Volume estimation for PNW- Databases -- NIMS and FIADB

Cubic and board foot volumes (in Scribner and International 1/4" log rules) are calculated for softwood and hardwood trees measured on forest land. A variety of volumes are estimated including gross and net volume of the merchantable stem, gross and net volume of both the sawlog portion and the upper stem portion of the bole, gross total stem volume of the entire bole from ground to tip.

All total stem volumes are calculated on all live trees in the inventory that are >= 1” DIA, and on dead trees that are >= 5” DIA.

All other volumes (gross and net growing stock and sawtimber volumes) are calculated on the merchantable stem, originally for the purpose of providing timber information. This is the most common volume most users will see in published reports. Gross volume from these equations has not been adjusted for the presence of cull (rot and defect). Net volume is gross volume minus an estimate of volume lost due to rot, physical defect, and/or other damage.

Growing stock volume is the volume of a tree, from a 1-foot stump to a 4" top, calculated on all trees >= 5” DIA. Board foot volume (sawtimber volume); for softwoods it is the volume of a tree from a 1-foot stump to a 6" top, calculated for softwood species >= 9” DIA; and for hardwoods, it is the volume of a tree from a 1-foot stump to an 8" top, calculated for hardwood species >= 11” DIA.

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

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

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

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

Board foot equations estimate volume of the fractional log up to the specified top diameter. The fractional log is the last log of the tree, which is less than the log rule specification.
The following volume names are used throughout the equations and are defined below:

**CUBIC VOLUME** (in cubic feet)  

<table>
<thead>
<tr>
<th>Type of Volume</th>
<th>Calculated on trees with a DIA of:</th>
<th>Volume name in equations</th>
</tr>
</thead>
<tbody>
<tr>
<td>All softwoods and hardwoods:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume of the total stem, ground to tip</td>
<td>&gt;= 1”</td>
<td>CVTS</td>
</tr>
<tr>
<td>Volume from a 1-foot stump to the tip</td>
<td>&gt;= 1”</td>
<td>CVT</td>
</tr>
<tr>
<td>Volume from a 1-foot stump to a 4-inch top</td>
<td>&gt;= 5”</td>
<td>CV4</td>
</tr>
<tr>
<td>Softwood sawlog volume:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume from a 1-foot stump to a 6-inch top</td>
<td>&gt;= 9”</td>
<td>CV6</td>
</tr>
<tr>
<td>Hardwood sawlog volume:</td>
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<td></td>
</tr>
<tr>
<td>Volume from a 1-foot stump to an 8-inch top</td>
<td>&gt;= 11”</td>
<td>CV8</td>
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**BOARD FOOT VOLUME** (square feet)  

<table>
<thead>
<tr>
<th>Type of Volume</th>
<th>Calculated on trees with a DIA of:</th>
<th>Volume name in equations</th>
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<tr>
<td>Softwoods:</td>
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<tr>
<td>Scribner volume, 16-foot log rule, 1-foot stump to a 6-inch top</td>
<td>&gt;= 9”</td>
<td>SV616</td>
</tr>
<tr>
<td>(Eastern OR; Eastern WA; CA)</td>
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<tr>
<td>Scribner volume, 32-foot log rule, 1-foot stump to a 6-inch top</td>
<td>&gt;= 9”</td>
<td>SV632</td>
</tr>
<tr>
<td>(Western OR; Western WA)</td>
<td></td>
<td></td>
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<tr>
<td>International 1/4&quot; volume, 16-foot log rule, 1-foot stump to a 6-inch top</td>
<td>&gt;= 9”</td>
<td>XINT6</td>
</tr>
<tr>
<td>(all states)</td>
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<tr>
<td>Hardwoods:</td>
<td></td>
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<tr>
<td>Scribner volume, 16-foot log rule, 1-foot stump to an 8-inch top</td>
<td>&gt;= 11”</td>
<td>SV816</td>
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<tr>
<td>(all states)</td>
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<td></td>
</tr>
<tr>
<td>International 1/4&quot; volume, 8-foot log rule, 1-foot stump to an 8-inch top</td>
<td>&gt;= 11”</td>
<td>XINT8</td>
</tr>
<tr>
<td>(all states)</td>
<td></td>
<td></td>
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</tbody>
</table>
The general procedure used to calculate volume is as follows:

a.) estimate cubic volume first to produce CVTS, CVT, CV4, and the TARIF number;
b.) estimate RATIO’s from equations that use DBH and TARIF as inputs;
c.) use the RATIO’s to convert cubic volume to Scribner and International 1/4" board-foot volumes;
d.) use the RATIO’s to convert the Scribner 16-foot log rule to the Scribner 32-foot log rule.

There are three methods to calculate cubic volume, depending on the equation. Each method produces an estimate for CVTS, CVT, CV4, and TARIF. In cases where volume equations do not exist for a given species, a suitable equation has been chosen and assigned to each species.

After cubic volume is calculated, all species use the same set of equations to develop the RATIO’s needed to produce the remaining volumes.

CUBIC VOLUME Method 1: The TARIF number is based on CVTS.

Softwood equations 1, 2, 4, 6-15, 17, 21, 22, 24  
Hardwood equations 25-31

1. Calculate CVTS from published or documented volume equations for the species.  
2. Calculate the TARIF number from CVTS, using the equation in DNR report #24.  
3. Calculate CV4 from the TARIF number and tree basal area.  
4. Calculate CVT from the TARIF number and DIA.

CUBIC VOLUME Method 2: The TARIF number is based on CV4.

Softwood equations 3, 5, 16, 18, 19, 20, 23

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

CUBIC VOLUME Method 3: The TARIF number is based on CV8.

Hardwood equations 32 to 44

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

13. CALCULATE CONVERSION RATIOS:

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

<table>
<thead>
<tr>
<th>RATIO</th>
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<tbody>
<tr>
<td>RC6</td>
<td>CV4 to CV6</td>
</tr>
<tr>
<td>RC8</td>
<td>CV4 to CV8 (if needed)</td>
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<tr>
<td>RS616</td>
<td>CV6 to SV616</td>
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<tr>
<td>RS816</td>
<td>SV616 to SV816</td>
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<tr>
<td>RS632</td>
<td>SV616 to SV632</td>
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<tr>
<td>R16</td>
<td>CV6 to XINT6</td>
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<td>R18</td>
<td>XINT6 to XINT8</td>
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SOFTWOOD CUBIC VOLUME EQUATIONS

Volume equation numbers

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<th>Species Code</th>
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<td>Singleleaf pinyon pine</td>
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</tr>
</tbody>
</table>
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.
<table>
<thead>
<tr>
<th>Equation</th>
<th>Species</th>
<th>Source</th>
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<tbody>
<tr>
<td>1</td>
<td>Douglas-fir</td>
<td>Brackett, 1973; DNR RPT # 24,1977</td>
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<td>DNR MEMO--SUMMERFIELD, 11/7/80</td>
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<td>Ponderosa pine</td>
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<tr>
<td>6</td>
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<td>DNR NOTE 27, 4/79</td>
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<td>W. hemlock</td>
<td>BROWNE (1962) BC FOREST SERV, P33</td>
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<td>REDCEDAR INTERIOR--DNR RPT # 24,1977</td>
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<td>INTERIOR BALSAM--DNR RPT # 24,1977</td>
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<td>Other junipers</td>
<td>Chojnacky, 1985</td>
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<td>24</td>
<td>Redwood</td>
<td>Krumland and Wensel 1975; DNR RPT # 24,1977</td>
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Equation 7

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


Equations 2, 4

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

Equation 6

Equations 14, 14.1, 14.2

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

Equation 24
Softwood cubic volume equations

Equation 1

\[
CVTSL = -3.21809 + 0.04948 \times \log(HT) \times \log(DBH) - 0.15664 \times (\log(DBH))^2
+ 2.02132 \times \log(DBH) + 1.63408 \times \log(HT) - 0.16185 \times (\log(HT))^2
\]

\[
CVTS = 10^{**CVTSL}
\]

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

\[
CV4 = \frac{TARIF \times \left( BA - 0.087266 \right)}{0.912733}
\]

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

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) \quad BA = \frac{.005454154 \times DBH^2}{2}
- CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
- CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
- TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)
- CVT = CUBIC FOOT VOLUME ABOVE STUMP
- CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP
Equation 2

\[ CVTSL = -6.110493 + 1.81306 \times \ln(DBH) + 1.083884 \times \ln(HT) \]  \hspace{1cm} (1)

\[ CVTS = \exp(CVTSL) \]  \hspace{1cm} (2)

\[ \text{TARIF} = \frac{\left( CVTS \times 0.912733 \right)}{\left( 1.033 \times \left( 1.0 + 1.382937 \times \exp\left( - 4.015292 \times \left( \frac{DBH}{10.0} \right) \right) \right) \times \left( BA + 0.087266 \right) - 0.174533 \right)} \]  \hspace{1cm} (3)

\[ CV4 = \frac{\text{TARIF} \times (BA - 0.087266)}{0.912733} \]  \hspace{1cm} (4)

\[ CVT = \frac{\text{TARIF} \times \left( 0.9679 - 0.1051 \times 0.5523\left(DBH - 1.5\right) \right) \times \left( 1.033 \times \left( 1.0 + 1.382937 \times \exp\left( - 4.015292 \times \left( \frac{DBH}{10.0} \right) \right) \right) \times \left( BA + 0.087266 \right) - 0.174533 \right)}{0.912733} \]  \hspace{1cm} (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) \hspace{0.5cm} BA = 0.005454154 \times DBH^2
- CVTSL = Natural Log, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
- CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
- TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)
- CVT = CUBIC FOOT VOLUME ABOVE STUMP
- CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP
Equation 3- (uses PNW 266 formulas from MacLean and Berger)

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

IF DBH < 6.0 THEN
  TMP_DBH = 6.0

‘CALCULATE BASAL AREA PER TREE USING DBH AND DBH_TEMP
  BA = DBH**2 * 0.005454154
  BA_TMP = TMP_DBH **2 * 0.005454154

‘CALCULATE A CUBIC FORM FACTOR (CF4) USING TMP_DBH and DBH
‘CF4 EQUATIONS VARY BY VOLUME EQUATION

   CF4 = 0.248569 + 0.0253524*(HT/DBH) - 0.0000560175*(HT**2/DBH)
   IF(CF4 < 0.3) CF4 = 0.3
   IF(CF4 > 0.4) CF4 = 0.4

   CF4_TMP = 0.248569 + 0.0253524*(HT/TMP_DBH) - 0.0000560175*(HT**2/TMP_DBH)
   IF(CF4_TMP < 0.3) CF4_TMP = 0.3
   IF(CF4_TMP > 0.4) CF4_TMP = 0.4

‘For ease of use and to improve readability of equations, calculate the following term and use it
‘in the equations that follow. Note that actual DBH and BA are used for all trees.
‘Do not use TMP_DBH or BA_TMP here.

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

IF DBH >= 6.0 THEN
  CV4 = CF4 * BA * HT
  TARIF = (CV4 * 0.912733) / (BA - 0.087266)
  IF (TARIF <= 0.0) TARIF=0.01
  CVTS = (CV4 * TERM) / (BA - 0.087266)
  CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733
ELSEIF
  DBH < 6.0 THEN
  CV4_TMP = CF4_TMP * BA_TMP * HT
  TARIF_TMP = (CV4_TMP * 0.912733) / (BA_TMP - 0.087266)
  IF (TARIF_TMP <= 0.0) TARIF_TMP = 0.01
  ‘CALCULATE An ADJUSTED TARIF FOR SMALL TREES (Both DBH and TMP_DBH are used)
  TARIF = TARIF_TMP * (0.5 * (TMP_DBH - DBH)**2 + (1.0 + 0.063 * (TMP_DBH - DBH)**2))
  IF (TARIF <= 0.0) TARIF = 0.01
  CVTS = TARIF * TERM
  CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733
  CV4 = CF4 * BA * HT (calculated with actual DBH and BA)
END IF

IF DBH < 5.0 THEN CV4 = NULL
IF DBH >= 5.0 THEN KEEP CV4 (i.e. don’t keep CV4_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP
Equation 4

\[
CVTSL = -8.521558 + 1.977243 \times \ln(DBH) - 0.105288 \times \left(\ln(HT)\right)^2 + \frac{136.0489}{HT} + 1.99546 \times \ln(HT) \tag{1}
\]

\[
CVTS = \exp(CVTSL) \tag{2}
\]

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

\[
CV4 = \frac{\left(\left(TARIF \times (BA - 0.087266)\right) / 0.912733\right)}{\left(\left(TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right)\right) \times \left(\left(1.033 \times \left(1.0 + 1.382937 \times \exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right)\times (BA + 0.087266) - 0.174533\right)} \tag{4}
\]

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

WHERE:

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

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

BA = BASAL AREA (DBH IN INCHES) \( BA= .005454154 \times DBH^2 \)

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

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

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

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP
Equation 5 (uses PNW 266 formulas from MacLean and Berger)

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

IF DBH < 6.0 THEN TMP_DBH = 6.0

'CALCULATE BASAL AREA PER TREE USING DBH AND DBH_TEMP
BA = DBH**2 * 0.005454154
BA_TMP = TMP_DBH **2 * 0.005454154

'CALCULATE A CUBIC FORM FACTOR (CF4) USING TMP_DBH and DBH
'CF4 EQUATIONS VARY BY VOLUME EQUATION

CF4 = 0.402060 - 0.899914 * (1/DBH)
   IF(CF4 < 0.3) CF4=0.3
   IF(CF4 > 0.4) CF4=0.4

CF4_TMP = 0.402060 - 0.899914 * (1/TMP_DBH)
   IF(CF4_TMP < 0.3) CF4_TMP=0.3
   IF(CF4_TMP > 0.4) CF4_TMP=0.4

'----------------------------------------

For ease of use and to improve readability of equations, calculate the following term and use it in the equations that follow. Note that actual DBH and BA are used for all trees. 'Do not use TMP_DBH or BA_TMP here.

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

'----------------------------------------

IF DBH >= 6.0 THEN
CV4 = CF4 * BA * HT
TARIF = (CV4 * 0.912733) / (BA - 0.087266)
   IF (TARIF <= 0.0) TARIF=0.01
CVTS = (CV4 * TERM )/ (BA - 0.087266)
CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5) ) * TERM / 0.912733

ELSEIF

DBH < 6.0 THEN
CV4_TMP = CF4_TMP *BA_TMP * HT
TARIF_TMP = (CV4_TMP * 0.912733) / (BA_TMP - 0.087266)
   IF (TARIF_TMP <= 0.0) TARIF_TMP = 0.01
'CALCULATE An ADJUSTED TARIF FOR SMALL TREES (Both DBH and TMP_DBH are used)
TARIF = TARIF_TMP * (0.5 * (TMP_DBH - DBH)**2 + (1.0 + 0.063 * (TMP_DBH - DBH)**2))
   IF (TARIF <= 0.0) TARIF = 0.01
CVTS = TARIF * TERM
CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5) ) * TERM / 0.912733
CV4 = CF4 * BA * HT (calculated with actual DBH and BA)

END IF

IF DBH < 5.0 THEN CV4 = NULL
IF DBH >= 5.0 THEN KEEP CV4 (i.e. don’t keep CV4_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP
Equation 6

\[ CVTSL = -2.72170 + 2.00857 \times \log(DBH) + 1.08620 \times \log(HT) - 0.00568 \times (DBH) \]  

(1)

\[ CVTS = 10^{CVTSL} \]  

(2)

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

(3)

\[ CV4 = \frac{\text{TARIF} \times (BA - 0.087266)}{0.912733} \]  

(4)

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

(5)

WHERE:

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

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

BA = BASAL AREA (DBH in INCHES) BA= .005454154 \times DBH^2

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

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

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

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP
Equation 7

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

CVTS = 10**CVTSL  

\[
\text{TARIF} = \frac{(CVTS \times 0.912733)}{\left(1.033 \times \left(1.0 + 3.182937 \times \exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\times (BA + 0.087266) - 0.174533\right)}
\]

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

\[
\text{CVT} = \frac{\left(TARIF \times (0.9679 - 0.1051 \times 0.5523^{DBH - 1.5})\times \left(1.033 \times \left(1.0 + 3.182937 \times \exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\times (BA + 0.087266) - 0.174533\right)}{0.912733}
\]

WHERE:
DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA (DBH IN INCHES) BA = .005454154 x DBH^2
CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP
Equation 8

CVTSL = –2.464614 + 1.701993 \times \log(DBH) + 1.067038 \times \log(HT) 

CVTS = 10^{CVTSL} \tag{2}

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

\[
\text{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733} \tag{4}
\]

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

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA (DBH IN INCHES) \quad BA = 0.005454154 \times DBH^2
CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP
Equation 9

\[
CVTSL = -2.379642 + 1.682300 \times \log(DBH) + 1.039712 \times \log(HT)
\]  
(1)

\[
CVTS = 10^{CVTSL}
\]  
(2)

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

\[
CV4 = \frac{TARIF \times (BA - 0.087266)}{0.912733}
\]  
(4)

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

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA (DBH IN INCHES)  BA= .005454154 x DBH²
CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP
Equation 10

\[
CVTSL = -2.502332 + 1.864963 \times \log(DBH) + 1.004903 \times \log(HT)
\]  
\[CVTS = 10^{CVTSL}\]  
\[
TARIF = \frac{\left(\frac{CVTS \times 0.912733}{1.033 \times \left(1.0 + 1.382937 \times \exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)}\right) \times \left(BA + 0.087266\right) - 0.174533}{0.912733}
\]
\[
CV4 = \frac{TARIF \times (BA - 0.087266)}{0.912733}
\]
\[
CVT = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(1.033 \times \left(1.0 + 1.382937 \times \exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times \left(\frac{DBH}{2.54}\right) - 0.174533}{0.912733}
\]

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) \quad BA = .005454154 \times DBH^2

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

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

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

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP
Equation 11

\[ CVTSL = -2.575642 + 1.806775 \times \log(DBH) + 1.094665 \times \log(HT) \]  \hspace{1cm} (1)

\[ CVTS = 10^{CVTSL} \]

\[ TARIF = \frac{(CVTS \times 0.912733)}{\left(1.033 \times \left(1.0 + 1.382937 \times \exp\left(-4.015292 \times \frac{DBH}{10.0}\right)\right)\right) \times (BA + 0.087266) - 0.174533} \]  \hspace{1cm} (3)

\[ CV4 = \frac{TARIF \times (BA - 0.087266)}{0.912733} \]  \hspace{1cm} (4)

\[ CVT = \frac{TARIF \times (0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}) \times \left(1.033 \times \left(1.0 + 1.382937 \times \exp\left(-4.015292 \times \frac{DBH}{10.0}\right)\right)\right) \times (BA + 0.087266) - 0.174533}{0.912733} \]  \hspace{1cm} (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) \( BA = 0.005454154 \times DBH^2 \)
- \( CVTSL \) = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
- \( CVTS \) = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
- \( TARIF \) = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)
- \( CVT \) = CUBIC FOOT VOLUME ABOVE STUMP
- \( CV4 \) = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP
Equation 12

CVSL = \(-2.539944 + 1.841226 \times \log(DBH) + 1.034051 \times \log(HT)\) \tag{1}

CVTS = 10\(^{CVSL}\)

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

\[
CV4 = \frac{\text{TARIF} \times (BA - 0.087266)}{0.912733}
\tag{4}
\]

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

WHERE:

- DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
- HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
- BA = BASAL AREA (DBH IN INCHES) \(BA = .005454154 \times DBH^2\)
- CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
- CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
- TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)
- CVT = CUBIC FOOT VOLUME ABOVE STUMP
- CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP
Equation 13

\[
\text{CVTSL} = -2.700574 + 1.754171 \times \log(DBH) + 1.164531 \times \log(HT)
\]  \hfill (1)

\[
\text{CVTS} = 10^{\text{CVTSL}}
\]  \hfill (2)

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

\[
\text{CV4} = \frac{TARIF \times (BA - 0.087266)}{0.912733}
\]  \hfill (4)

\[
\text{CVT} = \frac{TARIF \times \left(0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}\right) \times \left(1.033 \times \left(1.0 + 1.382937 \times \exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)\right)\right)\right) \times (BA + 0.087266) - 0.174533}{0.912733}
\]  \hfill (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) \quad \text{BA} = 0.005454154 \times \text{DBH}^2
CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP
Equation 14

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

IF STEMS=1 THEN  S = 1
IF STEMS>1 THEN  S = 0

VOLUME = ( -.13386 + ( .133726 x (Factor ^1/3 ) ) + ( .036329 x S) )^3

IF VOLUME <=0  then VOLUME = 0.1

WHERE:

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

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

DRC (inches) = Diameter at the root collar

HT (feet) = Total height of the tree

No boardfoot equation is available

Equation 14.1

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

IF STEMS = 1 THEN  S = 1
IF STEMS > 1 THEN  S = 0

VOLUME = (-0.14240 + ( .148190 x (Factor ^1/3 ) ) - (.016712 x S) )^3

IF VOLUME <=0  then VOLUME = 0.1

WHERE:

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

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

DRC (inches) = Diameter at the root collar

HT (feet) = Total height of the tree

No boardfoot equation is available
Equation 14.2

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

\[ \text{VOLUME} = (0.02434 + (0.119106 \times \text{Factor}^{\frac{1}{3}}))^{3} \]

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

\[ \text{CVTSL} = -2.615591 + 1.847504 \times \log(DBH) + 1.085772 \times \log(HT) \]  \hspace{1cm} (1)

\[ \text{CVTS} = 10^{\text{CVTSL}} \]

\[ \text{TARIF} = \frac{(\text{CVTS} \times 0.912733)}{\left(1.033 \times \left(1.0 + 1.382937 \times \exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)^{2}\right)\right)\right) \times (\text{BA} + 0.087266) - 0.174533} \]  \hspace{1cm} (3)

\[ \text{CV4} = \frac{\text{TARIF} \times (\text{BA} - 0.087266)}{0.912733} \]  \hspace{1cm} (4)

\[ \frac{\text{TARIF} \times (0.9679 - 0.1051 \times 0.5523^{DBH - 1.5}) \times \left(1.033 \times \left(1.0 + 1.382937 \times \exp\left(-4.015292 \times \left(\frac{DBH}{10.0}\right)^{2}\right)\right)\right) \times (\text{BA} + 0.087266) - 0.174533}{0.912733} \]  \hspace{1cm} (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) \hspace{1cm} BA = .005454154 \times DBH^{2}

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

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

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

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP
Equation 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_TMP <= 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**

\[ CVTS = 0.001106485 \times (DBH)^{1.8140497} \times (HT)^{1.2744923} \]  \hspace{1cm} (1)

\[ TARIF = \frac{(CVTS \times 0.912733)}{\left( 1.033 \times \left( 1.0 + 1.382937 \times \exp \left( -4.015292 \times \left( \frac{DBH}{10.0} \right) \right) \right) \times \left( BA + 0.087266 \right) - 0.174533 \right)} \]  \hspace{1cm} (2)

\[ CV4 = \frac{TARIF \times (BA - 0.087266)}{0.912733} \]  \hspace{1cm} (3)

\[ CVT = \frac{TARIF \times \left( 0.9679 - 0.1051 \times 0.5523^{DBH - 1.5} \right) \times \left( 1.033 \times \left( 1.0 + 1.382937 \times \exp \left( -4.015292 \times \left( \frac{DBH}{10.0} \right) \right) \right) \times \left( BA + 0.087266 \right) - 0.174533 \right)}{0.912733} \]  \hspace{1cm} (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) \hspace{0.5cm} BA = 0.005454154 \times DBH^2
- CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
- TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)
- CVT = CUBIC FOOT VOLUME ABOVE STUMP
- CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP
Equation 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
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

\[ CF4 = 0.225786 + 4.44236 \times \left( \frac{1}{HT} \right) \]
\[ CF4 < 0.27 \rightarrow CF4 = 0.27 \]
\[ CF4_{\text{TMP}} = 0.225786 + 4.44236 \times \left( \frac{1}{HT} \right) \]
\[ CF4_{\text{TMP}} < 0.27 \rightarrow CF4_{\text{TMP}} = 0.27 \]

‘----------------------------------------

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.

\[ \text{TERM} = \left( (1.033 \times (1.0 + 1.382937 \times \exp(-4.015292 \times \frac{\text{DBH}}{10.0}))) \times (\text{BA} + 0.087266) - 0.174533 \right) \]

‘----------------------------------------

IF DBH >= 6.0 THEN
\[ CV4 = CF4 \times BA \times HT \]
\[ \text{TARIF} = (CV4 \times 0.912733) / (BA - 0.087266) \]
\[ \text{IF (TARIF} <= 0.0) \text{TARIF} = 0.01 \]
\[ CVTS = \text{(CV4} \times \text{TERM}) / (BA - 0.087266) \]
\[ CVT = \text{TARIF} \times \left( 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)} \right) \times \text{TERM} / 0.912733 \]
ELSEIF
\[ \text{CV4_{\text{TMP}}} = CF4_{\text{TMP}} \times BA_{\text{TMP}} \times HT \]
\[ \text{TARIF}_{\text{TMP}} = (\text{CV4_{\text{TMP}}} \times 0.912733) / (BA_{\text{TMP}} - 0.087266) \]
\[ \text{IF (TARIF}_{\text{TMP}} <= 0.0) \text{TARIF}_{\text{TMP}} = 0.01 \]
‘CALCULATE An ADJUSTED TARIF FOR SMALL TREES (Both DBH and TMP_DBH are used)
\[ \text{TARIF} = \text{TARIF}_{\text{TMP}} \times \left( 0.5 \times (\text{TMP_DBH - DBH})^{**2} + (1.0 + 0.063 \times (\text{TMP_DBH - DBH})^{**2}) \right) \]
\[ \text{IF (TARIF <= 0.0) TARIF} = 0.01 \]
\[ CVTS = \text{TARIF} \times \text{TERM} \]
\[ CVT = \text{TARIF} \times \left( 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)} \right) \times \text{TERM} / 0.912733 \]
\[ \text{CV4 = CF4} \times \text{BA} \times HT \text{ (calculated with actual DBH and BA)} \]
END IF

IF DBH < 5.0 THEN CV4 = NULL
IF DBH >= 5.0 THEN KEEP CV4 (i.e. don’t keep CV4_TMP)

WHERE:

\[ \text{DBH (inches)} = \text{DBH (CM) CONVERTED TO INCHES (DBH/2.54)} \]
\[ \text{HT (feet)} = \text{HT (M) CONVERTED TO FEET (HT/0.3048)} \]
\[ \text{CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP} \]
\[ \text{TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # .27, P.2)} \]
\[ \text{CVT = CUBIC FOOT VOLUME ABOVE STUMP} \]
\[ \text{CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP} \]
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

't-------------

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_TMP <= 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

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

(1)

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

(2)

\[ CV4 = \frac{(CVTS + 3.48)}{(1.18052 + 0.32736 \times \exp(-0.1 \times DBH))} - 2.948 \]  

(3)

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

If CVTS < 0 then CVTS = 2  
If CV4 < 0 then CV4 = 1

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)  
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)  
BA = BASAL AREA (DBH IN INCHES)  
\[ BA = .005454154 \times DBH^2 \]  
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP  
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)  
CVT = CUBIC FOOT VOLUME ABOVE STUMP  
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP
Equation 22

Use for dbh>2

\[
CVTS = \frac{CVTSL}{10.0}
\]  

\[
CVTSL = -2.624325 + 1.847123 \times \log(DBH) + 1.044007 \times \log(HT)
\]  

(1)

\[
CVTS = \frac{CVTSL}{10.0}
\]  

(2)

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

(3)

\[
CV4 = \frac{TARIF \times (BA - 0.087266)}{0.912733}
\]  

(4)

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

(5)

WHERE:

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

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

BA = BASAL AREA (DBH IN INCHES) BA = .005454154 x DBH^2

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

CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP

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

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP
Equation 23 (uses PNW 266 formulas from MacLean and Berger)

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

IF DBH < 6.0 THEN TMP_DBH = 6.0

'CALCULATE BASAL AREA PER TREE USING DBH AND DBH_TEMP
BA = DBH**2 * 0.005454154
BA_TMP = TMP_DBH **2 * 0.005454154

'CALCULATE A CUBIC FORM FACTOR (CF4) USING TMP_DBH and DBH
'CF4 EQUATIONS VARY BY VOLUME EQUATION

CF4 = 0.299039 + 1.91272 * (1/HT) + 0.0000367217 * (HT**2/DBH)
    IF(CF4 < 0.3) CF4=0.3
    IF(CF4 > 0.4) CF4=0.4

CF4_TMP = 0.299039 + 1.91272 * (1/HT) + 0.0000367217 * (HT**2/TMP_DBH)
    IF(CF4_TMP < 0.3) CF4_TMP=0.3
    IF(CF4_TMP > 0.4) CF4_TMP=0.4

'----------------------------------------

For ease of use and to improve readability of equations, calculate the following term and use it in the equations that follow. Note that actual DBH and BA are used for all trees. 'Do not use TMP_DBH or BA_TMP here.

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

'----------------------------------------

IF DBH >= 6.0 THEN
CV4 = CF4 * BA * HT
TARIF = (CV4 * 0.912733) / (BA - 0.087266)
    IF (TARIF <= 0.0) TARIF=0.01
CVTS = (CV4 * TERM) / (BA - 0.087266)
CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733

ELSEIF

DBH < 6.0 THEN
CV4_TMP = CF4_TMP *BA_TMP * HT
TARIF_TMP = (CV4_TMP * 0.912733) / (BA_TMP - 0.087266)
    IF (TARIF_TMP <= 0.0) TARIF_TMP = 0.01
'CALCULATE An ADJUSTED TARIF FOR SMALL TREES (Both DBH and TMP_DBH are used)
TARIF = TARIF_TMP * ( 0.5 * (TMP_DBH - DBH)**2 + (1.0 + 0.063 * (TMP_DBH - DBH)**2) )
    IF (TARIF <= .0.0) TARIF = 0.01
CVTS = TARIF * TERM
CVT = TARIF * (0.9679 - 0.1051 * 0.5523**(DBH-1.5)) * TERM / 0.912733

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

END IF

IF DBH < 5.0 THEN CV4 = NULL
IF DBH >= 5.0 THEN KEEP CV4 (i.e. don’t keep CV4_TMP)

WHERE:

DBH (inches) = DBH (CM) CONVERTED TO INCHES (DBH/2.54)
HT (feet) = HT (M) CONVERTED TO FEET (HT/0.3048)
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP
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) \( BA = 0.005454154 \times DBH^2 \)
CVTS = CUBIC FOOT VOLUME, INCLUDING TOP AND STUMP
TARIF = TARIF NUMBER EQUATION (REF. DNR NOTE # 27, P.2)
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME ABOVE STUMP, 4-INCH TOP
SOFTWOOD BOARDFOOT VOLUME EQUATIONS

\[ RC6 = 0.993 \left( 0.993 \times 0.62 (DBH-6.0) \right) \]

\[ CV6 = RC6 \times CV4 \]

IF \( CV6 \geq CV4 \) THEN \( CV6 = CV4 \)

\[ CUBUS = CV4 - CV6 \]

\[ B4 = \frac{TARIF}{0.912733} \]

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

\[ RS616 = 10.0 \times RS616L \]

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

\[ SV616 = RS616 \times CV6 \]

\[ SV632 = RS632 \times SV616 \]

\[ SCRIB = SV632 \]

**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

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HARDWOOD CUBIC VOLUME EQUATIONS

Volume equation numbers
(Continued)

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HARDWOOD VOLUME EQUATION SOURCES

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

Equation 25

Equations 26,27,28,29,30

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

Equations 45, 46
HARDWOOD CUBIC VOLUME EQUATIONS

EQUATION 25

If HT < 18 then set HT = 18

\[
F = 0.3651 \times Z^{2.5} - 7.9032 \times Z^{2.5} \times \frac{ DBH }{ 1000.0 } + 3.295 \times Z^{2.5} \times \frac{ HT }{ 1000.0 }
\]

\[
- 1.9856 \times Z^{2.5} \times HT \times \frac{ DBH }{ 100000.0 } - 2.9668 \times Z^{2.5} \times \frac{ HT^2 }{ 1000000.0 }
\]

\[
+ 1.5092 \times Z^{2.5} \times \frac{ HT^{0.5} }{ 1000.0 } + 4.9395 \times Z^4 \times \frac{ DBH }{ 1000.0 }
\]

\[
- 2.05937 \times Z^4 \times \frac{ HT }{ 1000.0 } + 1.5042 \times Z^{3.3} \times HT \times \frac{ DBH }{ 1000000.0 }
\]

\[
- 1.1433 \times Z^{3.3} \times \frac{ HT^{0.5} }{ 100000.0 } + 1.809 \times Z^{4.1} \times \frac{ HT^2 }{ 100000000.0 }
\]

Where:

\[
Z = \left( \frac{ HT - 0.5 \times DBH }{ 24.0 } \right) \div \left( HT - 4.5 \right)
\]

CVT = 0.00545415 \times (DBH)^2 \times \left( HT - 4.5 \right) \times F

TARIF = \left( \left( \left( \left( \left( 0.9679 - 0.1051 \times 0.5523 \times (DBH - 1.5) \right) \times \left( 1.0330 \times \left( 1.0 + 1.382937 \times \exp \left( -4.015292 \times \left( \frac{ DBH }{ 10.0 } \right) \right) \right) \right) \times \left( BA + 0.087266 \right) - 0.174533 \right) \right) \right)

CVTS = TARIF \times \left( 0.912733 \right)

CV4 = TARIF \times \left( BA - 0.087266 \right)

CV8 = RC8 \times CV4

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) \quad BA = 0.005454154 \times DBH2
CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP
TARIF = TARIF NUMBER EQUATION
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME, 4-IN TOP
CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)
EQUATION 26

\[ CVTSL = -2.672775 + 1.920617 \times \log(DBH) + 1.074024 \times \log-HT \]  

(1)

\[ CVTS = 10^{\cdot CVTSL} \]  

(2)

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

(3)

\[
TARIF \times \left(0.9679 - 0.1051 \times 0.5523=DBH - 1.5\right) \times \left(1.033 \times \left(1.0 + 1.382937 \times \exp(-4.015292 \times \left(DBH - 10.0\right))\right)\right) \times (BA + 0.087266) - 0.174533
\]

\[
CVT = \frac{TARIF \times (BA - 0.087266)}{0.912733}
\]

(4)

\[
CV4 = \frac{TARIF \times (BA - 0.087266)}{0.912733}
\]

(5)

\[
RC8 = 0.983 \times 0.983 \times 0.65 = (DBH-8.6)
\]

(6)

\[
CV8 = RC8 \times CV4
\]

WHERE:

- \( DBH = DBH(CM) \) CONVERTED TO INCHES (\( DBH/2.54 \)
- \( HT = HT(M) \) CONVERTED TO FEET (\( HT/0.3048 \)
- \( BA = BASAL AREA (DBH \text{ IN INCHES}) \)
- \( \text{BA} = .005454154 \times DBH2 \)
- \( CVTSL = \log \text{BASE 10, CUBIC FOOT VOLUME, TOP AND STUMP} \)
- \( CVTS = \text{CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP} \)
- \( TARIF = \text{TARIF NUMBER EQUATION} \)
- \( CVT = \text{CUBIC FOOT VOLUME ABOVE STUMP} \)
- \( CV4 = \text{CUBIC FOOT VOLUME, 4-IN TOP} \)
- \( CV8 = \text{CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)} \)
EQUATION 27

CVTSL = \(-2.945047 + 1.803973 \times \log(DBH) + 1.238853 \times \log(HT)\)  

(1)

CVTS = 10**CVTSL  

(2)

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

(3)

\[
CVT = \frac{TARIF \times \left(BA - 0.087266\right)}{0.912733}
\]

(4)

\[
CV4 = \frac{TARIF \times \left(BA - 0.087266\right)}{0.912733}
\]

(5)

\[
RC8 = 0.983 - 0.983 \times 0.65^{(DBH-8.6)}
\]

(6)

\[
CV8 = RC8 \times CV4
\]

\[
CV4X = CV4
\]

WHERE:

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

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

BA = BASAL AREA (DBH IN INCHES)  

BA = .005454154 x DBH^2

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

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

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)
EQUATION 28

\[
CVTSL = -2.635360 + 1.946034 \times \log(DBH) + 1.024793 \times \log(HT)
\]  

(1)

CVTS = 10**CVTSL

(2)

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

(3)

\[
CVT = \frac{TARIF \times \left(BA - 0.087266\right)}{0.912733}
\]  

(4)

\[
CV4 = \frac{TARIF \times \left(BA - 0.087266\right)}{0.912733}
\]  

(5)

\[
RC8 = 0.983 \times 0.65^{(DBH-8.6)}
\]  

(6)

\[
CV8 = RC8 \times CV4
\]  

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) \quad BA = 0.005454154 \times DBH^2

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

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

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)
EQUATION 29

CVTSL = -2.757813 + 1.911681 \times \log(DBH) + 1.105403 \times \log(HT)

CVTS = 10^{CVTSL}

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

\[
CVT = \frac{TARIF \times \left(\frac{BA - 0.087266}{0.912733}\right)}{0.912733}
\]

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

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

CV8 = RC8 \times CV4

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) \quad BA = .005454154 \times DBH^2
CVTSL = LOG BASE 10, CUBIC FOOT VOLUME, TOP AND STUMP
CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP
TARIF = TARIF NUMBER EQUATION
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME, 4-IN TOP
CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)
EQUATION 30

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

\[ \text{CVTS} = 10^{\text{CVTSL}} \]  
(2)

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

\[ \text{CVT} = \frac{\text{TARIF} \times \left(\text{BA} - 0.087266\right)}{0.912733} \]  
(4)

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

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

\[ \text{CV8} = \text{RC8} \times \text{CV4} \]

\[ \text{CV4X} = \text{CV4} \]

WHERE:

- \( \text{DBH} \) = DBH(CM) CONVERTED TO INCHES (DBH/2.54)
- \( \text{HT} \) = HT (M) CONVERTED TO FEET (HT/0.3048)
- \( \text{BA} \) = BASAL AREA (DBH IN INCHES) \( \text{BA} = 0.005454154 \times \text{DBH}^2 \)
- \( \text{CVTSL} \) = LOG BASE 10, CUBIC FOOT VOLUME, TOP AND STUMP
- \( \text{CVTS} \) = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP
- \( \text{TARIF} \) = TARIF NUMBER EQUATION
- \( \text{CVT} \) = CUBIC FOOT VOLUME ABOVE STUMP
- \( \text{CV4} \) = CUBIC FOOT VOLUME, 4-IN TOP
- \( \text{CV8} \) = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)
EQUATION 31

CVTS = 0.0016144 × DBH² × HT  

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

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

\[ \text{CV4} = \frac{TARIF \times \left(BA - 0.087266\right)}{0.912733} \]

\[ \text{RC8} = 0.983 \times \left(0.983 \times 0.69 \times (DBH - 8.6)\right) \]

\[ \text{CV8} = RC8 \times CV4 \]

\[ \text{CV4X} = CV4 \]

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 × DBH^2
CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP
TARIF = TARIFF 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

\[ CVTS = 0.0120372263 \times DBH^{2.02232} \times HT^{0.68638} \]  
(1)

\[ CV4 = 0.0055212937 \times DBH^{2.07202} \times HT^{0.77467} \]  
(2)

\[ CV8 = 0.0018985111 \times DBH^{2.38285} \times HT^{0.77105} \]  
(3)

\[ CVT = CVTS \times RTS \]
\[ RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)} \]  
(4)

\[ CV4X = CVT \times \left( \frac{43.336}{DBH^3} + \frac{124.717}{DBH^4} + \frac{0.193437 \times HT}{DBH^3} + \frac{479.83}{DBH^3 \times HT} \right) \]  
(5)

\[ \text{TARIF} = \frac{CV8 \times 0.912733}{(0.983 - 0.983 \times 0.65^{(DBH-8.6)}) \times (BA - 0.087266)} \]  
(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) \( BA = .005454154 \times DBH^2 \)
CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP
TARIF = TARIF NUMBER EQUATION
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME, 4-IN TOP
CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)
EQUATION 33

\[ CVTS = 0.0057821322 \times DBH^{1.94553} \times HT^{0.88389} \]  \hspace{1cm} (1)

\[ CV4 = 0.0016380753 \times DBH^{2.05910} \times HT^{1.05293} \]  \hspace{1cm} (2)

\[ CV8 = 0.0007741517 \times DBH^{2.23009} \times HT^{1.03700} \]  \hspace{1cm} (3)

\[ CVT = CVTS \times RTS \]  \hspace{1cm} (4)

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

\[ CV4X = CVT \times \left( 0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{0.193437 \times HT}{DBH^3} + \frac{479.83}{DBH^3 \times HT} \right) \]  \hspace{1cm} (5)

\[ TARIF = \frac{(CV8 \times 0.912733)}{\left(0.983 - 0.983 \times 0.65^{(DBH-8.6)}\right) \times (BA - 0.087266)} \]  \hspace{1cm} (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) \hspace{0.5cm} BA= .005454154 \times DBH^2

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

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)
EQUATION 34

If HT > 120 feet then set HT = 120 feet

\[ \text{CVTS} = 0.0058870024 \times DBH^{1.94165} \times HT^{0.86562} \] (1)

\[ \text{CV4} = 0.0005774970 \times DBH^{2.19576} \times HT^{1.14078} \] (2)

\[ \text{CV8} = 0.0002526443 \times DBH^{2.30949} \times HT^{1.21069} \] (3)

\[ \text{CVT} = \text{CVTS} \times RTS \]

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

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

\[ \text{TARIF} = \frac{(\text{CV8} \times 0.912733)}{\left(0.983 - 0.983 \times 0.63^{(DBH-8.8)}\right) \times (BA - 0.087266)} \] (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 \times DBH^2
CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP
TARIF = TARIF NUMBER EQUATION
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME, 4-IN TOP
CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)
EQUATION 35

\[ CVTS = 0.0042870077 \times DBH^{2.33631} \times HT^{0.74872} \]  \hspace{1cm} (1)

\[ CV4 = 0.0009684363 \times DBH^{2.39565} \times HT^{0.98878} \]  \hspace{1cm} (2)

\[ CV8 = 0.0001880044 \times DBH^{1.87346} \times HT^{1.62443} \]  \hspace{1cm} (3)

\[ CVT = CVTS \times RTS \]  \hspace{1cm} (4)

\[ RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH - 1.5)} \]  \hspace{1cm} (4)

\[ CV4X = CVT \times \left( 0.99875 - \frac{43.336}{DBH^3} + \frac{124.717}{DBH^4} + \frac{0.193437 \times HT}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \]  \hspace{1cm} (5)

\[ TARIF = \frac{(CV8 \times 0.912733)}{\left( (0.983 - 0.983 \times 0.65^{DBH - 8.6}) \times (BA - 0.087266) \right)} \]  \hspace{1cm} (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) \hspace{1cm} BA = 0.005454154 \times DBH^2
CVTS = CUBIC FOOT VOLUME, TOTAL STEM, WITH TOP AND STUMP
TARIF = TARIF NUMBER EQUATION
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME, 4-IN TOP
CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)
EQUATION 36

\[
CVTS = 0.0191453191 \times DBH^{2.40248} \times HT^{0.28060} \tag{1}
\]

\[
CV4 = 0.0053866353 \times DBH^{2.61268} \times HT^{0.31103} \tag{2}
\]

CV8 = CV4 \tag{3}

\[
CVT = CVTS \times RTS \tag{4}
\]

\[
RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH^{-1.5})} \tag{4}
\]

\[
CV4x = CVT \times \left( 0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{(0.193437 \times HT)}{DBH^3} + \frac{479.83}{(DBH^3 \times HT)} \right) \tag{5}
\]

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

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) \quad BA = .005454154 \times DBH^2

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

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)
EQUATION 37

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

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

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

CVT = CVTS × RTS \quad (4)

RTS = 0.9679 − 0.1051 × 0.5523^{(DBH−1.5)} \quad (4)

CV4X = CVT × \left[ 0.99875 − \frac{43.336}{DBH^3} − \frac{124.717}{DBH^4} + \frac{(0.193437 × HT)}{DBH^3} + \frac{479.83}{\left(DBH^3 × HT\right)^4} \right]  \quad (5)

TARIF = \frac{(CV8 × 0.912733)}{\left(0.983 − 0.983 × 0.65^{(DBH−8.5)}\right) × (BA − 0.087266)} \quad (6)

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)
HT = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA (DBH IN INCHES) \quad BA = .005454154 × DBH^2
FC = HARDWOOD FORM CLASS
CVTS = CUBIC FOOT VOLUME, TOP AND STUMP
TARIF = TARIF NUMBER EQUATION
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME, 4-IN TOP
CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)
EQUATION 38

\[ \text{CVTS} = 0.0070538108 \times \text{DBH}^{1.97437} \times \text{HT}^{0.85034} \]  

\[ \text{CV4} = 0.0036795695 \times \text{DBH}^{2.12635} \times \text{HT}^{0.83339} \]  

\[ \text{CV8} = 0.0012478663 \times \text{DBH}^{2.68099} \times \text{HT}^{0.42441} \times \text{FC}^{0.28385} \]

\[ \text{CVT} = \text{CVTS} \times \text{RTS} \]

\[ \text{RTS} = 0.9679 - 0.1051 \times 0.5523^{(\text{DBH} - 1.5)} \]  

\[ \text{CV4X} = \text{CV} \times \left( 0.99875 - \frac{43.336}{\text{DBH}^3} - \frac{124.717}{\text{DBH}^4} + \frac{(0.193437 \times \text{HT})}{\text{DBH}^3} + \frac{479.83}{(\text{DBH}^3 \times \text{HT})} \right) \]  

\[ \text{TARIF} = \frac{(\text{CV} \times 0.912733)}{\left( 0.983 - 0.983 \times 0.65^{(\text{DBH} - 8.6)} \right) \times (\text{BA} - 0.087266)} \]

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) \quad BA = 0.005454154 \times \text{DBH}^2

FC = HARDWOOD FORM CLASS

CVTS = CUBIC FOOT VOLUME, TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)
EQUATION 39

\[
CVTS = 0.0125103008 \times DBH^{2.33089} \times HT^{0.46100}
\]

(1)

\[
CV4 = 0.0042324071 \times DBH^{2.53987} \times HT^{0.50591}
\]

(2)

\[
CV8 = 0.0036912408 \times DBH^{1.79732} \times HT^{0.83884} \times FC^{0.15958}
\]

(3)

\[
CVT = CVTS \times RTS
\]

(4)

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

(4)

\[
CV4X = CVT \times \left[ \frac{0.99875}{DBH^3} - \frac{43.336}{DBH^2} + \frac{124.717}{DBH^4} + \left( \frac{0.193437 \times HT}{DBH^3} \right) + \frac{479.83}{DBH^3 \times HT} \right]
\]

(5)

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

(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 \times DBH^2
FC = HARDWOOD FORM CLASS
CVTS = CUBIC FOOT VOLUME, TOP AND STUMP
TARIF = TARIF NUMBER EQUATION
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME, 4-IN TOP
CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)
EQUATION 40

If HT > 120 feet then set HT = 120 feet

\[ CVTS = 0.0067322665 \times DBH^{1.96628} \times HT^{0.83458} \]  \hspace{1cm} (1)

\[ CV4 = 0.0025616425 \times DBH^{1.99295} \times HT^{1.01532} \]  \hspace{1cm} (2)

\[ CV8 = 0.0006181530 \times DBH^{1.72635} \times HT^{1.26462} \times FC^{0.37868} \]  \hspace{1cm} (3)

\[ CVT = CVTS \times RTS \]  \hspace{1cm} (4)

\[ RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH^{-1.5})} \]  \hspace{1cm} (4)

\[ CV4X = CVT \times \left(0.99875 - \frac{43.336}{DBH^3} - \frac{124.717}{DBH^4} + \frac{0.193437 \times HT}{DBH^3} + \frac{479.83}{DBH^3 \times HT}\right) \]  \hspace{1cm} (5)

\[ TARIF = \frac{(CV8 \times 0.912733)}{\left((0.983 - 0.983 \times 0.65^{(DBH-8.5)}) \times (BA - 0.087266)\right)} \]  \hspace{1cm} (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) \hspace{1cm} BA = 0.005454154 \times DBH^2

FC = HARDWOOD FORM CLASS

CVTS = CUBIC FOOT VOLUME, TOP AND STUMP

TARIF = TARIF NUMBER EQUATION

CVT = CUBIC FOOT VOLUME ABOVE STUMP

CV4 = CUBIC FOOT VOLUME, 4-IN TOP

CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)
EQUATION 41

\[ CVTS = 0.0072695058 \times DBH^{2.14321} \times HT^{0.74220} \]  \hfill (1)

\[ CV4 = 0.0024277027 \times DBH^{2.25575} \times HT^{0.87108} \]  \hfill (2)

\[ CV8 = 0.0008281647 \times DBH^{2.10651} \times HT^{0.91215} \times FC^{0.32652} \]  \hfill (3)

\[ CVT = CVTS \times RTS \]
\[ RTS = 0.9679 - 0.1051 \times 0.5523^{(DBH-1.5)} \]  \hfill (4)

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

\[ \text{TARIF} = \frac{(CV8 \times 0.912733)}{\left( 0.983 - 0.983 \times 0.65^{(DBH-8.6)} \right) \times (BA - 0.087266)} \]  \hfill (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) \quad BA = .005454154 \times DBH^2
FC = HARDWOOD FORM CLASS
CVTS = CUBIC FOOT VOLUME, TOP AND STUMP
TARIF = TARIF NUMBER EQUATION
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME, 4-IN TOP
CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)
EQUATION 42

\[
\text{CVTS} = 0.0097438611 \times DBH^{2.20527} \times HT^{0.61190} \tag{1}
\]

\[
\text{CV4} = 0.0031670596 \times DBH^{2.32519} \times HT^{0.74348} \tag{2}
\]

\[
\text{CV8} = 0.0006540144 \times DBH^{2.24437} \times HT^{0.81358} \times FC^{0.43381} \tag{3}
\]

\[
\text{CVT} = \text{CVTS} \times \text{RTS}
\]

\[
\text{RTS} = 0.9679 - 0.1051 \times 0.5523 \times (DBH^{-1.5})
\]

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

\[
\text{TARIF} = \frac{(CV8 \times 0.912733)}{\left(0.983 - 0.983 \times 0.65(DBH^{-8.6}) \times (BA - 0.087266)\right)} \tag{6}
\]

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) \quad BA = 0.005454154 \times DBH^2
FC = HARDWOOD FORM CLASS
CVTS = CUBIC FOOT VOLUME, TOP AND STUMP
TARIF = TARIF NUMBER EQUATION
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME, 4-IN TOP
CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)
EQUATION 43

\[ CVTS = 0.0065261029 \times DBH^{2.31958} \times HT^{0.62528} \]  
(1)

\[ CV4 = 0.0024574847 \times DBH^{2.53284} \times HT^{0.60764} \]  
(2)

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

\[ CVT = CVTS \times RTS \]  
(4)

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

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

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

WHERE:

DBH = DBH(CM) CONVERTED TO INCHES (DBH/2.54)
HT = HT (M) CONVERTED TO FEET (HT/0.3048)
BA = BASAL AREA (DBH IN INCHES) BA = .005454154 x DBH^2
FC = HARDWOOD FORM CLASS
CVTS = CUBIC FOOT VOLUME, TOP AND STUMP
TARIF = TARIF NUMBER EQUATION
CVT = CUBIC FOOT VOLUME ABOVE STUMP
CV4 = CUBIC FOOT VOLUME, 4-IN TOP
CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)
EQUATION 44

\[ CVTS = 0.0136818837 \times DBH^{2.02989} \times HT^{0.63257} \] (1)

\[ CV4 = 0.0041192264 \times DBH^{2.14915} \times HT^{0.77843} \] (2)

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

\[ CVT = CVTS \times RTS \]

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

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

\[ TARIF = \frac{CV8 \times 0.912733}{ \left( 0.983 - 0.983 \times 0.65^{(DBH-8.8)} \right) \times (BA - 0.087266)} \] (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) \( BA = 0.005454154 \times DBH^{2} \)
- FC = HARDWOOD FORM CLASS
- CVTS = CUBIC FOOT VOLUME, TOP AND STUMP
- TARIF = TARIF NUMBER EQUATION
- CVT = CUBIC FOOT VOLUME ABOVE STUMP
- CV4 = CUBIC FOOT VOLUME, 4-IN TOP
- CV8 = CUBIC FOOT VOLUME, SAWLOG (8-IN TOP)
EQUATION 45

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

IF STEMS =1 then

VOLUME = (-0.13363 + ( 0.128222 x (Factor \(^{1/3}\) ) ) + 0 .080208 ) \(^3\)

ELSE IF STEMS > 1 THEN

VOLUME = (-0.13363 + ( 0.128222 x (Factor \(^{1/3}\) )) \(^3\)

IF VOLUME <=0  then VOLUME = 0.1

WHERE:

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

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

DRC (inches) = Diameter at the root collar
HT (feet) = Total height of the tree

No boardfoot equation is available

Equation 46

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

IF STEMS > 1 then

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

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

Else

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

IF STEMS =1 then

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

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

Else

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

IF VOLUME <=0  then VOLUME = 0.1

WHERE:

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

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

DRC (inches) = Diameter at the root collar
HT (feet) = Total height of the tree
HARDWOOD BOARDFOOT VOLUME RATIOS and EQUATIONS

\[ \text{CUBUS} = CV4 - CV8 \quad (1) \]
\[ \text{RC6} = 0.993 - 0.993 \times 0.62^{(DBH-6.0)} \quad (2) \]

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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:

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

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

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

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\[ CV6 = RC6 \times CV4X \quad (3) \]

\[ B4 = \frac{\text{TARIFX}}{0.912733} \]

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

\[ \text{RS616} = 10.0 \quad (5) \]

\[ SV616 = RS616 \times CV6 \quad (6) \]

\[ \text{RI6} = -2.904154 + 3.466328 \times \log(DBH \times \text{TARIFX}) - 0.02765985 \times DBH - 0.00008205 \times \text{TARIFX}^2 + \frac{11.29598}{DBH^2} \quad (7) \]

\[ \text{XINT6} = RI6 \times CV6 \quad (8) \]

\[ RS616 = 0.990 - 0.58 \times (0.484^{DBH-9.5}) \quad (9) \]

Calculated on hardwood species only:

\[ RI8 = 0.990 - 0.55 \times (0.485^{DBH-9.5}) \quad (10) \]

\[ \text{XINT8} = \text{XINT6} \times RI8 \quad (11) \]

WHERE:
B4 = BINGO FACTOR
CUBUS = CUBIC FOOT VOLUME, UPPER-STEM PORTION
RC6 = RATIO TO CONVERT CUBIC 4-INCH TOP TO CUBIC 6-INCH TOP
CV6 = CUBIC FOOT VOLUME, 6-INCH TOP (SAWLOG)
RS616 = RATIO TO CONVERT CUBIC 6-INCH TOP TO SCRIB 6-INCH TOP IN 16-FT LOGS
SV616 = SCRIBNER VOLUME--6-INCH TOP (IN 16-FT LOGS)
RS816 = RATIO TO CONVERT CUBIC 6-INCH TOP TO SCRIB 8-INCH TOP IN 16-FT LOGS
SV816 = SCRIBNER VOLUME--8-INCH TOP (IN 16-FT LOGS)
XINT6 = INTERNATIONAL ¼ INCH VOLUME--6-INCH TOP (IN 16-FT LOGS)
XINT8 = INTERNATIONAL ¼ INCH VOLUME--8-INCH TOP (IN 16-FT LOGS)
RI8 = RATIO TO CONVERT INTERNATIONAL ¼ INCH 6-INCH TOP TO INTERNATIONAL ¼ INCH 8-INCH TOP
XINT8 = INTERNATIONAL ¼ INCH VOLUME--8-INCH TOP (IN 8-FT LOGS)