Volume estimation for the PNW-FIA Integrated Database

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 gound to tip, current annual growth volume, and annual mortality volume. These volumes are calculated on different sized trees (in terms of diameter at breast height (DBH), depending on the specific type of volume.

All total stem volumes are calculated on all trees in the inventory that are larger than seedlings (>= 1" (2.5cm) DBH).

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 is generally the first output from volume equations and 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.

Cubic volume is referred to as growing-stock volume, which is the volume of a tree, from a 1-foot stump to a 4" top, calculated on all trees >= 5" (12.5cm) DBH.
Board foot volume is referred to as 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" (22.5cm) DBH; and for hardwoods, it is the volume of a tree from a 1-foot stump to an 8" top, calculated for hardwood species >= 11" (27.5cm) DBH.

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 DBH of:	Volume name in equations
All softwoods and hardwoods:		
Volume of the total stem, ground to tip	>= 1” (2.5cm)	CVTS
Volume from a 1-foot stump to the tip	>= 1” (2.5cm)	CVT
Volume from a 1-foot stump to a 4-inch top	>= 5” (12.5cm)	CV4
Softwood sawlog volume:		
Volume from a 1-foot stump to a 6-inch top	>= 9” (22.5cm)	CV6
Hardwood sawlog volume:		
Volume from a 1-foot stump to an 8-inch top	>= 11” (27.5cm)	CV8

BOARD FOOT VOLUME (square feet)

Type of Volume	Calculated on trees with a DBH 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” (22.5cm)	SV616
Scribner volume, 32-foot log rule, 1-foot stump to a 6-inch top (Western OR; Western WA)	>= 9” (22.5cm)	SV632
International 1/4" volume, 16-foot log rule, 1-foot stump to a 6-inch top (all states)	>= 9” (22.5cm)	XINT6
Hardwoods:		
Scribner volume, 16-foot log rule 1-foot stump to an 8-inch top (all states)	>=11” (27.5cm)	SV816
International 1/4" volume, 8-foot log rule, 1-foot stump to an 8-inch top (all states)	>= 11” (27.5cm)	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 Eqns. 1,2,4,6-15,17,21,22,24
Hardwood Eqns. 1-7

1. Calculate CVTS from published or documented volume equations for the species.
2. Calculate the TARIF number from CVTS, using the equation in DNR note #27.
3. Calculate CV4 from the TARIF number and tree basal area.
4. Calculate CVT from the TARIF number and DBH.

CUBIC VOLUME Method 2: The TARIF number is based on CV4.
Softwood Eqns. 3,5,16,18-20,23

5. Calculate CV4 directly from published equations, using DBH and height.
6. Calculate the TARIF number from CV4 and tree basal area.
7. If the tree >= 6" DBH then Calculate CVTS from CV4.
8. If the tree < 6" DBH then adjust the TARIF before calculating CVTS.
9. Calculate CVT from the TARIF number and DBH.

CUBIC VOLUME Method 3: The TARIF number is based on CV8.
Hardwood Eqns. 8-20

10. Calculate CVTS, CV4, and CV8 directly from published equations;
11. Calculate TARIF from CV8.
12. Calculate CVT from CV8.

For all trees:

13. CALCULATE CONVERSION RATIOS: 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

Species Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
11	Pacific silver fir	11	11	10	10	--
14	Bristlecone fir	--	--	--	--	18
15	White fir	23	--	10	--	23
17	Grand fir	11	11	10	10	23
19	Subalpine fir	11	11	10	10	18
20	California red fir	--	--	--	--	18
21	Shasta red fir	18	18	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
56	Mcnabb cypress	--	--	--	--	19
62	California juniper	--	--	--	--	21
64	Western juniper	21	21	21	21	21
65	Utah juniper	--	--	--	--	21
72	Subalpine larch	--	22	--	22	--
73	Western larch	--	22	22	22	--
81	Incense cedar	19	19	19	19	19
92	Brewer spruce	13	--	13	--	12
93	Engelmann spruce	13	13	12	12	12
98	Sitka spruce	13	13	--	--	12
101	Whitebark pine	15	15	15	15	20
102	Bristlecone pine	--	--	--	--	16
103	Knobcone pine	15	--	15	--	16
104	Foxtail pine	--	--	--	--	16
108	Lodgepole pine	15	15	15	15	16
109	Coulter pine	--	--	--	--	5
113	Limber pine	15	--	15	--	16
116	Jeffrey pine	5	--	4	--	5
117	Sugar pine	20	20	20	20	20
119	Western white pine	15	15	15	15	20
120	Bishop pine	--	--	--	--	16
122	Ponderosa pine	5	4*	4*	4*	5
124	Monterey pine	--	--	--	--	16
127	Gray pine	--	--	--	--	5
130	Scotch pine	17	17	17	17	17
133	Singleleaf pinyon	--	--	--	--	21
137	Washoe pine	--	--	--	--	5
201	Bigcone Douglas-fir	--	--	--	--	3
202	Douglas-fir	1	1	2	2	3
211	Redwood	24	--	--	--	24
212	Giant Sequoia	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	Unknown Conifer	17	17	17	17	17

* Equation 5 was used for all trees < 5” dbh, in all states

There are 24 equations used to estimate softwood cubic-foot volume. Each equation below has been crosswalked to a particular tree species in the table above. A brief reference for each equation is listed below—the full citation is at the end of this document.
Click on an equation number to view the actual equation and procedure used to estimate volume.

EQUATION 1 DOUGLAS-FIR	(WEYERHAUSER-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 5 PONDEROSA PINE	Used for all trees <5” dbh, in all states
EQUATION 6 W.HEMLOCK	(DNR NOTE 27,4/79)
EQUATION 7 W.HEMLOCK	(BROWN (1962) BC FOREST SERV,P33)
EQUATION 8 REDCEDAR	(REDCEDAR INTERIOR--DNR RPT#24,1977)
EQUATION 9 REDCEDAR	(REDCEDAR COAST--DNR RPT#24,1977)
EQUATION10 TRUE FIRS	(INTERIOR BALSAM--DNR RPT#24,1977)
EQUATION11 TRUE FIRS	(COAST BALSAM--DNR RPT#24,1977)
EQUATION12 SPRUCE	(SITKA SPRUCE INTERIOR--DNR RPT#24,1977)
EQUATION13 SPRUCE	(SITKA SPRUCE MATURE--DNR RPT#24,1977)
EQUATION15 LODGEPOLE PINE	(LODGEPOLE PINE--DNR RPT#24,1977)
EQUATION16 LODGEPOLE PINE	(USDA-FS RES NOTE PNW-266)
EQUATION17 MTN.HEMLOCK	(BELL, OSU RES.BULL 35)
EQUATION18 SHASTA RED FIR	(USDA-FS RES NOTE PNW-266)
EQUATION19 INCENSE CEDAR	(USDA-FS RES NOTE PNW-266)
EQUATION20 SUGAR PINE	(USDA-FS RES NOTE PNW-266)
EQUATION21 W.JUNIPER	(CHITTESTER,1984)
EQUATION22 W.LARCH	(LARCH--DNR RPT#24,1977)
EQUATION23 WHITE FIR	(USDA-FS RES NOTE PNW-266)
EQUATION24 REDWOOD	(Krumland, B.E. and L.E. Wensel. 1975.)

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/ACRE (DBH IN INCHES) $BA = 0.005454154 \times DBH^2$
CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE NO.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/ACRE (DBH IN INCHES) $BA = 0.005454154 \times DBH^2$
CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE NO.27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 3

TMP_DBH = *DBH*

If DBH < 6.0 **inches then TMP_DBH** = **6.0 inches and BA** = $6^2 \times 0.005454154$

$$\textbf{CF4} = 0.248569 + 0.0253524 \times \frac{HT}{TMP\_DBH} - 0.0000560175 \times \left(\frac{HT^2}{TMP\_DBH} \right) \quad (1)$$

IF CF4 < 0.3 THEN CF4 = 0.3
IF CF4 > 0.4 THEN CF4 = 0.4

$$\textbf{CV4} = 0.005454154 \times TMP\_DBH^2 \times HT \times CF4 \quad (2)$$

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

IF TMP_DBH > 6.0 THEN

$$\textbf{CVTS} = CV4 \times \frac{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0} \right) \right) \right) \right) \times \left(BA + 0.087266 \right) - 0.174533 \right)}{\left(BA - 0.087266 \right)} \quad (4)$$

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

IF TMP_DBH = 6.0 THEN

$$\textbf{SMALL\_TARIF} = 0.5 \times \left(6.0 - DBH \right)^2 + \left(1.0 + 0.063 \times \left(6.0 - DBH \right)^2 \times TARIF \right) \quad (3)$$

IF SMALL_TARIF <= 0.0 THEN SMALL_TARIF = 0.01

$$\textbf{CVTS} = SMALL\_TARIF \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0} \right) \right) \right) \right) \times \left(BA + 0.087266 \right) - 0.174533 \right) \quad (4)$$

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

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA/ACRE (DBH IN INCHES) $BA = 0.005454154 \times DBH^2$
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE NO.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/ACRE (DBH IN INCHES) $BA = 0.005454154 \times DBH^2$
CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE NO.27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 5

TMP_DBH = *DBH*

If DBH < 6.0 **inches then TMP_DBH** = **6.0 inches and BA** = $6^2 \times 0.005454154$

$$\textbf{CF4} = 0.402060 - 0.899914 \times \left(\frac{1}{TMP\_DBH} \right) \quad (1)$$

IF CF4 < 0.3 THEN CF4 = 0.3
IF CF4 > 0.4 THEN CF4 = 0.4

$$\textbf{CV4} = 0.005454154 \times TMP\_DBH^2 \times HT \times CF4 \quad (2)$$

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

IF TMP_DBH > 6.0 THEN

$$\textbf{CVTS} = CV4 \times \frac{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0} \right) \right) \right) \right) \times \left(BA + 0.087266 \right) - 0.174533 \right)}{\left(BA - 0.087266 \right)} \quad (4)$$

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

IF TMP_DBH = 6.0 THEN

$$\textbf{SMALL\_TARIF} = 0.5 \times \left(6.0 - DBH \right)^2 + \left(1.0 + 0.063 \times \left(6.0 - DBH \right)^2 \times TARIF \right) \quad (3)$$

IF SMALL_TARIF <= 0.0 THEN SMALL_TARIF = 0.01

$$\textbf{CVTS} = SMALL\_TARIF \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0} \right) \right) \right) \right) \times \left(BA + 0.087266 \right) - 0.174533 \right) \quad (4)$$

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

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA/ACRE (DBH IN INCHES) $BA = 0.005454154 \times DBH^2$
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE NO.27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 6

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

CVTS=10**CVTSL

(2)

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

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

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

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA/ACRE (DBH IN INCHES) $BA = 0.005454154 \times DBH^2$
CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE NO.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/ACRE (DBH IN INCHES) $BA = 0.005454154 \times DBH^2$
CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE NO.27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 8

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

CVTS=10**CVTSL

(2)

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

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

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

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA/ACRE (DBH IN INCHES) $BA = 0.005454154 \times DBH^2$
CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE NO.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/ACRE (DBH IN INCHES) $BA = 0.005454154 \times DBH^2$
CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE NO.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/ACRE (DBH IN INCHES) $BA = 0.005454154 \times DBH^2$
CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE NO.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/ACRE (DBH IN INCHES) $BA = 0.005454154 \times DBH^2$
CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE NO.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/ACRE (DBH IN INCHES) $BA = 0.005454154 \times DBH^2$
CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE NO.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/ACRE (DBH IN INCHES) $BA = 0.005454154 \times DBH^2$
CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE NO.27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 14

NOT USED

Equation 15

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

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/ACRE (DBH IN INCHES) $BA = 0.005454154 \times DBH^2$
CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE NO.27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 16

TMP_DBH = *DBH*

If DBH < 6.0 **inches then TMP_DBH** = **6.0 inches and BA** = $6^2 \times 0.005454154$

$$\textbf{CF4} = 0.422709 - 0.0000612236 \times \left(\frac{HT^2}{TMP\_DBH} \right) \quad (1)$$

IF CF4 < 0.3 THEN CF4 = 0.3
IF CF4 > 0.4 THEN CF4 = 0.4

$$\textbf{CV4} = 0.005454154 \times TMP\_DBH^2 \times HT \times CF4 \quad (2)$$

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

IF TMP_DBH > 6.0 THEN

$$\textbf{CVTS} = CV4 \times \frac{\left(\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0} \right) \right) \right) \right) \times \left(BA + 0.087266 \right) - 0.174533 \right) \right)}{\left(BA - 0.087266 \right)} \quad (4)$$

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

IF TMP_DBH = 6.0 THEN

$$\textbf{SMALL\_TARIF} = 0.5 \times \left(6.0 - DBH \right)^2 + \left(1.0 + 0.063 \times \left(6.0 - DBH \right)^2 \times TARIF \right) \quad (3)$$

IF SMALL_TARIF <= 0.0 THEN SMALL_TARIF = 0.01

$$\textbf{CVTS} = SMALL\_TARIF \times \left(\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0} \right) \right) \right) \right) \times \left(BA + 0.087266 \right) - 0.174533 \right) \right) \quad (4)$$

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

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA/ACRE (DBH IN INCHES) $BA = 0.005454154 \times DBH^2$
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE NO.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/ACRE (DBH IN INCHES) $BA = 0.005454154 \times DBH^2$
CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE NO.27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 18

TMP_DBH = *DBH*

If DBH < 6.0 **inches then TMP_DBH** = **6.0 inches and BA** = $6^2 \times 0.005454154$

$$\textbf{CF4} = 0.231237 + 0.028176 \times \left(\frac{HT}{TMP\_DBH} \right) \quad (1)$$

IF CF4 < 0.3 THEN CF4 = 0.3
IF CF4 > 0.4 THEN CF4 = 0.4

$$\textbf{CV4} = 0.005454154 \times TMP\_DBH^2 \times HT \times CF4 \quad (2)$$

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

IF TMP_DBH > 6.0 THEN

$$\textbf{CVTS} = CV4 \times \frac{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0} \right) \right) \right) \right) \times (BA + 0.087266) - 0.174533 \right)}{(BA - 0.087266)} \quad (4)$$

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

IF TMP_DBH = 6.0 THEN

$$\textbf{SMALL\_TARIF} = 0.5 \times (6.0 - DBH)^2 + \left(1.0 + 0.063 \times (6.0 - DBH)^2 \times TARIF \right) \quad (3)$$

IF SMALL_TARIF <= 0.0 THEN SMALL_TARIF = 0.01

$$\textbf{CVTS} = SMALL\_TARIF \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times \exp\left(-4.015292 \times \left(\frac{DBH}{10.0} \right) \right) \right) \right) \times \left(BA + 0.087266 \right) - 0.174533 \right) \quad (4)$$

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

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA/ACRE (DBH IN INCHES) $BA = 0.005454154 \times DBH^2$
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE NO.27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 19

TMP_DBH = *DBH*

If DBH < 6.0 **inches then TMP_DBH** = **6.0 inches and BA** = $6^2 \times 0.005454154$

$$\textbf{CF4} = 0.225786 + 4.44236 \times \left(\frac{1}{HT}\right) \quad (1)$$

IF CF4 < 0.27 THEN CF4 = 0.27

$$\textbf{CV4} = 0.005454154 \times TMP\_DBH^2 \times HT \times CF4 \quad (2)$$

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

IF TMP_DBH > 6.0 THEN

$$\textbf{CVTS} = CV4 \times \frac{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{(BA - 0.087266)} \quad (4)$$

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

IF TMP_DBH = 6.0 THEN

$$\textbf{SMALL\_TARIF} = 0.5 \times (6.0 - DBH)^2 + \left(1.0 + 0.063 \times (6.0 - DBH)^2 \times TARIF\right) \quad (3)$$

IF SMALL_TARIF <= 0.0 THEN SMALL_TARIF = 0.01

$$\textbf{CVTS} = SMALL\_TARIF \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right) \quad (4)$$

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

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA/ACRE (DBH IN INCHES) $BA = 0.005454154 \times DBH^2$
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE NO.27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP
DBH = DIAMETER BREAST HEIGHT IN CENTIMETERS
HT = HEIGHT IN METERS

Equation 20

TMP_DBH = *DBH*

If DBH < 6.0 **inches then TMP_DBH** = **6.0 inches and BA** = $6^2 \times 0.005454154$

$$\textbf{CF4} = 0.358550 - 0.488134 \times \left(\frac{1}{TMP\_DBH} \right) \quad (1)$$

IF CF4 < 0.3 THEN CF4 = 0.3
IF CF4 > 0.4 THEN CF4 = 0.4

$$\textbf{CV4} = 0.005454154 \times TMP\_DBH^2 \times HT \times CF4 \quad (2)$$

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

IF TMP_DBH > 6.0 THEN

$$\textbf{CVTS} = CV4 \times \frac{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0} \right) \right) \right) \right) \times (BA + 0.087266) - 0.174533 \right)}{(BA - 0.087266)} \quad (4)$$

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

IF TMP_DBH = 6.0 THEN

$$\textbf{SMALL\_TARIF} = 0.5 \times (6.0 - DBH)^2 + \left(1.0 + 0.063 \times (6.0 - DBH)^2 \times TARIF \right) \quad (3)$$

IF SMALL_TARIF <= 0.0 THEN SMALL_TARIF = 0.01

$$\textbf{CVTS} = SMALL\_TARIF \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0} \right) \right) \right) \right) \times (BA + 0.087266) - 0.174533 \right) \quad (4)$$

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

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA/ACRE (DBH IN INCHES) $BA = 0.005454154 \times DBH^2$
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE NO.27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 21

$$\mathbf{CVTS} = 0.005454154 \times \left[0.30708901 + 0.00086157622 \times HT - 0.0037255243 \times DBH \times \frac{HT}{HT - 4.5} \right] \times DBH^2 \times HT \times \left(\frac{HT}{HT - 4.5} \right)^2 \quad (1)$$

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

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

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

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA/ACRE (DBH IN INCHES) $BA = 0.005454154 \times DBH^2$
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE NO.27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 22

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

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

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

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

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

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA/ACRE (DBH IN INCHES) $BA = 0.05454154 \times DBH^2$
CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE NO.27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 23

TMP_DBH = *DBH*

If DBH < 6.0 **inches then TMP_DBH** = **6.0 inches and BA** = $6^2 \times 0.005454154$

$$\textbf{CF4} = 0.299039 + 1.91272 \times \left(\frac{1}{HT}\right) + 0.0000367217 \times \frac{\left(HT^2\right)}{TMP\_DBH} \quad (1)$$

IF CF4 < 0.3 THEN CF4 = 0.3
IF CF4 > 0.4 THEN CF4 = 0.4

$$\textbf{CV4} = 0.005454154 \times TMP\_DBH^2 \times HT \times CF4 \quad (2)$$

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

IF TMP_DBH > 6.0 THEN

$$\textbf{CVTS} = CV4 \times \frac{\left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right)}{(BA - 0.087266)} \quad (4)$$

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

IF TMP_DBH = 6.0 THEN

$$\textbf{SMALL\_TARIF} = 0.5 \times (6.0 - DBH)^2 + \left(1.0 + 0.063 \times (6.0 - DBH)^2 \times TARIF\right) \quad (3)$$

IF SMALL_TARIF <= 0.0 THEN SMALL_TARIF = 0.01

$$\textbf{CVTS} = SMALL\_TARIF \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533\right) \quad (4)$$

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

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA/ACRE (DBH IN INCHES) $BA = 0.05454154 \times DBH^2$
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE NO.27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

Equation 24

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

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

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

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

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA/ACRE (DBH IN INCHES) $BA = 0.05454154 \times DBH^2$
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE NO.27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

SOFTWOOD BOARDFOOT VOLUME EQUATIONS

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

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

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)

SOFTWOOD VOLUME EQUATION SOURCES

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)

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.

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)

Chambers, Charles and Bruce Foltz. 1979. The TARIF system--revisions and additions. DNR Note #27. State of Washington, Department of Natural Resources. (see page 2)

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.Forest Research Lab, School of Forestry, Oregon State University, Corvallis, OR. (see page 6)

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)

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)

HARDWOOD CUBIC VOLUME EQUATIONS

Species Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
312	Bigleaf maple	37	26	37	26	37
313	Boxelder	--	--	--	--	38
321	Rocky Mountain maple	--	--	--	--	--
322	Bigtooth maple	--	--	--	--	--
330	California buckeye	--	--	--	--	43
341	Tree of heaven	--	--	--	--	26
351	Red alder	26	25	26	25	26
352	White alder	26	--	26	--	26
361	Pacific madrone	40	26	40	26	40
374	Water birch	--	--	--	--	26
375	Paper birch	--	--	--	--	--
376	Western paper birch	--	26	--	26	--
431	Golden chinkapin	32	26	--	26	32
475	Curlleaf mountain-mahogany	--	--	45	--	45
492	Pacific dogwood	--	26	--	26	26
500	Hawthorn	--	--	--	--	--
510	Eucalyptus	26	--	--	--	31
542	Oregon ash	38	26	38	26	38
590	Holly	26	26	26	26	26
600	Walnut	26	26	26	--	38
631	Tanoak	34	--	--	--	34
660	Apple	26	26	26	26	42
730	California sycamore	26	26	26	26	42
740	Cottonwood and poplar	--	--	--	--	--
741	Balsam poplar	--	--	--	--	--
742	Eastern cottonwood	--	--	--	--	--
745	Plains cottonwood	--	--	--	--	--
746	Quaking aspen	26	26	26	26	28
747	Black cottonwood	26	26	26	26	27
748	Fremont poplar	--	--	--	--	27
755	Mesquite	--	--	--	--	--
760	Cherry	26	26	26	26	26
800	Oak-deciduous	--	--	--	--	43
801	California live oak	--	--	--	--	43
805	Canyon live oak	42	--	--	--	42
807	Blue oak	--	--	--	--	39
810	Emory oak	--	--	--	--	--
811	Englemann oak	--	--	--	--	36
815	Oregon white oak	41	26	41	26	41
818	California black oak	41	--	41	26	41
821	California white oak	--	--	--	--	35
839	Interior live oak	--	--	--	--	44
901	Black locust	--	--	--	--	41
920	Willow	26	26	26	26	40
981	California-laurel	33	--	--	--	33
998	Unknown hardwood	26	26	26	26	41
999	Unknown Tree	26	26	26	26	41

HARDWOOD VOLUME EQUATION SOURCE

EQUATION 25	ALDER	(CURTIS/BRUCE, PNW-56)
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)
EQUATION34	TANOAK	(PILLSBURY (H,D), CHARLES BOLSINGER 1/3/83)
EQUATION35	CALIF WHITE OAK	(PILLSBURY (H,D), CHARLES BOLSINGER 1/3/83)
EQUATION36	ENGELMANN OAK	(PILLSBURY (H,D), CHARLES BOLSINGER 1/3/83)
EQUATION37	BIGLEAF MAPLE	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION38	CALIF BLACK OAK	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION39	BLUE OAK	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION40	PACIFIC MADRONE	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION41	ORE WHITE OAK	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION42	CANYON LIVE OAK	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION43	COAST LIVE OAK	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION44	INT LIVE OAK	(PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)
EQUATION45	MTN. MAHOGANY	(Chojnacky, 1985)

HARDWOOD CUBIC VOLUME EQUATIONS

EQUATION 25

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

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

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

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

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

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

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

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

$$\mathbf{CV4X} = CV4$$

WHERE:
DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)
HT = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA
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)

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

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

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

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

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

$$\mathbf{CV4X} = CV4$$

WHERE

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)
HT = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA
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)

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

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

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

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

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

$$\mathbf{CV4X} = CV4$$

WHERE

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)
HT = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA
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)

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

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

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

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

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

$$\mathbf{CV4X} = CV4$$

WHERE

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)
HT = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA
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)

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

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

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

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

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

$$\mathbf{CV4X} = CV4$$

WHERE

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)
HT = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA
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)

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

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

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

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

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

$$\mathbf{CV4X} = CV4$$

WHERE

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)
HT = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA
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

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

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

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

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

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

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

$$\mathbf{CV4X} = CV4$$

WHERE

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)
HT = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA
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

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

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

$$\mathbf{CV8} = 0.0018985111 \times DBH^{2.38285} \times HT^{0.77105} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$
$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)}$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

WHERE

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)
HT = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA
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
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

$$\mathbf{CVTS} = 0.0058870024 \times DBH^{1.94165} \times HT^{0.86562} \quad (1)$$

$$\mathbf{CV4} = 0.0005774970 \times DBH^{2.19576} \times HT^{1.14078} \quad (2)$$

$$\mathbf{CV8} = 0.0002526443 \times DBH^{2.30949} \times HT^{1.21069} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$
$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)}$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

WHERE

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)
HT = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA
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
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

$$\mathbf{CVTS} = 0.0191453191 \times DBH^{2.40248} \times HT^{0.28060} \quad (1)$$

$$\mathbf{CV4} = 0.0053866353 \times DBH^{2.61268} \times HT^{0.31103} \quad (2)$$

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
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
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
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
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

$$\mathbf{CVTS} = 0.0067322665 \times DBH^{1.96628} \times HT^{0.83458} \quad (1)$$

$$\mathbf{CV4} = 0.0025616425 \times DBH^{1.99295} \times HT^{1.01532} \quad (2)$$

$$\mathrm{CV8} = 0.0006181530 \times DBH^{1.72635} \times HT^{1.26462} \times FC^{0.37868} \quad (3)$$

$$\mathrm{CVT} = CVTS * RTS \quad (4)$$

$$RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)} \quad (4)$$

$$\mathbf{CV4X} = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \quad (5)$$

$$\mathbf{TARIF} = \frac{(CV8 \times 0.912733)}{\left(\left(0.983 - o.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266) \right)} \quad (6)$$

WHERE

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)
HT = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA
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
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
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
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
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

CVTS = $(A + B \times DSXH^{.3333} + C \times D)^3$

WHERE

A = -0.13363
B = 0.128222
C = 0 .080208
D = 1
DSXH = $DRC \times DRC \div THT$ DRC is diameter at root collar and THT is total height

Mountain mahogany
Cubic foot volume of all wood and bark to a 1.5 inch branch diameter
From INT-339, Chojnacky, 1985
Pinyon-Juniper Volume Equations for the Central Rocky Mountain States

HARDWOOD BOARDFOOT VOLUME EQUATIONS

$$\textbf{CUBUS} = CV4 - CV8 \quad (1)$$

$$\textbf{RC6} = 0.993 - 0.993 \times 0.62^{(DBH-6.0)} \quad (2)$$

IF EQN < 8 THEN CV4X =CVT

TARIFX = TARIF

$$\text{CV4X} = \text{CVT} \times 0.99875 - \frac{43.336}{\text{DBH}^3} - \frac{124.717}{\text{DBH}^4} + \frac{0.193437 \times \text{HT}}{\text{DBH}^3} + \frac{479.83}{\text{DBH}^3 \times \text{HT}}$$

$$\text{TARIFX} = \frac{\text{CV8} \times 0.912733}{0.983 - 0.983 \times 0.65^{\text{DBH}-8.6} \times \text{BA} - 0.087266}$$

$$\textbf{CV6} = RC6 \times CV4X \quad (3)$$

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

$$\text{RS616L} = 0.174439 + 0.117594 \times \log(DBH) \times \log(B4) - \frac{8.210585}{DBH^2} + 0.236693 \times \log(B4) - 0.00001345 \times (B4)^2 - 0.00001937 \times DBH^2 \quad (4)$$

$$\textbf{RS616} = 10.0^{RS616L} \quad (5)$$

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

$$\textbf{RI6} = -2.904154 + 3.466328 \times log(DBH \times TARIF) - 0.02765985 \times DBH - 0.00008205 \times TARIF^2 + \frac{11.29598}{DBH^2} \quad (6)$$

$$\textbf{XINT6} = RI6 \times CV6 \quad (7)$$

$$RS616 = 0.990 - 0.58 \times \left(0.484^{DBH-9.5}\right) \quad (8)$$

$$SV816 = RS816 \times SV616 \quad (9)$$

$$RI8 = 0.990 - 0.55 \times \left(0.485^{DBH-9.5}\right) \quad (10)$$

$$XINT8 = XINT6 \times RI8 \quad (11)$$

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 8-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)

HARDWOOD VOLUME EQUATION SOURCES

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.

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)

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

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.