

# FIA Volume Equation documentation updated on 9-19-2014

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## 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  $\geq 1$ " DIA, and on dead trees that are  $\geq 5$ " 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  $\geq 5$ " 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  $\geq 9$ " DIA; and for hardwoods, it is the volume of a tree from a 1-foot stump to an 8" top, calculated for hardwood species  $\geq 11$ " DIA.

Note, that the sawlog and upper stem volumes are the cubic volume of sawtimber-sized trees, not to be confused with sawtimber (boardfoot) volume.

The log length for the log rule used in sawtimber (board-foot) calculations differs by species group and location, as follows:

On the west side of Oregon and Washington--  
Scribner volume uses a 32-foot log rule for softwoods, and a 16-foot log rule for hardwoods;  
International 1/4" volume uses a 16-foot log rule for softwoods, and an 8-foot log rule for hardwoods.

On the east side of Oregon and Washington, and all of California--  
Scribner volume uses a 16-foot log rule for softwoods, and a 16-foot log rule for hardwoods;  
International 1/4" volume uses a 16-foot log rule for softwoods, and an 8-foot log rule for hardwoods.

Board foot equations estimate volume of the fractional log up to the specified top diameter. The fractional log is the last log of the tree, which is less than the log rule specification.

The following volume names are used throughout the equations and are defined below:

CUBIC VOLUME (in cubic feet)

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

BOARD FOOT VOLUME (square feet)

| <u>Type of Volume</u>  | <u>Calculated on trees with a DIA of:</u> | <u>Volume name in equations</u> |
|--|---|---------------------------------|
| <u>Softwoods:</u>  |   |                                 |
| Scribner volume, 16-foot log rule, 1-foot stump to a 6-inch top (Eastern OR; Eastern WA; CA) | >= 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                           |
| <u>Hardwoods:</u>  |   |                                 |
| 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.
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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  $\geq 6$ " 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.
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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.
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### 13. CALCULATE CONVERSION RATIOS:

For all trees:

After CVTS and CV4 have been estimated, use equations to calculate the ratios. These ratios are used to convert cubic to board foot volume, and 16 to 32-foot log rules as follows:

| <u>RATIO</u> | <u>Used to convert:</u> |
|--------------|-------------------------|
| RC6          | CV4 to CV6              |
| RC8          | CV4 to CV8 (if needed)  |
| RS616        | CV6 to SV616            |
| RS816        | SV616 to SV816          |
| RS632        | SV616 to SV632          |
| RI6          | CV6 to XINT6            |
| RI8          | XINT6 to XINT8          |

# SOFTWOOD CUBIC VOLUME EQUATIONS

## Volume equation numbers

| Species Code | Species                | Halfstate |     |      |     |      |
|--------------|------------------------|-----------|-----|------|-----|------|
|              |                        | WOR       | WWA | EOR  | EWA | CA   |
| 11           | Pacific silver fir     | 11        | 11  | 10   | 10  | 11   |
| 14           | Bristlecone fir        | --        | --  | --   | --  | 18   |
| 15           | White fir              | 23        | 11  | 10   | 10  | 23   |
| 17           | Grand fir              | 11        | 11  | 10   | 10  | 23   |
| 19           | Subalpine fir          | 11        | 11  | 10   | 10  | 18   |
| 20           | California red fir     | 18        | --  | 10   | --  | 18   |
| 21           | Shasta red fir         | 18        | --  | 18   | --  | 18   |
| 22           | Noble fir              | 11        | 11  | 10   | 10  | 18   |
| 41           | Port-Orford-cedar      | 19        | 19  | 19   | 19  | 8    |
| 42           | Alaska-cedar           | 9         | 9   | 8    | 8   | 8    |
| 50           | Cypress                | --        | --  | --   | --  | 19   |
| 51           | Arizona cypress        | --        | --  | --   | --  | 19   |
| 52           | Baker cypress          | --        | --  | --   | --  | 19   |
| 54           | Monterey cypress       | --        | --  | --   | --  | 19   |
| 55           | Sargent's cypress      | --        | --  | --   | --  | 19   |
| 56           | McNabb cypress         | --        | --  | --   | --  | 19   |
| 62           | California juniper     | --        | --  | --   | --  | 14   |
| 64           | Western juniper        | 21        | 21  | 21   | 21  | 21   |
| 65           | Utah juniper           | --        | --  | --   | --  | 14   |
| 66           | Rocky mountain juniper | --        | --  | 14.2 | --  | 14.2 |
| 72           | Subalpine larch        | --        | 22  | 22   | 22  | --   |
| 73           | Western larch          | 22        | 22  | 22   | 22  | 22   |
| 81           | Incense cedar          | 19        | 19  | 19   | 19  | 19   |
| 92           | Brewer spruce          | 13        | --  | 13   | 13  | 12   |
| 93           | Engelmann spruce       | 13        | 13  | 12   | 12  | 12   |
| 98           | Sitka spruce           | 13        | 13  | 13   | 13  | 12   |
| 101          | Whitebark pine         | 15        | 15  | 15   | 15  | 20   |
| 102          | Bristlecone pine       | --        | --  | --   | --  | 16   |
| 103          | Knobcone pine          | 15        | 15  | 15   | --  | 16   |
| 104          | Foxtail pine           | --        | --  | --   | --  | 16   |
| 108          | Lodgepole pine         | 15        | 15  | 15   | 15  | 16   |
| 109          | Coulter pine           | --        | --  | --   | --  | 5    |
| 113          | Limber pine            | --        | --  | 16   | --  | 16   |
| 116          | Jeffrey pine           | 5         | --  | 4    | --  | 5    |
| 117          | Sugar pine             | 20        | --  | 20   | --  | 20   |
| 119          | Western white pine     | 15        | 15  | 15   | 15  | 20   |
| 120          | Bishop pine            | 16        | --  | 16   | --  | 16   |
| 122          | Ponderosa pine         | 5         | 4   | 4    | 4   | 5    |
| 124          | Monterey pine          | --        | --  | --   | --  | 16   |
| 127          | Gray pine              | --        | --  | --   | --  | 5    |
| 130          | Scotch pine            | 15        | --  | --   | --  | --   |
| 133          | Singleleaf pinyon pine | --        | --  | --   | --  | 14.1 |

## SOFTWOOD CUBIC VOLUME EQUATIONS

### Volume equation numbers (continued)

|              |                              | Halfstate |     |     |     |    |
|--------------|------------------------------|-----------|-----|-----|-----|----|
| Species Code | Species                      | WOR       | WWA | EOR | EWA | CA |
| 137          | Washoe pine                  | --        | --  | --  | --  | 5  |
| 142          | Great Basin bristlecone pine | --        | --  | --  | --  | 16 |
| 201          | Bigcone Douglas-fir          | --        | --  | --  | --  | 3  |
| 202          | Douglas-fir                  | 1         | 1   | 2   | 2   | 3  |
| 211          | Redwood                      | 24        | 24  | 24  | --  | 24 |
| 212          | Giant Sequoia                | 24        | --  | 24  | --  | 24 |
| 231          | Pacific yew                  | 9         | 9   | 8   | 8   | 8  |
| 242          | Western redcedar             | 9         | 9   | 8   | 8   | 8  |
| 251          | California nutmeg            | --        | --  | --  | --  | 8  |
| 263          | Western hemlock              | 6         | 6   | 6   | 6   | 6  |
| 264          | Mountain hemlock             | 17        | 17  | 17  | 17  | 17 |
| 298/299      | Unknown Conifer              | 17        | 17  | 17  | 17  | 17 |

There are many equations used to estimate softwood cubic-foot volume. Each equation below has been cross-walked to a particular tree species in the table above.

Click on an equation number to view the actual equation and procedure used to estimate volume.

## SOFTWOOD VOLUME EQUATION SOURCES

|                               |  |   |
|-------------------------------|--|---|
| <a href="#">EQUATION 1</a>    | <a href="#">DOUGLAS-FIR</a>            | (Brackett, 1973; DNR RPT # 24,1977)           |
| <a href="#">EQUATION 2</a>    | <a href="#">DOUGLAS-FIR</a>            | (DNR MEMO--SUMMERFIELD,11/7/80)               |
| <a href="#">EQUATION 3</a>    | <a href="#">DOUGLAS-FIR</a>            | (USDA-FS RES NOTE PNW-266)                    |
| <a href="#">EQUATION 4</a>    | <a href="#">PONDEROSA PINE</a>         | (DNR MEMO--SUMMERFIELD,11/7/80)               |
| <a href="#">EQUATION 5</a>    | <a href="#">PONDEROSA PINE</a>         | (USDA-FS RES NOTE PNW-266)                    |
| <a href="#">EQUATION 6</a>    | <a href="#">W.HEMLOCK</a>              | (DNR NOTE 27,4/79)                            |
| <a href="#">EQUATION 7</a>    | <a href="#">W.HEMLOCK</a>              | (BROWNE (1962) BC FOREST SERV,P33)            |
| <a href="#">EQUATION 8</a>    | <a href="#">REDCEDAR</a>               | (REDCEDAR INTERIOR--DNR RPT # 24,1977)        |
| <a href="#">EQUATION 9</a>    | <a href="#">REDCEDAR</a>               | (REDCEDAR COAST--DNR RPT # 24,1977)           |
| <a href="#">EQUATION 10</a>   | <a href="#">TRUE FIRS</a>              | (INTERIOR BALSAM--DNR RPT # 24,1977)          |
| <a href="#">EQUATION 11</a>   | <a href="#">TRUE FIRS</a>              | (COAST BALSAM--DNR RPT # 24,1977)             |
| <a href="#">EQUATION 12</a>   | <a href="#">SPRUCE</a>                 | (SITKA SPRUCE INTERIOR--DNR RPT # 24,1977)    |
| <a href="#">EQUATION 13</a>   | <a href="#">SPRUCE</a>                 | (SITKA SPRUCE MATURE--DNR RPT # 24,1977)      |
| <a href="#">EQUATION 14</a>   | <a href="#">Other junipers</a>         | (Chojnacky, 1985)                             |
| <a href="#">EQUATION 14.1</a> | <a href="#">Singleleaf pinyon</a>      | (Chojnacky, 1985)                             |
| <a href="#">EQUATION 14.2</a> | <a href="#">Rocky mountain juniper</a> | (Chojnacky, 1985)                             |
| <a href="#">EQUATION 15</a>   | <a href="#">LODGEPOLE PINE</a>         | (LODGEPOLE PINE--DNR RPT # 24,1977)           |
| <a href="#">EQUATION 16</a>   | <a href="#">LODGEPOLE PINE</a>         | (USDA-FS RES NOTE PNW-266)                    |
| <a href="#">EQUATION 17</a>   | <a href="#">MTN.HEMLOCK</a>            | (BELL, OSU RES.BULL 35)                       |
| <a href="#">EQUATION 18</a>   | <a href="#">SHASTA RED FIR</a>         | (USDA-FS RES NOTE PNW-266)                    |
| <a href="#">EQUATION 19</a>   | <a href="#">INCENSE CEDAR</a>          | (USDA-FS RES NOTE PNW-266)                    |
| <a href="#">EQUATION 20</a>   | <a href="#">SUGAR PINE</a>             | (USDA-FS RES NOTE PNW-266)                    |
| <a href="#">EQUATION 21</a>   | <a href="#">W.JUNIPER</a>              | (CHITTESTER,1984)                             |
| <a href="#">EQUATION 22</a>   | <a href="#">W.LARCH</a>                | (LARCH--DNR RPT # 24,1977)                    |
| <a href="#">EQUATION 23</a>   | <a href="#">WHITE FIR</a>              | (USDA-FS RES NOTE PNW-266)                    |
| <a href="#">EQUATION 24</a>   | <a href="#">REDWOOD</a>                | (Krumland and Wensel 1975; DNR RPT # 24,1977) |

#### Equation 7

Browne, J.E. 1962. Standard cubic-foot volume tables for the commercial tree species of British Columbia. B.C. Forest Service, Victoria. 107 p.

#### Equations 1, 8, 9, 10, 11, 12, 13, 15

Brackett, M. 1973. Notes on TARIF tree volume computation. Res. Management Report 24. WA Dept. of Nat. Resources. Olympia. 26p.

Brackett, Michael. 1977. Notes on TARIF tree-volume computation. DNR report # 24. State of Washington, Department of Natural Resources, Olympia, WA. 132p.  
(see Weyerhaeuser Eqn. #4, page 6)

#### Equations 2, 4

Summerfield, Edward. 1980. In-house memo describing equations for Douglas-fir and ponderosa pine. State of Washington, Department of Natural Resources. On file with the PNW Research Station.

#### Equations 3, 5, 16, 18, 19, 20, 23

MacLean, Colin and John M. Berger. 1976. Softwood tree-volume equations for major California species. PNW Research Note, PNW-266. Pacific Northwest Forest and Range Experiment Station, Portland Oregon. 34p. (see page 4)

#### Equation 6

Chambers, C.J. and Foltz, B. 1979. The TARIF system -- revisions and additions., Resource Management Report # 27. WA Dept. of Nat. Resources. Olympia. (see page 2)

#### Equations 14, 14.1, 14.2

Chojnacky D.C., 1985. Pinyon-Juniper Volume Equations for the Central Rocky Mountain States. Res. Note INT-339, USDA, Forest Service, Intermountain Res. Station, Ogden, UT 84401.

#### Equation 17

Bell, J.F., Marshall, D.D. and Johnson G.P. 1981. Tarif tables for mountain hemlock: developed from an equation of total stem cubic-foot volume. Research Bulletin #35. OSU Forest Research Lab, School of Forestry, Oregon State University, Corvallis, OR. (see page 6)

#### Equation 21

Chittester, Judith and Colin MacLean. 1984. Cubic-foot tree-volume equations and tables for western juniper. Research Note, PNW-420. Pacific Northwest Forest and Range Experiment Station. Portland, Oregon. 8p. (see page 4)

#### Equation 24

Krumland, B.E. and L.E. Wensel. 1975. Preliminary young growth volume tables for coastal California conifers. Research Note #1. In-house memo. Co-op Redwood Yield Research Project. Department of Forestry and Conservation, College of Natural Resources, U of Cal, Berkeley. On file with the PNW Research Station. (see Table 1, page 4)

## Softwood cubic volume equations

### Equation 1

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

$$\text{CVTS} = 10^{**}\text{CVTSL} \quad (2)$$

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

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

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

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<sup>2</sup>

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP



## Equation 2

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

$$CVTS = \exp(CVTSL) \quad (2)$$

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

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

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

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<sup>2</sup>

CVTSL = Natural Log, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

### Equation 3– ( uses PNW 266 formulas from MacLean and Berger)

'FOR THIS SET OF EQUATIONS CREATE A TEMPORARY DBH AND BA for trees less than 6"DBH

IF DBH < 6.0 THEN **TMP\_DBH** = 6.0

'CALCULATE BASAL AREA PER TREE USING DBH AND DBH\_TEMP

**BA** = DBH\*\*2 \* 0.005454154

**BA\_TMP** = TMP\_DBH \*\*2 \* 0.005454154

'CALCULATE A **CUBIC FORM FACTOR** (CF4) USING TMP\_DBH and DBH

'CF4 EQUATIONS VARY BY VOLUME EQUATION

**CF4** = 0.248569 + 0.0253524\*(HT/DBH) - 0.0000560175\*(HT\*\*2/ DBH)

IF(CF4 < 0.3) CF4 =0.3

IF(CF4 > 0.4) CF4 =0.4

**CF4\_TMP** = 0.248569 + 0.0253524\*(HT/TMP\_DBH) - 0.0000560175\*(HT\*\*2/ TMP\_DBH)

IF(CF4\_TMP < 0.3) CF4\_TMP=0.3

IF(CF4\_TMP > 0.4) CF4\_TMP=0.4

'-----

'For ease of use and to improve readability of equations, calculate the following term and use it  
'in the equations that follow. Note that actual DBH and BA are used for all trees.

'Do not use TMP\_DBH or BA\_TMP here.

**TERM** = ((1.033 \* (1.0 + 1.382937 \* EXP(-4.015292 \* (DBH/10.0)))) \* (BA + 0.087266) - 0.174533 )

'-----

IF DBH >= 6.0 THEN

**CV4** = CF4 \* BA \* HT

**TARIF** = (CV4 \* 0.912733) / (BA - 0.087266)

IF (TARIF <= 0.0) TARIF=0.01

**CVTS** = (CV4 \* TERM) / (BA - 0.087266)

**CVT** = TARIF \* (0.9679 - 0.1051 \* 0.5523\*\*(DBH-1.5) ) \* TERM / 0.912733

ELSEIF

DBH < 6.0 THEN

**CV4\_TMP** = CF4\_TMP \* BA\_TMP \* HT

**TARIF\_TMP** = (CV4\_TMP \* 0.912733) / (BA\_TMP - 0.087266)

IF (TARIF\_TMP <= 0.0) TARIF\_TMP = 0.01

'CALCULATE An **ADJUSTED TARIF** FOR SMALL TREES (Both DBH and TMP\_DBH are used)

**TARIF** = TARIF\_TMP \* ( 0.5 \* (TMP\_DBH - DBH)\*\*2 + (1.0 + 0.063 \* (TMP\_DBH - DBH)\*\*2) )

IF (TARIF <= .0.0) TARIF = 0.01

**CVTS** = TARIF \* TERM

**CVT** = TARIF \* (0.9679 - 0.1051 \* 0.5523\*\*(DBH-1.5) ) \* TERM / 0.912733

**CV4** = CF4 \* BA \* HT (calculated with actual DBH and BA)

END IF

IF DBH < 5.0 THEN CV4 = NULL

IF DBH >= 5.0 THEN KEEP CV4 (i.e. don't keep CV4\_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

## Equation 4

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

$$CVTS = \exp(CVTSL) \quad (2)$$

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

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

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

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<sup>2</sup>

CVTSL = Natural Log (ln), CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

## Equation 5 (uses PNW 266 formulas from MacLean and Berger)

'FOR THIS SET OF EQUATIONS CREATE A TEMPORARY DBH AND BA for trees less than 6"DBH

IF DBH < 6.0 THEN **TMP\_DBH** = 6.0

'CALCULATE BASAL AREA PER TREE USING DBH AND DBH\_TEMP

**BA** = DBH\*\*2 \* 0.005454154

**BA\_TMP** = TMP\_DBH \*\*2 \* 0.005454154

'CALCULATE A **CUBIC FORM FACTOR** (CF4) USING TMP\_DBH and DBH

'CF4 EQUATIONS VARY BY VOLUME EQUATION

**CF4** = 0.402060 - 0.899914 \* (1/DBH)

IF(CF4 < 0.3) CF4=0.3

IF(CF4 > 0.4) CF4=0.4

**CF4\_TMP** = 0.402060 - 0.899914 \* (1/TMP\_DBH)

IF(CF4\_TMP < 0.3) CF4\_TMP=0.3

IF(CF4\_TMP > 0.4) CF4\_TMP=0.4

'-----

'For ease of use and to improve readability of equations, calculate the following term and use it  
'in the equations that follow. Note that actual DBH and BA are used for all trees.

'Do not use TMP\_DBH or BA\_TMP here.

**TERM** = ((1.033 \* (1.0 + 1.382937 \* EXP(-4.015292 \* (DBH/10.0)))) \* (BA + 0.087266) - 0.174533 )

'-----

IF DBH >= 6.0 THEN

**CV4** = CF4 \* BA \* HT

**TARIF** = (CV4 \* 0.912733) / (BA - 0.087266)

IF (TARIF <= 0.0) TARIF=0.01

**CVTS** = (CV4 \* TERM) / (BA - 0.087266)

**CVT** = TARIF \* (0.9679 - 0.1051 \* 0.5523\*\*(DBH-1.5) ) \* TERM / 0.912733

ELSEIF

DBH < 6.0 THEN

**CV4\_TMP** = CF4\_TMP \* BA\_TMP \* HT

**TARIF\_TMP** = (CV4\_TMP \* 0.912733) / (BA\_TMP - 0.087266)

IF (TARIF\_TMP <= 0.0) TARIF\_TMP = 0.01

'CALCULATE An **ADJUSTED TARIF** FOR SMALL TREES (Both DBH and TMP\_DBH are used)

**TARIF** = TARIF\_TMP \* ( 0.5 \* (TMP\_DBH - DBH)\*\*2 + (1.0 + 0.063 \* (TMP\_DBH - DBH)\*\*2) )

IF (TARIF <= .0.0) TARIF = 0.01

**CVTS** = TARIF \* TERM

**CVT** = TARIF \* (0.9679 - 0.1051 \* 0.5523\*\*(DBH-1.5) ) \* TERM / 0.912733

**CV4** = CF4 \* BA \* HT (calculated with actual DBH and BA)

END IF

IF DBH < 5.0 THEN CV4 = NULL

IF DBH >= 5.0 THEN KEEP CV4 (i.e. don't keep CV4\_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

## Equation 6

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

$$CVTS = 10^{**}CVTSL \quad (2)$$

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

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

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

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<sup>2</sup>

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

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

$$CVTS = 10^{**}CVTSL \quad (2)$$

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

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

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

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<sup>2</sup>

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

## Equation 8

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

$$CVTS = 10^{**}CVTSL \quad (2)$$

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

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

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

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<sup>2</sup>

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

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

$$CVTS = 10^{**}CVTSL \quad (2)$$

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

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

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

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<sup>2</sup>

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

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

$$CVTS = 10^{**}CVTSL \quad (2)$$

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

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

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

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<sup>2</sup>

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

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

$$CVTS = 10^{**}CVTSL \quad (2)$$

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

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

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

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<sup>2</sup>

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

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

$$CVTS = 10^{**}CVTSL$$

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

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

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

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<sup>2</sup>

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

## Equation 13

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

$$CVTS = 10^{**}CVTSL \quad (2)$$

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

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

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

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<sup>2</sup>

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<sup>1/3</sup>) ) + ( .036329 x S ) )<sup>3</sup>

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<sup>1/3</sup>) ) - ( .016712 x S ) )<sup>3</sup>

IF VOLUME <=0 then VOLUME = 0.1

### WHERE:

VOLUME = cubic foot volume from ground level to a 1.5-inch minimum branch diameter  
(includes live wood, dead wood, and bark)

STEMS = number of stems 3 inches and larger within the first foot above DRC. When STEMS=1 it is a single stemmed tree

DRC (inches) = Diameter at the root collar

HT (feet) = Total height of the tree

**No boardfoot equation is available**

## Equation 14.2

IF (DRC >= 3 AND HT > 0) then Factor = DRC x DRC x HT;

$$\text{VOLUME} = (0.02434 + (0.119106 \times (\text{Factor}^{1/3})) )^3$$

IF VOLUME <=0 then VOLUME = 0.1

WHERE:

VOLUME = cubic foot volume from ground level to a 1.5-inch minimum branch diameter (includes live wood, dead wood, and bark)

DRC (inches) = Diameter at the root collar

HT (feet) = Total height of the tree

**No boardfoot equation is available**

## Equation 15

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

$$\text{CVTS} = 10^{**}\text{CVTSL}$$

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

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

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

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<sup>2</sup>

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

## Equation 16 (uses PNW 266 formulas from MacLean and Berger)

'FOR THIS SET OF EQUATIONS CREATE A TEMPORARY DBH AND BA for trees less than 6"DBH

IF DBH < 6.0 THEN **TMP\_DBH** = 6.0

'CALCULATE BASAL AREA PER TREE USING DBH AND DBH\_TEMP

**BA** = DBH\*\*2 \* 0.005454154

**BA\_TMP** = TMP\_DBH \*\*2 \* 0.005454154

'CALCULATE A **CUBIC FORM FACTOR** (CF4) USING TMP\_DBH and DBH

'CF4 EQUATIONS VARY BY VOLUME EQUATION

**CF4** = 0.422709 - 0.0000612236 \* (HT\*\*2/DBH)

IF(CF4 < 0.3) CF4=0.3

IF(CF4 > 0.4) CF4=0.4

**CF4\_TMP** = 0.422709 - 0.0000612236 \* (HT\*\*2/TMP\_DBH)

IF(CF4\_TMP < 0.3) CF4\_TMP=0.3

IF(CF4\_TMP > 0.4) CF4\_TMP=0.4

'-----

'For ease of use and to improve readability of equations, calculate the following term and use it  
'in the equations that follow. Note that actual DBH and BA are used for all trees.

'Do not use TMP\_DBH or BA\_TMP here.

**TERM** = ((1.033 \* (1.0 + 1.382937 \* EXP(-4.015292 \* (DBH/10.0)))) \* (BA + 0.087266) - 0.174533 )

'-----

IF DBH >= 6.0 THEN

**CV4** = CF4 \* BA \* HT

**TARIF** = (CV4 \* 0.912733) / (BA - 0.087266)

IF (TARIF <= 0.0) TARIF=0.01

**CVTS** = (CV4 \* TERM) / (BA - 0.087266)

**CVT** = TARIF \* (0.9679 - 0.1051 \* 0.5523\*\*(DBH-1.5) ) \* TERM / 0.912733

ELSEIF

DBH < 6.0 THEN

**CV4\_TMP** = CF4\_TMP \* BA\_TMP \* HT

**TARIF\_TMP** = (CV4\_TMP \* 0.912733) / (BA\_TMP - 0.087266)

IF (TARIF\_TMP <= 0.0) TARIF\_TMP = 0.01

'CALCULATE An **ADJUSTED TARIF** FOR SMALL TREES (Both DBH and TMP\_DBH are used)

**TARIF** = TARIF\_TMP \* ( 0.5 \* (TMP\_DBH - DBH)\*\*2 + (1.0 + 0.063 \* (TMP\_DBH - DBH)\*\*2) )

IF (TARIF <= .0.0) TARIF = 0.01

**CVTS** = TARIF \* TERM

**CVT** = TARIF \* (0.9679 - 0.1051 \* 0.5523\*\*(DBH-1.5) ) \* TERM / 0.912733

**CV4** = CF4 \* BA \* HT (calculated with actual DBH and BA)

END IF

IF DBH < 5.0 THEN CV4 = NULL

IF DBH >= 5.0 THEN KEEP CV4 (i.e. don't keep CV4\_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

## Equation 17

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

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

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

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

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<sup>2</sup>

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP



## Equation 18 (uses PNW 266 formulas from MacLean and Berger)

'FOR THIS SET OF EQUATIONS CREATE A TEMPORARY DBH AND BA for trees less than 6"DBH

IF DBH < 6.0 THEN **TMP\_DBH** = 6.0

'CALCULATE BASAL AREA PER TREE USING DBH AND DBH\_TEMP

**BA** = DBH\*\*2 \* 0.005454154

**BA\_TMP** = TMP\_DBH \*\*2 \* 0.005454154

'CALCULATE A **CUBIC FORM FACTOR** (CF4) USING TMP\_DBH and DBH

'CF4 EQUATIONS VARY BY VOLUME EQUATION

**CF4** = 0.231237 + 0.028176 \* (HT/DBH)

IF(CF4 < 0.3) CF4=0.3

IF(CF4 > 0.4) CF4=0.4

**CF4\_TMP** = 0.231237 + 0.028176 \* (HT/TMP\_DBH)

IF(CF4\_TMP < 0.3) CF4\_TMP=0.3

IF(CF4\_TMP > 0.4) CF4\_TMP=0.4

'-----

'For ease of use and to improve readability of equations, calculate the following term and use it  
'in the equations that follow. Note that actual DBH and BA are used for all trees.

'Do not use TMP\_DBH or BA\_TMP here.

**TERM** = ((1.033 \* (1.0 + 1.382937 \* EXP(-4.015292 \* (DBH/10.0)))) \* (BA + 0.087266) - 0.174533 )

'-----

IF DBH >= 6.0 THEN

**CV4** = CF4 \* BA \* HT

**TARIF** = (CV4 \* 0.912733) / (BA - 0.087266)

IF (TARIF <= 0.0) TARIF=0.01

**CVTS** = (CV4 \* TERM) / (BA - 0.087266)

**CVT** = TARIF \* (0.9679 - 0.1051 \* 0.5523\*\*(DBH-1.5) ) \* TERM / 0.912733

ELSEIF

DBH < 6.0 THEN

**CV4\_TMP** = CF4\_TMP \* BA\_TMP \* HT

**TARIF\_TMP** = (CV4\_TMP \* 0.912733) / (BA\_TMP - 0.087266)

IF (TARIF\_TMP <= 0.0) TARIF\_TMP = 0.01

'CALCULATE An **ADJUSTED TARIF** FOR SMALL TREES (Both DBH and TMP\_DBH are used)

**TARIF** = TARIF\_TMP \* ( 0.5 \* (TMP\_DBH - DBH)\*\*2 + (1.0 + 0.063 \* (TMP\_DBH - DBH)\*\*2) )

IF (TARIF <= .0.0) TARIF = 0.01

**CVTS** = TARIF \* TERM

**CVT** = TARIF \* (0.9679 - 0.1051 \* 0.5523\*\*(DBH-1.5) ) \* TERM / 0.912733

**CV4** = CF4 \* BA \* HT (calculated with actual DBH and BA)

END IF

IF DBH < 5.0 THEN CV4 = NULL

IF DBH >= 5.0 THEN KEEP CV4 (i.e. don't keep CV4\_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

## Equation 19 (uses PNW 266 formulas from MacLean and Berger)

'FOR THIS SET OF EQUATIONS CREATE A TEMPORARY DBH AND BA for trees less than 6"DBH

IF DBH < 6.0 THEN **TMP\_DBH** = 6.0

'CALCULATE BASAL AREA PER TREE USING DBH AND DBH\_TEMP

**BA** = DBH\*\*2 \* 0.005454154

**BA\_TMP** = TMP\_DBH \*\*2 \* 0.005454154

'CALCULATE A **CUBIC FORM FACTOR** (CF4) USING TMP\_DBH and DBH

'CF4 EQUATIONS VARY BY VOLUME EQUATION

**CF4** = 0.225786 + 4.44236 \* (1/HT)

IF(CF4 < .27) CF4=.27

**CF4\_TMP** = 0.225786 + 4.44236 \* (1/HT)

IF(CF4\_TMP < .27) CF4\_TMP=.27

'-----

'For ease of use and to improve readability of equations, calculate the following term and use it  
'in the equations that follow. Note that actual DBH and BA are used for all trees.

'Do not use TMP\_DBH or BA\_TMP here.

**TERM** = ((1.033 \* (1.0 + 1.382937 \* EXP(-4.015292 \* (DBH/10.0)))) \* (BA + 0.087266) - 0.174533 )

'-----

IF DBH >= 6.0 THEN

**CV4** = CF4 \* BA \* HT

**TARIF** = (CV4 \* 0.912733) / (BA - 0.087266)

IF (TARIF <= 0.0) TARIF=0.01

**CVTS** = (CV4 \* TERM) / (BA - 0.087266)

**CVT** = TARIF \* (0.9679 - 0.1051 \* 0.5523\*\*(DBH-1.5) ) \* TERM / 0.912733

ELSEIF

DBH < 6.0 THEN

**CV4\_TMP** = CF4\_TMP \* BA\_TMP \* HT

**TARIF\_TMP** = (CV4\_TMP \* 0.912733) / (BA\_TMP - 0.087266)

IF (TARIF\_TMP <= 0.0) TARIF\_TMP = 0.01

'CALCULATE An **ADJUSTED TARIF** FOR SMALL TREES (Both DBH and TMP\_DBH are used)

**TARIF** = TARIF\_TMP \* ( 0.5 \* (TMP\_DBH - DBH)\*\*2 + (1.0 + 0.063 \* (TMP\_DBH - DBH)\*\*2) )

IF (TARIF <= .0.0) TARIF = 0.01

**CVTS** = TARIF \* TERM

**CVT** = TARIF \* (0.9679 - 0.1051 \* 0.5523\*\*(DBH-1.5) ) \* TERM / 0.912733

**CV4** = CF4 \* BA \* HT (calculated with actual DBH and BA)

END IF

IF DBH < 5.0 THEN CV4 = NULL

IF DBH >= 5.0 THEN KEEP CV4 (i.e. don't keep CV4\_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # .27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

## Equation 20 – (uses PNW 266 formulas from MacLean and Berger)

'FOR THIS SET OF EQUATIONS CREATE A TEMPORARY DBH AND BA for trees less than 6"DBH

IF DBH < 6.0 THEN **TMP\_DBH** = 6.0

'CALCULATE BASAL AREA PER TREE USING DBH AND DBH\_TEMP

**BA** = DBH\*\*2 \* 0.005454154

**BA\_TMP** = TMP\_DBH \*\*2 \* 0.005454154

'CALCULATE A **CUBIC FORM FACTOR** (CF4) USING TMP\_DBH and DBH

'CF4 EQUATIONS VARY BY VOLUME EQUATION

**CF4** = 0.358550 - 0.488134 \* (1/DBH)

IF(CF4 < 0.3) CF4=0.3

IF(CF4 > 0.4) CF4=0.4

**CF4\_TMP** = 0.358550 - 0.488134 \* (1/ TMP\_DBH)

IF(CF4\_TMP < 0.3) CF4\_TMP=0.3

IF(CF4\_TMP > 0.4) CF4\_TMP=0.4

'-----

'For ease of use and to improve readability of equations, calculate the following term and use it

'in the equations that follow. Note that actual DBH and BA are used for all trees.

'Do not use TMP\_DBH or BA\_TMP here.

**TERM** = ((1.033 \* (1.0 + 1.382937 \* EXP(-4.015292 \* (DBH/10.0)))) \* (BA + 0.087266) - 0.174533 )

'-----

IF DBH >= 6.0 THEN

**CV4** = CF4 \* BA \* HT

**TARIF** = (CV4 \* 0.912733) / (BA - 0.087266)

IF (TARIF <= 0.0) TARIF=0.01

**CVTS** = (CV4 \* TERM) / (BA - 0.087266)

**CVT** = TARIF \* (0.9679 - 0.1051 \* 0.5523\*\*(DBH-1.5) ) \* TERM / 0.912733

ELSEIF

DBH < 6.0 THEN

**CV4\_TMP** = CF4\_TMP \* BA\_TMP \* HT

**TARIF\_TMP** = (CV4\_TMP \* 0.912733) / (BA\_TMP - 0.087266)

IF (TARIF\_TMP <= 0.0) TARIF\_TMP = 0.01

'CALCULATE An **ADJUSTED TARIF** FOR SMALL TREES (Both DBH and TMP\_DBH are used)

**TARIF** = TARIF\_TMP \* ( 0.5 \* (TMP\_DBH - DBH)\*\*2 + (1.0 + 0.063 \* (TMP\_DBH - DBH)\*\*2) )

IF (TARIF <= .0.0) TARIF = 0.01

**CVTS** = TARIF \* TERM

**CVT** = TARIF \* (0.9679 - 0.1051 \* 0.5523\*\*(DBH-1.5) ) \* TERM / 0.912733

**CV4** = CF4 \* BA \* HT (calculated with actual DBH and BA)

END IF

IF DBH < 5.0 THEN CV4 = NULL

IF DBH >= 5.0 THEN KEEP CV4 (i.e. don't keep CV4\_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # .27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

## Equation 21

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

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

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

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

If 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<sup>2</sup>

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

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

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

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

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

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

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<sup>2</sup>

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

## Equation 23 (uses PNW 266 formulas from MacLean and Berger)

'FOR THIS SET OF EQUATIONS CREATE A TEMPORARY DBH AND BA for trees less than 6"DBH

IF DBH < 6.0 THEN **TMP\_DBH** = 6.0

'CALCULATE BASAL AREA PER TREE USING DBH AND DBH\_TEMP

**BA** = DBH\*\*2 \* 0.005454154

**BA\_TMP** = TMP\_DBH \*\*2 \* 0.005454154

'CALCULATE A **CUBIC FORM FACTOR** (CF4) USING TMP\_DBH and DBH

'CF4 EQUATIONS VARY BY VOLUME EQUATION

**CF4** = 0.299039 + 1.91272 \* (1/HT) + 0.0000367217 \* (HT\*\*2/DBH)

IF(CF4 < 0.3) CF4=0.3

IF(CF4 > 0.4) CF4=0.4

**CF4\_TMP** = 0.299039 + 1.91272 \* (1/HT) + 0.0000367217 \* (HT\*\*2/TMP\_DBH)

IF(CF4\_TMP < 0.3) CF4\_TMP=0.3

IF(CF4\_TMP > 0.4) CF4\_TMP=0.4

'-----

'For ease of use and to improve readability of equations, calculate the following term and use it  
'in the equations that follow. Note that actual DBH and BA are used for all trees.

'Do not use TMP\_DBH or BA\_TMP here.

**TERM** = ((1.033 \* (1.0 + 1.382937 \* EXP(-4.015292 \* (DBH/10.0)))) \* (BA + 0.087266) - 0.174533 )

'-----

IF DBH >= 6.0 THEN

**CV4** = CF4 \* BA \* HT

**TARIF** = (CV4 \* 0.912733) / (BA - 0.087266)

IF (TARIF <= 0.0) TARIF=0.01

**CVTS** = (CV4 \* TERM) / (BA - 0.087266)

**CVT** = TARIF \* (0.9679 - 0.1051 \* 0.5523\*\*(DBH-1.5) ) \* TERM / 0.912733

ELSEIF

DBH < 6.0 THEN

**CV4\_TMP** = CF4\_TMP \* BA\_TMP \* HT

**TARIF\_TMP** = (CV4\_TMP \* 0.912733) / (BA\_TMP - 0.087266)

IF (TARIF\_TMP <= 0.0) TARIF\_TMP = 0.01

'CALCULATE An **ADJUSTED TARIF** FOR SMALL TREES (Both DBH and TMP\_DBH are used)

**TARIF** = TARIF\_TMP \* ( 0.5 \* (TMP\_DBH - DBH)\*\*2 + (1.0 + 0.063 \* (TMP\_DBH - DBH)\*\*2) )

IF (TARIF <= .0.0) TARIF = 0.01

**CVTS** = TARIF \* TERM

**CVT** = TARIF \* (0.9679 - 0.1051 \* 0.5523\*\*(DBH-1.5) ) \* TERM / 0.912733

**CV4** = CF4 \* BA \* HT (calculated with actual DBH and BA)

END IF

IF DBH < 5.0 THEN CV4 = NULL

IF DBH >= 5.0 THEN KEEP CV4 (i.e. don't keep CV4\_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

## Equation 24

$$CVTS = \exp(-6.2597 + 1.9967 \times \ln(DBH) + 0.9642 \times \ln(HT)) \quad (1)$$

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

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

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

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)

HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)

BA = BASAL AREA (DBH IN INCHES)      BA = .005454154 x DBH<sup>2</sup>

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP

# SOFTWOOD BOARDFOOT VOLUME EQUATIONS

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

$$CV6 = RC6 \times CV4$$

IF CV6 > CV4 THEN CV6 = CV4

$$CUBUS = CV4 - CV6$$

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

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

$$RS616 = 10.0^{RS616L}$$

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

$$SV616 = RS616 \times CV6$$

$$SV632 = RS632 \times SV616$$

$$SCRIB = SV632$$

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

$$R16 = -2.904154 + 3.466328 \times \log(DBH \times TARIF) - 0.02765985 \times DBH - 0.00008205 \times TARIF^2 + \frac{11.29598}{DBH^2}$$

$$XINT6 = R16 \times CV6$$

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)

R16 = 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

| Species Code | Species                          | Halfstate |     |     |     |    |
|--------------|----------------------------------|-----------|-----|-----|-----|----|
|              |                                  | WOR       | WWA | EOR | EWA | CA |
| 312          | Bigleaf maple                    | 37        | 25  | 37  | 25  | 37 |
| 313          | Boxelder                         | 37        | 25  | 37  | 25  | 38 |
| 320          | Norway maple                     | 37        | --  | --  | --  | -- |
| 321          | Rocky Mountain maple             | 45        | 45  | 45  | 45  | 45 |
| 322          | Bigtooth maple                   | 45        | 45  | 45  | 45  | 45 |
| 333          | California buckeye               | --        | --  | --  | --  | 43 |
| 341          | Tree of heaven                   | 26        | --  | 26  | --  | -- |
| 351          | Red alder                        | 25        | 26  | 26  | 26  | 26 |
| 352          | White alder                      | 26        | 26  | 26  | 26  | 26 |
| 361          | Pacific madrone                  | 40        | 25  | --  | --  | 40 |
| 374          | Water birch                      | 25        | 25  | 25  | 25  | 25 |
| 375          | Paper birch                      | 25        | 25  | 25  | 25  | 25 |
| 431          | Golden chinkapin                 | 32        | 25  | 32  | --  | 32 |
| 475          | Curlleaf mountain-mahogany       | 45        | 45  | 45  | 45  | 45 |
| 492          | Pacific dogwood                  | 25        | 25  | 25  | 25  | 37 |
| 500          | Hawthorn                         | 25        | 25  | 25  | 25  | 42 |
| 510/511      | Eucalyptus                       | --        | --  | --  | --  | 31 |
| 542          | Oregon ash                       | 38        | 25  | 38  | 25  | 38 |
| 547          | Velvet ash                       | --        | --  | --  | --  | 38 |
| 590/591      | Holly                            | 25        | 25  | 25  | 25  | 25 |
| 600          | Walnut                           | --        | --  | --  | --  | 38 |
| 603          | Northern California black walnut | 38        | --  | --  | 38  | 38 |
| 604          | Southern California black walnut | --        | --  | --  | --  | 38 |
| 611          | Sweet gum                        | --        | --  | --  | --  | 26 |
| 631          | Tanoak                           | 34        | --  | --  | --  | 34 |
| 660          | Apples                           | 25        | 25  | 25  | 25  | 42 |
| 661          | Oregon crabapple                 | 25        | 25  | 25  | 25  | 42 |
| 730          | California sycamore              | --        | --  | --  | --  | 42 |
| 731          | American sycamore                | --        | --  | --  | --  | 42 |
| 746          | Quaking aspen                    | 25        | 25  | 25  | 25  | 28 |
| 747          | Black cottonwood                 | 25        | 25  | 25  | 25  | 27 |
| 748          | Fremont poplar                   | --        | --  | --  | --  | 27 |
| 756          | honey mesquite                   | --        | --  | --  | --  | 46 |
| 758          | screwbean mesquite               | --        | --  | --  | --  | 46 |
| 760          | Cherry                           | 25        | 25  | 25  | 25  | 26 |
| 763          | Common chokecherry               | 25        | 25  | 25  | 25  | 41 |
| 768          | Bitter cherry                    | 25        | 25  | 25  | 25  | 26 |
| 771          | Sweet cherry                     | 25        | --  | --  | --  | -- |

# HARDWOOD CUBIC VOLUME EQUATIONS

## Volume equation numbers (Continued)

| Species Code | Species              | Halfstate |     |     |     |    |
|--------------|----------------------|-----------|-----|-----|-----|----|
|              |                      | WOR       | WWA | EOR | EWA | CA |
| 801          | California live oak  | --        | --  | --  | --  | 43 |
| 805          | Canyon live oak      | 42        | --  | --  | --  | 42 |
| 807          | Blue oak             | --        | --  | --  | --  | 39 |
| 811          | Englemann oak        | --        | --  | --  | --  | 36 |
| 815          | Oregon white oak     | 41        | 25  | 41  | 25  | 41 |
| 818          | California black oak | 38        | --  | 38  | --  | 38 |
| 821          | California white oak | 35        | --  | --  | --  | 35 |
| 826          | Chinkapin oak        | --        | --  | --  | --  | 38 |
| 839          | Interior live oak    | --        | --  | --  | --  | 44 |
| 901          | Black locust         | 37        | --  | 37  | 25  | 38 |
| 920          | Willows              | 25        | 25  | 25  | 25  | 40 |
| 922          | Black willow         | 40        | --  | --  | --  | 40 |
| 926          | Balsam willow        | 25        | --  | --  | --  | -- |
| 927          | White willow         | 25        | 25  | --  | --  | -- |
| 929          | Weeping willow       | --        | --  | 25  | --  | -- |
| 981          | California-laurel    | 33        | --  | --  | --  | 33 |
| 990          | Desert ironwood      | --        | --  | 46  | 46  | 46 |
| 997          | Russian-olive        | 37        | 25  | 37  | 25  | 38 |
|              |                      |           |     |     |     |    |
| 998          | Unknown hardwood     | 25        | 25  | 25  | 25  | 41 |
| 999          | Unknown Tree         | 25        | 25  | 25  | 25  | 41 |

## HARDWOOD VOLUME EQUATION SOURCES

|                             |                                 |   |
|-----------------------------|---------------------------------|---|
| <a href="#">EQUATION 25</a> | <a href="#">ALDER</a>           | (CURTIS/BRUCE, PNW-56 and DNR 24)                 |
| <a href="#">EQUATION 26</a> | <a href="#">ALDER</a>           | (BC-ALDER--DNR RPT#24,1977)                       |
| <a href="#">EQUATION 27</a> | <a href="#">COTTONWOOD</a>      | (BC-COTTONWOOD--DNR RPT#24,1977)                  |
| <a href="#">EQUATION 28</a> | <a href="#">ASPEN</a>           | (BC-ASPEN--DNR RPT#24,1977)                       |
| <a href="#">EQUATION 29</a> | <a href="#">BIRCH</a>           | (BC-BIRCH--DNR RPT#24,1977)                       |
| <a href="#">EQUATION 30</a> | <a href="#">BIGLEAF MAPLE</a>   | (BC-MAPLE--DNR RPT#24,1977)                       |
| <a href="#">EQUATION 31</a> | <a href="#">EUCALYPTUS</a>      | (MEMO,COLIN D. MacLEAN 1/27/83,(REVISED 2/7/83) ) |
| <a href="#">EQUATION 32</a> | <a href="#">G.CHINQUAPIN</a>    | (PILLSBURY (H,D), CHARLES BOLSINGER 1/3/83)       |
| <a href="#">EQUATION 33</a> | <a href="#">C.LAUREL</a>        | (PILLSBURY (H,D), CHARLES BOLSINGER 1/3/83)       |
| <a href="#">EQUATION 34</a> | <a href="#">TANOAK</a>          | (PILLSBURY (H,D), CHARLES BOLSINGER 1/3/83)       |
| <a href="#">EQUATION 35</a> | <a href="#">CALIF WHITE OAK</a> | (PILLSBURY (H,D), CHARLES BOLSINGER 1/3/83)       |
| <a href="#">EQUATION 36</a> | <a href="#">ENGELMANN OAK</a>   | (PILLSBURY (H,D), CHARLES BOLSINGER 1/3/83)       |
| <a href="#">EQUATION 37</a> | <a href="#">BIGLEAF MAPLE</a>   | (PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)    |
| <a href="#">EQUATION 38</a> | <a href="#">CALIF BLACK OAK</a> | (PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)    |
| <a href="#">EQUATION 39</a> | <a href="#">BLUE OAK</a>        | (PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)    |
| <a href="#">EQUATION 40</a> | <a href="#">PACIFIC MADRONE</a> | (PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)    |
| <a href="#">EQUATION 41</a> | <a href="#">ORE WHITE OAK</a>   | (PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)    |
| <a href="#">EQUATION 42</a> | <a href="#">CANYON LIVE OAK</a> | (PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)    |
| <a href="#">EQUATION 43</a> | <a href="#">COAST LIVE OAK</a>  | (PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)    |
| <a href="#">EQUATION 44</a> | <a href="#">INT LIVE OAK</a>    | (PILLSBURY (H,D,FC), CHARLES BOLSINGER 1/3/83)    |
| <a href="#">EQUATION 45</a> | <a href="#">MTN. MAHOGANY</a>   | (Chojnacky, 1985)                                 |
| <a href="#">EQUATION 46</a> | <a href="#">MESQUITE</a>        | (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

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

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

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

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

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

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

$$\text{RC8} = 0.983 - (0.983 \times 0.65^{(DBH-8.6)}) \tag{6}$$

$$\text{CV8} = \text{RC8} \times \text{CV4} \tag{6}$$

$$\text{CV4X} = \text{CV4}$$

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<sup>2</sup>

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

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

$$\text{CVTS} = 10^{**}\text{CVTSL} \quad (2)$$

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

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

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

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

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

$$\text{CV4X} = \text{CV4}$$

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<sup>2</sup>

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

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

$$\text{CVTS} = 10^{**}\text{CVTSL} \quad (2)$$

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

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

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

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

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

$$\text{CV4X} = \text{CV4}$$

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<sup>2</sup>

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

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

$$\text{CVTS} = 10^{**}\text{CVTSL} \quad (2)$$

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

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

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

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

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

$$\text{CV4X} = \text{CV4}$$

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<sup>2</sup>

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

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

$$\text{CVTS} = 10^{**}\text{CVTSL} \quad (2)$$

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

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

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

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

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

$$\text{CV4X} = \text{CV4}$$

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<sup>2</sup>

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

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

$$\text{CVTS} = 10^{**}\text{CVTSL} \quad (2)$$

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

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

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

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

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

$$\text{CV4X} = \text{CV4}$$

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<sup>2</sup>

CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, TOP AND STUMP

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

## EQUATION 31

$$CVTS = 0.0016144 \times DBH^2 \times HT \quad (1)$$

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

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

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

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

$$CV8 = RC8 \times CV4 \quad (5)$$

$$CV4X = CV4$$

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<sup>2</sup>

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

## EQUATION 32

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

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

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

$$CVT = CVTS * RTS \quad (4)$$

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

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

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

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<sup>2</sup>

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

## EQUATION 33

$$CVTS = 0.0057821322 \times DBH^{1.94553} \times HT^{0.88389} \quad (1)$$

$$CV4 = 0.0016380753 \times DBH^{2.05910} \times HT^{1.05293} \quad (2)$$

$$CV8 = 0.0007741517 \times DBH^{2.23009} \times HT^{1.03700} \quad (3)$$

$$CVT = CVTS * RTS \quad (4)$$

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

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

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

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<sup>2</sup>

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

## EQUATION 34

If HT > 120 feet then set HT = 120 feet

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

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

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

$$CVT = CVTS * RTS \quad (4)$$

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

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

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

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<sup>2</sup>

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

## EQUATION 35

$$CVTS = 0.0042870077 \times DBH^{2.33631} \times HT^{0.74872} \quad (1)$$

$$CV4 = 0.0009684363 \times DBH^{2.39565} \times HT^{0.98878} \quad (2)$$

$$CV8 = 0.0001880044 \times DBH^{1.87346} \times HT^{1.62443} \quad (3)$$

$$CVT = CVTS * RTS \quad (4)$$

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

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

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

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<sup>2</sup>

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

## EQUATION 36

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

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

$$CV8 = CV4 \quad (3)$$

$$CVT = CVTS * RTS \quad (4)$$

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

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

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

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<sup>2</sup>

CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

## EQUATION 37

$$CVTS = 0.0101786350 \times DBH^{2.22462} \times HT^{0.57561} \quad (1)$$

$$CV4 = 0.0034214162 \times DBH^{2.35347} \times HT^{0.69586} \quad (2)$$

$$CV8 = 0.0004236332 \times DBH^{2.10316} \times HT^{1.08584} \times FC^{0.40017} \quad (3)$$

$$CVT = CVTS * RTS \quad (4)$$

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

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

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

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<sup>2</sup>

FC= HARDWOOD FORM CLASS

CVTS= CUBIC FOOT VOLUME, TOP AND STUMP

TARIF= TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)



## EQUATION 38

$$CVTS = 0.0070538108 \times DBH^{1.97437} \times HT^{0.85034} \quad (1)$$

$$CV4 = 0.0036795695 \times DBH^{2.12635} \times HT^{0.83339} \quad (2)$$

$$CV8 = 0.0012478663 \times DBH^{2.68099} \times HT^{0.42441} \times FC^{0.28385} \quad (3)$$

$$CVT = CVTS * RTS \quad (4)$$

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

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

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

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<sup>2</sup>

FC=HARDWOOD FORM CLASS

CVTS = CUBIC FOOT VOLUME, TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

## EQUATION 39

$$CVTS = 0.0125103008 \times DBH^{2.33089} \times HT^{0.46100} \quad (1)$$

$$CV4 = 0.0042324071 \times DBH^{2.53987} \times HT^{0.50591} \quad (2)$$

$$CV8 = 0.0036912408 \times DBH^{1.79732} \times HT^{0.83884} \times FC^{0.15958} \quad (3)$$

$$CVT = CVTS * RTS \quad (4)$$

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

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

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

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<sup>2</sup>

FC=HARDWOOD FORM CLASS

CVTS = CUBIC FOOT VOLUME, TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

## EQUATION 40

If HT > 120 feet then set HT = 120 feet

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

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

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

$$CVT = CVTS * RTS \quad (4)$$

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

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

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

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<sup>2</sup>

FC=HARDWOOD FORM CLASS

CVTS = CUBIC FOOT VOLUME, TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

# EQUATION 41

$$CVTS = 0.0072695058 \times DBH^{2.14321} \times HT^{0.74220} \quad (1)$$

$$CV4 = 0.0024277027 \times DBH^{2.25575} \times HT^{0.87108} \quad (2)$$

$$CV8 = 0.0008281647 \times DBH^{2.10651} \times HT^{0.91215} \times FC^{0.32652} \quad (3)$$

$$CVT = CVTS * RTS \quad (4)$$

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

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

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

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<sup>2</sup>

FC=HARDWOOD FORM CLASS

CVTS = CUBIC FOOT VOLUME, TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

## EQUATION 42

$$CVTS = 0.0097438611 \times DBH^{2.20527} \times HT^{0.61190} \quad (1)$$

$$CV4 = 0.0031670596 \times DBH^{2.32519} \times HT^{0.74348} \quad (2)$$

$$CV8 = 0.0006540144 \times DBH^{2.24437} \times HT^{0.81358} \times FC^{0.43381} \quad (3)$$

$$CVT = CVTS * RTS \quad (4)$$

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

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

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

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<sup>2</sup>

FC=HARDWOOD FORM CLASS

CVTS = CUBIC FOOT VOLUME, TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

## EQUATION 43

$$CVTS = 0.0065261029 \times DBH^{2.31958} \times HT^{0.62528} \quad (1)$$

$$CV4 = 0.0024574847 \times DBH^{2.53284} \times HT^{0.60764} \quad (2)$$

$$CV8 = 0.0006540144 \times DBH^{2.24437} \times HT^{0.81358} \times FC^{0.43381} \quad (3)$$

$$CVT = CVTS * RTS \quad (4)$$

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

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

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

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<sup>2</sup>

FC=HARDWOOD FORM CLASS

CVTS = CUBIC FOOT VOLUME, TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)

## EQUATION 44

$$CVTS = 0.0136818837 \times DBH^{2.02989} \times HT^{0.63257} \quad (1)$$

$$CV4 = 0.0041192264 \times DBH^{2.14915} \times HT^{0.77843} \quad (2)$$

$$CV8 = 0.0006540144 \times DBH^{2.24437} \times HT^{0.81358} \times FC^{0.43381} \quad (3)$$

$$CVT = CVTS * RTS \quad (4)$$

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

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

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

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<sup>2</sup>

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<sup>1/3</sup>) ) + 0 .080208 )<sup>3</sup>

ELSE IF STEMS > 1 THEN

VOLUME = (-0.13363 + ( 0.128222 x (Factor<sup>1/3</sup>) ))<sup>3</sup>

IF VOLUME <=0 then VOLUME = 0.1

### WHERE:

VOLUME = cubic foot volume from ground level to a 1.5-inch minimum branch diameter (includes live wood, dead wood, and bark)

STEMS = number of stems 3 inches and larger within the first foot above DRC. When STEMS=1 it is a single stemmed tree

DRC (inches) = Diameter at the root collar

HT (feet) = Total height of the tree

**No boardfoot equation is available**

## Equation 46

IF (DRC >= 3 AND HT > 0) then Factor = DRC x DRC x HT;

IF STEMS > 1 then

if DRC\*\*2 \* HT/1000 <=2 then

VOLUME = 0.020 + 1.8972 \* DRC\*\*2\*HT/1000 + 0.5756 \* (DRC\*\*2\*HT/1000)\*\*2

Else

VOLUME = 6.927 + 1.8972 \* DRC\*\*2\*HT/1000 - 9.210 / (DRC\*\*2\*HT/1000)

IF STEMS =1 then

if DRC\*\*2 \* HT/1000 <=2 then

VOLUME = -0.043 + 2.3378 \* DRC\*\*2\*HT/1000 + 0.8024 \* (DRC\*\*2\*HT/1000)\*\*2

Else

VOLUME = 9.586 + 2.3378 \* DRC\*\*2\*HT/1000 - 12.839 / (DRC\*\*2\*HT/1000)

IF VOLUME <=0 then VOLUME = 0.1

### WHERE:

VOLUME = cubic foot volume from ground level to a 1.5-inch minimum branch diameter (includes live wood, dead wood, and bark)

STEMS = number of stems 3 inches and larger within the first foot above DRC. When STEMS=1 it is a single stemmed tree.

DRC (inches) = Diameter at the root collar

HT (feet) = Total height of the tree



# HARDWOOD BOARDFOOT VOLUME RATIOS and EQUATIONS

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

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

-----  
 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:

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

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

If TARIF or TARIFX are <0 then set them to .01

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

$$\text{B4} = \frac{\text{TARIFX}}{0.912733}$$

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

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

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

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

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

$$\text{RS816} = 0.990 - 0.58 \times (0.484^{\text{DBH}-9.5}) \quad (8)$$

$$\text{SV816} = \text{RS816} \times \text{SV616} \quad (9)$$

Calculated on hardwood species only:

$$\text{R/8} = 0.990 - 0.55 \times (0.485^{\text{DBH}-9.5}) \quad (10)$$

$$\text{XINT8} = \text{XINT6} \times \text{R/8} \quad (11)$$

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)

R/8 = 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)