$$ADBH = \frac{(DBH + 4.1177)}{0.95354} \quad 1$$

$$OUTERVOL = 0.0000081905 \times \left(ADBH^{2.19576}\left(HT^{1.14078}\right)\right) \quad 2$$

$$INNERVOL = 0.0000081905 \times \left(DBH^{2.19576}\left(HT^{1.14078}\right)\right) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 37 (Blue oak)

$$ADBH = \frac{(DBH + 0.44003)}{0.95354} \quad 1$$

$$OUTERVOL = 0.0000204864 \times \left(ADBH^{2.53987}\left(HT^{0.50591}\right)\right) \quad 2$$

$$INNERVOL = 0.0000204861 \times \left(DBH^{2.53987}\left(HT^{0.50591}\right)\right) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 38 BIOPAK EQUATION

$$\mathrm{BB} = 3.3 + 9.0 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 39 BIOPAK EQUATION 936

$$\mathrm{BB} = -1.2 + 24.0 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

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 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

$$\mathrm{BLB} = 13.0 + 12.4 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 2 BIOPAK EQUATION 919

$$\mathrm{BLB} = 3.6 + 44.2 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 3 BIOPAK EQUATION 28

$$\mathrm{BLB} = \exp\left(-4.1817 + 2.3324 \times \log\left(DBH\right)\right)$$

EQUATION 4 BIOPAK EQUATION 877

$$\mathrm{BLB} = 16.8 + 14.4 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 5 BIOPAK EQUATION 847

$$\mathrm{BLB} = 9.7 + 22.0 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 6 BIOPAK EQUATION 2

$$\mathrm{BLB} = \exp\left(-3.6941 + 2.1382 \times \log\left(DBH\right)\right)$$

EQUATION 7 BIOPAK EQUATION 702

$$\mathrm{BLB} = \exp\left(-4.1068 + 1.5177 \times \log\left(DBH\right) + 1.0424 \times \log\left(HT\right)\right)$$

EQUATION 8

$$\mathrm{BLB} = \exp\left(-7.637 + 3.3648 \times \log\left(DBH\right)\right)$$

EQUATION 9 BIOPAK EQUATION 901

$$\mathrm{BLB} = 9.5 + 16.8 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 10 BIOPAK EQUATION 459

$$\mathrm{BLB} = 0.199 + 0.00381 \times DBH^2 \times HT$$

EQUATION 11 BIOPAK EQUATION 907

$$\mathrm{BLB} = 7.8 + 12.3 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 12

$$\mathrm{BLB} = \exp\left(-4.570 + 2.271 \times \log\left(DBH\right)\right)$$

EQUATION 13 BIOPAK EQUATION 51

$$\mathrm{BLB} = \exp\left(-7.2775 + 2.3337 \times \log\left(DBH \times \pi\right)\right)$$

EQUATION 14 BIOPAK EQUATION 944

$$\mathrm{BLB} = 1.7 + 26.2 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 15 BIOPAK EQUATION 932

$$\mathrm{BLB} = 2.5 + 36.8 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 16

$$\mathrm{BLB} = \exp\left(-4.5648 + 2.6232 \times \log\left(DBH\right)\right) - BF$$

where: $$\mathrm{BF} = \left(\exp\left(-4.5648 + 2.6232 \times \log\left(DBH\right)\right)\right) \times \frac{1}{(2.7638 + 0.062 \times DBH^{1.3364}}$$

EQUATION 17

$$\mathrm{BLB} = \exp\left(-5.2581 + 2.6045 \times \log\left(DBH\right)\right)$$

EQUATION 18 BIOPAK EQUATION 883

$$\mathrm{BLB} = 4.5 + 22.7 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 19 BIOPAK EQUATION 925

$$\mathrm{BLB} = 5.3 + 9.7 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 20 BIOPAK EQUATION 895

$$\mathrm{BLB} = 20.4 + 7.7 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 21 BIOPAK EQUATION 446

$$\mathrm{BLB} = 0.626 + 0.00079 \times DBH^2 \times HT$$

EQUATION 22 BIOPAK EQUATION 859

$$\mathrm{BLB} = 12.6 + 23.5 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 23 Weyerhaeuser Co Equation

$$\mathrm{BLB} = 0.047 + 0.00413 \times DBH^2 \times HT$$

EQUATION 24 BIOPAK EQUATION 913

$$\mathrm{BLB} = 4.2 + 17.4 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 25 BIOPAK EQUATION 950

$$\mathrm{BLB} = -0.6 + 45.1 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 26 BIOPAK EQUATION 938

$$\mathrm{BLB} = 8.1 + 21.5 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 27 Snell et.al 1983, bigleaf maple

$$\mathrm{BLB} = \exp\left(4.0543553 + 2.1505 \times \log\left(DBH\right)\right)\left(1 - \frac{1}{(4.6762 + 0.0163 \times DBH^{2.039})}\right) \Big/ 1000$$

EQUATION 28 Snell et.al 1983, pacific madrone

$$BLB = \exp\left(3.0136553 + 2.4839 \times \log(DBH)\right)\left(1 - \frac{1}{(1.6013 + 0.1060 \times DBH^{1.309})}\right) \Big/ 1000$$

EQUATION 29 Snell et.al 1983, giant chinkapin

$$BLB = \exp\left(3.1980553 + 2.2699 \times \log(DBH)\right)\left(1 - \frac{1}{1.6048 + 0.2979 \times DBH^{0.6828}}\right) \Big/ 1000$$

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