

File: 195-30/Sca

June 19, 2003

**BY EMAIL**

To: Regional Managers

From: Bill Howard  
Director  
Revenue Branch

**Re: *Scaling Manual*, Amendment No. 4**

The purpose of this memo is to notify you of the above amendment, provide you with the attached summary of the amendment, and ask that you advise all scaling staff.

For your information, the *Scaling Manual* can be found at:  
<http://www.for.gov.bc.ca/hva/manuals/scal.htm>

The manual may also be purchased through Crown Publications, 521 Fort Street, Victoria, British Columbia, V8W 1E7 (telephone 250-386-4636). Crown Publications will advise out of service manual holders of the amendment.

If you have any questions, please contact Jim Crover, Scaling Policy Forester, Revenue Branch at [Jim.Crover@gems9.gov.bc.ca](mailto:Jim.Crover@gems9.gov.bc.ca) (telephone 250-356-1955) or Robert Frear, Technical Scaling Co-ordinator, Revenue Branch at [Robert.Frear@gems6.gov.bc.ca](mailto:Robert.Frear@gems6.gov.bc.ca) (telephone 250-356-7673).



Bill Howard  
Director  
Revenue Branch

Attachment

pc: Ministry of Forests Subscribers, *Scaling Manual*



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## MANUAL REVISION TRANSMITTAL

FOR FURTHER INFORMATION OR IF YOU HAVE A CHANGE OF ADDRESS,  
PLEASE CONTACT:

Jim Crover  
Scaling Policy Forester

Revenue Branch  
Ministry of Forests  
6<sup>th</sup> Floor - 727 Fisgard Street  
Victoria, BC  
V8W 1R8

Phone: 356-1955  
PROFS userid: Jim.Crover@gems9.gov.bc.ca  
FAX: 387-5670

### MANUAL TITLE

Scaling Manual

**AMENDMENT**  
Amendment  
No. 4

**ISSUE DATE**  
June 18, 2003

### MANUAL CO-ORDINATOR

Judy Laton  
Manuals Co-ordinator

**AUTHORIZATION (Name, Title)**  
W. Howard  
Director, Revenue Branch

Please make the following changes to your copy of the above Ministry manual.

| ACTION<br>(Remove/Insert) | (VOL.) CHAPTER-SECTION-SUBJECT | PAGE(S)         | COMMENTS                |
|---------------------------|--------------------------------|-----------------|-------------------------|
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| REMOVE                    | Appendix 1A                    | 13 - 14         | After Chapter 1A Tab    |
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$$V = \frac{A_1 + A_2}{2} \times L$$

where: V is the volume of the log in m<sup>3</sup>.  
A<sub>1</sub> is the area of the small end of the log in m<sup>2</sup>.  
A<sub>2</sub> is the area of the large end of the log in m<sup>2</sup>.  
L is the length of the log in m.

***Figure 1.2 The Smalian formula.***

The elimination of the FBM log scale was met with much resistance from the forest industry, and was an eddy of controversy from within government as well as within industry. Although cubic scaling represented a stronger and more consistent basis for forest depletion and revenue collection for government, the industry was very reluctant to base commercial transactions on a scale that had a different relationship to product output. Dual scales in cubic and FBM became commonplace and are common to this day, as are the use of conversion factors to better relate scale data to a given product.

The Scribner Decimal C Scale is still the basis for most forest commerce in the western United States and Alaska, as well as in the Asian markets. Similarly, there is still a demand for scaler's with experience using the B.C. Log Scale (FBM), even though it was removed from official use years ago.

The use of dual scales clearly reflects the observation that one scale often does not satisfy all needs.

Figure 1.3 itemizes principal scaling events in greater detail.

|         |                                                                                                                                                                     |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1884    | Scribner's Lumber and Logbook, Doyle Rule (F. B. M.) used as basis for scaling.                                                                                     |
| 1894    | Provision for Appointment of Official Scaler's under the Official Scaler's Act.                                                                                     |
| 1895    | BC Board-foot Log Scale (FBM) established as the official scale.                                                                                                    |
| 1902    | Log grades first established made official by Timber Measurement Act, 1902.                                                                                         |
| 1912    | Provision for Re-scales to be made, also the issuance of licences (proclaimed under the first BC <i>Forest Act</i> , which also established the BC Forest Service). |
| 1915    | Doyle rule no longer accepted, new log grades for cedar, fir, spruce, pine and cottonwood.                                                                          |
| 1920    | Scaling fund established, official scalers were given the opportunity to apply for civil service status.                                                            |
| 1944    | Cubic measure first authorized for use - BC Cubic Scale (Lumber Cubic).                                                                                             |
| 1948    | Hemlock log grades introduced.                                                                                                                                      |
| 1952    | New timber sales and TFL permits to be scaled by BC cubic scale - Dual scale performed (i.e., Cubic Scale and BCFBM).                                               |
| 1963    | Weight scaling introduced in BC Interior.                                                                                                                           |
| 1965    | Firmwood cubic scale introduced (FBM and cubic).                                                                                                                    |
| 1972    | BC Log Scale (FBM) and lumber cubic discontinued.                                                                                                                   |
| 1979    | Metric Scale replaced Imperial firmwood cubic (BC metric cubic scale proclaimed the official scale for BC).                                                         |
| 1979    | Alleged scaling incident at Shoal Island.                                                                                                                           |
| 1980-81 | Portable data recorders for scaling developed by the Ministry and Epic Data Limited.                                                                                |
| 1981    | Coastal letter grades adopted (change from numeric to letter grades).                                                                                               |
| 1985    | Revenue scaling was privatized.                                                                                                                                     |
| 1988    | Log grading was introduced to the Interior (Sawlog, Lumber Reject, Firmwood Reject grades).                                                                         |
| 1988    | Provision made for industry to transmit scale data electronically.                                                                                                  |
| 1989    | Auditor General Review cites shortcomings in scaling and scale controls.                                                                                            |
| 1990    | Zero Waste Policy Introduced - Waste Measurement Procedures introduced for entire province.                                                                         |

*Figure 1.3 Scaling in BC - Principal Events.*

After scaling and grading, the logs are picked up by stackers and put into log bunks according to their log grade or company sort code. From there, the logs are bundled and transported to a processing facility, or other destination. Interior piece scale production is predominantly in the form of small operator scaling, often in the millyard.

#### 1.2.4.2 Weight Scaling

Instead of scaling each piece, weight scaling is a sampling method where only a portion of the total production is measured or sampled. Based on the sample results, estimates are made about the production.

The 1960s and 1970s saw the rapid growth of B.C.'s interior forest industry fueled by the construction of pulp mills and the resultant demand for sawmill residues. Over the same period, government policy provided incentives for licensees to adopt close utilization standards in the bush. This coupled with improvements in sawmilling technology resulted in truckloads arriving at the scale site with dramatically smaller average log size and increased number of pieces on the truck. Weight scaling represented an opportunity to estimate harvested volumes with an acceptable level of accuracy and it costs lower than scaling each piece.

When first introduced in the early 1960s, weight scaling was restricted to homogeneous small diameter spruce and lodgepole pine stands. Its use was subsequently expanded as confidence was gained using the approach. Today, over 95% of interior production is weight scaled.

On the coast, less homogeneous forest types, more complex sorting and marketing needs, and more complex transportation and log handling opportunities have impaired the acceptance of weight scaling. While weight scaling offered the same cost savings, it also represented an opportunity to account for logging production before it was put into the water and transported to processing plants. During the 1960s, almost all the coastal logging production was stick scaled while it was boomed in the water. Sinkage often accounted for very significant losses before the logs were scaled. If logs were weighed before they were watered, depletion could be correctly stated and Crown revenues could be controlled. Needless to say, the Forest Service encouraged weight scaling for coastal operations.

Weight scaling grew in prominence on the coast during the 1970s and early 1980s (up to 30% of coastal harvest) but lost in prominence with the growth of dryland sorts and the inability of the weight scale system to provide reliable species and grade volumes to coastal users. In 1994, weight scaling on the coast accounts for less than 15% of the total harvest.

### 1.2.4.3 Special Forest Products

Instead of raw logs, sometimes partially or fully manufactured products are scaled. These are known as special forest products.

Special forest products comprise about 3% of forest production in B.C. and includes Christmas trees, posts, stakes, shakes and shingles, bolts and blocks, and other products as outlined in Chapter 8. To be classified as a special forest product, the product must conform to the product description, be contemplated in the cutting authority (i.e., for Crown timber), and be manufactured on the area of harvest.

For scaling, the scaler does a piece count or uses a variety of approaches to estimate the volume. All special forest products except Christmas trees are recorded in cubic metres for cut administration and reporting purposes.

#### 1A.2.7.4 Type of Scale

Section 5 sets out the different types of scale:

- a. by scaling each piece (piece scaling),
- b. by scaling samples, or
- c. other methods, including an estimate approved by the persons named under Section 5.

Where timber is scaled using an approved sampling method, subsection 5 (1.1) (b) of the *Scaling Regulation* sets out the legislative requirements that must be satisfied (i.e., must be scaled in accordance with an approved sampling plan. The approved sampling plan must carry a sampling error objective of  $\pm 1$  percent (19 times out of 20) for the population volume covered under the plan. Weight scaling, the main sampling procedure used in scaling, is covered under Chapters 9 and 10 of this manual.

This section also requires that special forest products other than Christmas trees must be scaled by a method approved by the regional manager, district manager, or a forest officer authorized by either of them. Christmas trees must be scaled by classifying each tree according to species and length class, and counting the number of trees in each classification. Chapter 8 of this manual documents scaling of special forest products in detail.

#### 1A.2.7.5 Scaling Procedures

Section 6 of the *Scaling Regulation* prescribes how a scaler is to scale timber and record scale data. This manual details these requirements.

#### 1A.2.7.6 Timber Grading

Sections 7, 8, and 9 of the *Scaling Regulation* set out the requirements for classifying the grade of timber as required under subsection 6 (k).

Section 7 prescribes that timber cut from an area in which timber is appraised using a log based appraisal must be graded in accordance with the Schedule of Coast Grades. Timber cut from all other areas must be graded using the Schedule of Interior Grades.

Section 8 outlines the placement of grades in the schedule where the grade criteria match more than one grade.

Section 9 (1) defines what rounding conventions are to be applied in using the schedules of timber grades.

Section 9 (2) prescribes the disposition of grades where timber has been bucked at the scale site into lengths less than prescribed minimums (see Bucking at the Scale Site, Section 1A.2.7.3). Under Section 9 (3), where logs lengths exceed 12.8 meters on the coast, the diameter used for applying the Coast Schedule of Grades is the diameter measured at the point 12.8 meters from the large end of the log.

Timber Grading is discussed in detail under Chapter 6.

#### **1A.2.7.7 Calculation of Log Volumes**

Section 10 of the *Scaling Regulation* prescribes the method and standards for calculating scaled log volumes under the British Columbia metric scale.

The basis for the BC Metric Scale is detailed in Chapter 5 of this manual and the standard for calculating volumes are contained in Appendix 7B.

#### **1A.2.8 Section 97 - Scale Return Submission**

Subsection 97 (1) of the *Forest Act* requires the owner of the scale site, the operator of the scale site, the person whose timber is being scaled, and the person who performed the scale to complete a scale return in a form approved by the minister. The section further requires a copy of the scale return to be delivered within a prescribed time to the person whose timber is scaled and to the regional or district manager and also retain a copy at the scale site.

Subsection 11 (1) of the *Scaling Regulation* prescribes the required timing for submission of the scale return to be seven days after the end of the period stated under the scale site authorization. Subsection 11 (2) further prescribes penalties where these timing requirements are not met. These penalties may be waived under Subsection 11 (3) where the Regional Manager is satisfied the course of the late submission was beyond the control of the person required to submit the scale return.

Section 12 of the *Scaling Regulation* further authorizes the regional manager to order the electronic submission of scale returns where the annual volume from the scale site exceeds 50 000 m<sup>3</sup>.

#### **1A.2.9 Section 97 - Scale Return Check Scales**

Subsection 97 (4) of the *Forest Act* provides that where a check scale conducted under Section 94 (4) of the *Forest Act* varies from the original scale by a prescribed percentage in terms of volume or value, the check scale governs for purposes of the *Forest Act*. Section 14 of the *Scaling Regulation* sets the prescribed percentage at 3 percent.

Subsection 97 (5) of the *Forest Act* authorizes the named persons to exempt replacement of the original scale by the check scale where it is considered the original scale was

Coastal grades have changed over the years in response to varying needs. The most recent major revisions were made in 1981 with the implementation of a new schedule of grades. This schedule developed by a joint ministry/industry committee introduced the letter grades (recorded as alphabetical characters), and replaced their numeric predecessors. The 1981 schedule was subsequently revised in 1990.

### **6.1.2 Interior Grading**

Significant growth in the interior forest sector did not commence until the mid 1960s. The first interior grading system under the *Scaling Regulation* was introduced in 1988 to enable reduced stumpage rates to be applied to lower quality logs. Prior to this, grading was restricted to firmwood reject logs and 'category 04' logs, recovered from decadent and damaged stands. The interior schedule was subsequently amended in 1990 to meet the needs of a new utilization policy.

## 6.2 Timber Grading Requirement

In British Columbia, all timber harvested from private or Crown lands or salvaged from the foreshore must be scaled. Grading is a legal requirement and an integral component of the scale.

The legal authority for grading falls under the *Scaling Regulation*. This regulation prescribes two grading schedules; one for the coast and one for the interior. The method of stumpage used in the area where the timber is cut determines which schedule must be used:

- timber cut in areas where a log based appraisal is used (predominantly coast) must be graded with the Schedule of Coast Timber Grades, and
- timber cut in areas where a lumber based appraisal is used (predominantly interior) must be graded using the Schedule of Interior Timber Grades.

This chapter details how timber is graded in accordance with the schedules of timber grades.  Special forest products described in Chapter 8 are not graded. 

# Special Forest Products

---

# 8

Some scaling involves the measurement of partially or fully manufactured products instead of raw logs. These products are known as special forest product. This chapter documents the classification and scaling requirements for special forest products. Topics covered include:

- when can timber be scaled as a special forest products instead of a raw log,
- exportability of partially manufactured products,
- product descriptions for each product including botanical forest products,
- timber marking requirements, and
- scaling methods and documentation requirements.

## 8.1 Definition of Special Forest Products

In some cases, operators are permitted to partially or fully manufacture products before having timber scaled. Such products are known as Special Forest Products.

Special Forest Products are designated in the  *Special Forest Products Regulation* to include:

|                   |                                            |
|-------------------|--------------------------------------------|
| Christmas trees   | Cants                                      |
| Firewood          | Posts and rails (split and round)          |
| Mining timbers    | Shake and shingle bolts, blocks and blanks |
| Stakes and sticks | Shakes                                     |

The *Appraisal Manuals (Coast and Interior)* maintain up-to-date listings of Special Forest Products and their reserve stumpage rates.

### 8.1.1 Classification as Special Forest Products

The *Forest Act* requires that timber must be scaled prior to manufacture into any product other than Special Forest Products manufactured on the harvest site. The Special Forest Product may then be scaled instead of the timber.

To be classified as a Special Forest Product, the product:

- must be manufactured on the harvest site;
- the product must conform to the product description; and
- the product must be contemplated (named) in the harvesting authority (for Crown timber).

Timber that does not conform to these requirements must be scaled in log form using the B.C. Metric Scale (described in Chapter 5) and graded using appropriate grade schedules (described in Chapter 6) prior to any manufacturing.

### **8.1.2 Exporting Special Forest Products**

While special forest products, by definition, are partially or fully manufactured, they still may not be considered manufactured for the purpose of export.

As such, if scalers are requested by their employer to classify special forest products with respect to their exportability, a knowledge of export requirements is essential.

If scalers are asked to classify any material for the purpose of export, they must be familiar with the current export policy set by the Ministry of Forests. Contact either the district or regional office for copies of the policy and clarification.

A forest officer should be contacted to determine export criteria and product specifications. ►◄

## 8.2 Special Forest Product Descriptions

To scale Special Forest Products, a scaler must be able to identify and code the products, know how to calculate the volume of the product in cubic metres, and be able to document the scale so that charges may be calculated.



The Forest Service will approve the classification and scaling method of a special forest product when issuing a cutting authority, based on the following product descriptions and applications.

### 8.2.1 Christmas Trees

**Product Code:** XM

**Description:** In British Columbia, most christmas trees are Douglas-fir. Trees are selected for appearance, density, form vigour, taper, balance, foliage condition, cleanliness, freshness and size. The Crown sells christmas trees by the piece with charges dependent on the height of the tree.

**Dimensions:** Three height categories are recognized and segregated as grades, these are:

#### Height Category

|           |   |
|-----------|---|
| Over 5 m  | 1 |
| 3 to 5 m  | 2 |
| Under 3 m | 3 |

**Scale Method(s):** Christmas tree piece count method is used in all cases.

### 8.2.2 Firewood

**Product Code:** FW

**Description:** Firewood is manufactured from round or split fuel logs to specific sizes for heating purposes. Firewood is a finished product.

**Dimensions:** Firewood lengths range from 30 to 60 cm. Although 60 cm is the longest common length, some modern heating systems will take a "cordwood" length up to 1.2 m. Firewood is consumer marketed in diameters up to 20 cm.

**Scale Method(s):** The Stacked Special Forest Product Method is used for scaling both split and round firewood. Unless specified in a cutting authority, firewood is not be be classified as such.

### 8.2.3 Mining Timbers

**Product Code:** MT

**Description:** Mining timbers are round red cedar logs with the bark removed. They are used as support structures in mines. Props and caps are somewhat smaller pieces used in conjunction with the heavier timbers. They are an end product and are not to be classified as mining timbers, props or caps if they will not be used for their described purpose.

**Dimensions:** The top diameters range from 10 cm to a maximum of 38 cm. Lengths range from 1.4 m to a maximum of 2.4 m.

**Scale Method(s):** The B.C. Metric Scale is used.

### 8.2.4 Stakes and Sticks

This section includes a variety of products which were previously assigned separate product codes. The same product code now applies to the entire group of products. The full list of products, previously classified separately, is included below for reference.

*Car Stakes***Product Code:** SS

**Description:** Car stakes are round stakes used as side supports on railroad flat cars. They often have one squared end to fit the side pockets built into the car deck and the remainder of the stake has the bark left on. It is now more common to make car stakes from sawn timbers from a mill. These sawn timbers are not classified as car stakes. Car stakes are a finished product and cannot be classified as such with the intent to further process the product into another finished product.

**Dimensions:** Stakes are approximately 10 to 15 cm in diameter and 3 to 5 m in length. The diameter at any place on a piece must not exceed 15 cm.

**Scale Method(s):** Either the Piece Sampling method or the Stacked Special Forest Product method may be used.

*Grape Stakes***Product Code:** SS

**Description:** Grape stakes are either split or round pieces of any species, with or without bark, and are used to support grape vines. They are also used to support ginseng sun shades. Grape stakes are an end product.

**Dimensions:** The diameter range is from 7 to 10 cm and may not to exceed 10 cm in diameter at any point. Maximum length is 3.5 m.

**Scale Method(s):** The Piece Sampling Method is preferred if the stakes are round and well sorted by size categories and the Stacked Method used if the stakes are split and/or the stack is unsorted to size category.

*Hop Poles***Product Code:** SS

**Description:** Hop poles are either split or round pieces of any species without bark and are used to support hop vines.

**Dimensions:** Top diameters range is from 7 cm to a maximum of 13 cm. Length ranges from 4 m to a maximum of 6 m. Hop poles are an end product and are not classified as such if their intended use is for manufacturing another product.

**Scale Method(s):** As with grape stakes, the piece sampling method is preferred if the poles are round and well sorted by size categories and the stacked method used if the poles are split and/or the stack is unsorted by size. Unless provided for in the cutting authority, hop poles with diameters exceeding 10 cm at any point must be scaled using the B.C. Metric Scale.

### *Lagging (Split)*

**Product Code:** SS

**Description:** Split wood of varying thickness, width and length. Lagging is split planking used especially for preventing cave-ins in earthwork or for supporting an arch during construction. As with cribbing, lagging is only manufactured for use as an end product at a specific site for a specified project.

**Dimensions:** There are no restrictions for thickness, width or length but they cannot be classified as lagging if marketed for projects or uses other than their described use at a specific site.

**Scale Method(s):** The Stacked Special Forest Product Method is used. No lagging has been scaled in the past two years because of its limited application.

### *Orchard Props*

**Product Code:** SS

**Description:** Orchard props are split or round logs used to support fruit tree branches. Although not necessarily debarked, they are an end product and may not be used for a purpose other than their described purpose.

**Dimensions:** The top diameters range from 7 cm to a maximum of 10 cm. The lengths can reach a maximum of 2.5 m.

**Scale Method(s):** The Piece Sampling Method is preferred if the pieces are round and well sorted into size classes, and the Stacked Method is used if the pieces are split and/or not sorted into size classes.

### *Pickets and Palings*

**Product Code:** SS

**Description:** Pickets and palings are split, bark free boards and stakes (usually red cedar), used in fence construction. All four faces are usually split, although the edges may be sawn. The faces are never sawn. They are typically rounded or pointed on the top and are considered to be a finished product. They may not be classified as a picket or paling if intended for another purpose or for further manufacturing.

**Dimensions:** Thicknesses range from 1 to 2.5 cm and widths range from 7 to 13 cm. Picket lengths range up to 1.2 m but palings tend to be longer, as in a stockade type fence, up to 2.5 m.

**Scale Method(s):** The Stacked Special Forest Product Method is preferred as pickets and palings are split products.

### *Stakes and Stocks (Sticks)*

**Product Code:** SS

**Description:** Stakes and stocks can be any product with or without bark and a large end diameter of less than 10 cm. Typical products are tepee poles, bulldoze sticks, spears, movie props and other special purpose products that are not defined elsewhere in this manual.

**Dimensions:** The large end diameter of the product must be less than 10 cm. There are no restrictions on length.

**Scale Method(s):** Any of the scaling methods may be chosen, including the B. C. Metric Scale described in Chapter 5, the Piece Sampling Method or the Stacked Method, depending on practicality. A Forest Service scaling representative will assist the scaler in determining that practicality.

### 8.2.5 Cants

**Product Code:** CA

**Description:** A cant is a partially manufactured product which has two flat faces that are further processed through an edger or resaw to make boards. Waney areas are where the bark or the sapwood surface are still present on the product. Cants are produced from dead and down post-logging residue that, as determined by the regional manager, would not make a sawlog.

**Dimensions:** There are no restrictions for end dimensions or length because the classification was established to allow improved utilization of waste material left on a harvest site. If scaler's are asked to further classify cants for the export market, they should refer to the current export policy. 

**Scale Method(s):** The piece sampling method or the B.C. Metric Scale method may be used to obtain a volume in cubic metres.

### 8.2.6 Posts and Rails (Split and Round)

This section also includes a number of products which previously were individually classified as special forest products. The same product code now applies, and the full range of products within the coding is listed for reference.

*Fence Posts (Round)***Product Code:** PR

**Description:** Round fence posts are peeled logs (usually lodgepole pine) manufactured to various dimensions for use in the construction of a fence. Modern fence post manufacturing processes include sharpening and chemical treatment against decay. Fence posts are a finished product and are not further processed into another end product, but will not require treatment at the harvest site to qualify.

**Dimensions:** Posts are graded in sizes to suit consumer markets. Line post top diameters range from 6 to 15 cm and butt diameters range up to 18 cm in these size classes. Corner post top diameters are usually larger than line posts but do not exceed 22 cm. Standard length classes are "sixes" (1.8 m), "six-sixes" (2 m), "sevens" (2.2 m), "eights" (2.4 m), and "tens" (3 m). Posts exceeding these dimensions are an exception, and their consideration as a Special Forest Product is doubtful.

**Scale Method(s):** Either the piece sampling or the stacked methods may be used depending on practicality. Unless provided for in the cutting authority, piece scale or weight scale as logs using the B.C. Metric Scale described in Chapters 5 and 6.

*Fence Rails (Split)***Product Code:** PR

**Description:** Split fence rails are normally manufactured from red cedar trees unsuitable for the manufacture of lumber. They have three or four split, debarked faces and serve the same function as round rails. Both ends of rails are often chamfered to fit pockets drilled in split red cedar posts to suit the decorative rail fence market. Split fence rails are a finished product and are not manufactured further.

**Dimensions:** Each split face ranges from 5 to 10 cm in width at any point depending on the size class. In manufacture, a circumference range is often used to grade rails into sizes corresponding to particular markets. A "Jumbo" rail is about 33 cm around, a "pony" rail is about 25 cm around, and a "Garden" rail is less than 25 cm around. Length classes are the same as for round rails at 1.8, 2, 2.2, 2.4, 3, and 3.6 m.

**Scale Method(s):** The stacked method is considered the most practical scaling method.

#### *Fence Posts (Split)*

**Product Code:** PR

**Description:** Split fence posts are normally manufactured from red cedar trees considered unsuitable for the manufacture of lumber. They have three or four split, debarked faces and serve the same function as round posts. Pockets are often drilled for two or three fence rails to suit the decorative rail fence market. Split fence posts are a finished product and are not further manufactured.

**Dimensions:** Each split face ranges from 8 to 13 cm in width at any point depending on the size class. In manufacture, a circumference range is often used to grade posts into sizes. A "Jumbo" post is approximately 46 cm around, a "Pony" post is about 40 cm and a "Garden" post is less than 40 cm around. Corner post top diameters are usually larger than line posts but do not exceed 15 cm per face or 60 cm around. Length classes are the same as for round posts at 1.8, 2, 2.2, 2.4 and 3 m.

**Scale Method(s):** The Stacked Special Forest Product Method is the practical scaling method.

#### *Fence Rails (Round)*

**Product Code:** PR

**Description:** Round fence rails are peeled logs (usually lodgepole pine) manufactured to various dimensions for use in the construction of a fence. Fence rails are used in place of or in addition to wires and boards. Because rails are not exposed to conditions as harsh as posts are, treatment against decay is not as common. Fence rails are a finished product and are not processed further.

**Dimensions:** Rails are graded to diameter and length classes to suit site conditions or consumer markets. Rail diameters range up to 10 cm measured at any point in the length. Lengths are commonly classed in "sixes" (1.8 m), "eights" (2.4 m), "tens" (3 m) and "twelves" (3.6 m).

**Scale**                      Either the Piece Sampling or the Stacked Methods may be used  
**Method(s):**              depending on the practicality. Unless provided for in the cutting  
                                 authority, dimensions larger than 10 cm are scaled as logs using the  
                                 B.C. Metric Scale.

### **8.2.7 Shake and Shingle Bolts, Blocks and Blanks**

**Product Code:**      SB

**Description:**        Shake bolts and blocks are usually bark free segments cut from logs  
                                 or slabs, usually of red cedar but increasingly from other species  
                                 used for the manufacture of shakes. Although they are commonly  
                                 marketed at this stage, bolts and blocks are only a "partially  
                                 manufactured" product, and may not be sold for a use other than  
                                 their described use. Shake blanks are split from blocks, from which  
                                 two "taper sawn" shakes are made from each blank.

**Dimensions:**        Shake bolts are cut into lengths of approximately 1.4 or 1.45 m from  
                                 which shake blocks are cut into the standard lengths of 46 cm (called  
                                 "eighteens"), and 61 cm (called "twenty fours").

**Scale**                      Blocks and blanks are typically close piled onto very uniform 1.5  
**Method(s):**              cord pallets for shipping and marketing. It is common practice to  
                                 use the stacked method of scaling after the blocks are loaded on  
                                 pallets. An air space factor of 0.7 is used if the blocks are not  
                                 debarked and a factor of 0.8 is used if they are debarked.

*Shingle Bolts and Blocks***Product Code:** SB

**Description:** As with shake bolts and blocks, shingle bolts and blocks are usually debarked segments cut from logs or slabs, usually of red cedar but increasingly from other species, used in the manufacture of shingles. The only difference is that they can be shorter and smaller than shake bolts. Although they are commonly marketed at this stage, bolts and blocks are a partially manufactured product, and may not be sold for another purpose other than their described purpose.

**Dimensions:** Shingle bolts are cut into lengths of approximately 1.3 and 1.45 m from which Shingle blocks are cut into standard lengths of 41 cm (called "sixteens"), 46 cm (called "eighteens"), and a maximum of 61 cm (called "twenty fours").

**Scale Method(s):** Because the blocks are typically close piled onto very uniform 1.5 cord pallets for shipping and marketing, it is therefore practical to use the stacked method of scaling after the blocks are palletized, as described for shake bolts and blocks.

**8.2.8 Shakes****Product Code:** SK

**Description:** Shakes are split from blocks or are taper sawn from blanks and are usually of red cedar, but increasingly of other species. Shakes are a finished or end product and are marketed as such.

**Dimensions:** Shakes are variable in width and thickness according to grade but do not usually exceed 2.5 cm in thickness. They are almost always tapered. Lengths are in the standard lengths of 46 cm (called "eighteens") and 61 cm (called "twenty fours").

**Scale Method(s):** Because shakes are typically close piled onto very uniform 1.5 cord pallets for shipping and marketing, it is practical to use the Stacked method of scaling after the blocks are palletized. If this is the case, it is permissible to count the number of cords and convert to cubic metres by multiplying the number of cords by 3.62457. This provides the enclosed volume in cubic metres. Multiply this volume by a solid wood conversion factor of 0.8 to obtain the solid wood volume in cubic metres. The formula is:

$$\text{Volume (m}^3\text{)} = \text{cords} \times 3.62457 \times \text{solid wood factor (0.8)}$$

### **8.3 Botanical Forest Products**

Increasingly, non-timber products are coming into commercial use. At present, the Ministry of Forests does not regulate the harvest of the vast majority of botanical Forest Products, but because they are related to the forest industry and affect forest management decisions and policy, these products will inevitably enter the scaling field. Measurement and recording of these products will become increasingly important to these processes as they evolve.

A current total of 222 recognized botanical forest products are harvested in B.C. These products can be grouped into eight general categories:

- medicinal and pharmaceutical products,
- wild edible mushrooms,
- floral and greenery products,
- wild berries and fruit,
- herb and vegetable products,
- landscaping products,
- craft products, and
- miscellaneous botanical forest products.

The following descriptions are for only the most common products.

### 8.3.1 Medicinal and Pharmaceutical Products

**Product Codes:** None

**Description:** Many plants and fungi produce compounds with medicinal value. Some of these products have long-established markets and represents a continuing economic opportunity. Medicinal plants used for herbal and alternative health products are marketed primarily through small buying houses which process and package the products for the retail market. Practically no information is available on the harvesting of these products except for cascara and western yew.

Extract of cascara bark is recognized as a useful tonic laxative and yew bark is the source of the drug Taxol, an important cancer therapy.

**Scale Method(s):** There is no requirement that harvesters or collectors of medicinal products to make payments to the Crown at this time. However, with respect to yew bark, it is a requirement to report the amount harvested in kilograms, specified in either dry weight or wet weight. If logs are removed, the logs must be scaled and reported in the same manner as any other commercial timber. Reporting details are available in the *Policy on Yew Bark Harvesting and Collection*.

### 8.3.2 Wild Edible Mushrooms

**Product Codes:** None

**Description:** Forest lands, particularly lodgepole pine forests, are a prime habitat for the Pine mushroom, one of the preferred species for texture and flavour among many groups. Because of its increasing importance as a commercial product, it is necessary to plan the harvesting process to ensure the long term survival of both the forest and the mushroom crop. Chanterelles and Morels are also important commercial species.

**Dimensions:** The Pine mushroom is sorted into six different grades by maturity, with the Grade 1 "button" being the most valuable, and the Grade 6 "over-mature" being the least valuable. Mushrooms classified in each grade are then weighed.

**Scale Method(s):** Mushrooms are not scaled or recorded at this time. If trees are removed or damaged, the logs must be scaled and reported in the same manner as any other commercial timber.

### 8.3.3 Floral and Greenery Products

**Product Code:** None

**Description:** The forest contains a huge inventory of plant species, providing many opportunities for craftspersons to design, manufacture and market decorative products such as wreaths and floral arrangements. These products can be grouped into five different categories:

- greenery
- conifer boughs
- essential oils
- basketry fillers
- fresh or dried flowers

Salal, cedar boughs and various ferns are the most prominent of the decorative vegetations at this time.

**Dimensions:** These products are usually not measured by weight.

**Scale Method(s):** Cedar foliage harvest is recorded by weight according to agreements between harvesters and district managers. Most other products do not yet require recording. If trees are removed or damaged, the logs must be scaled and reported in the same manner as any other commercial timber.

### 8.3.4 Wild Berries and Fruit

**Product Code:** None

**Description:** At present, little information is available about the commercial harvest of wild berries and fruits. All regions in the province report extensive personal use of local fruits and berries, and is considered to have high recreational value. Thirty-four species are collected on a personal basis and seven species are harvested commercially. The most well known of such plants are the wild blueberry, wild blackberry and wild strawberry. Other popular berries include cranberries, huckleberries, salmonberries and thimbleberries.

### 8.3.5 Herb and Vegetable Products

**Product Code:** None

**Description:** Many plant species in British Columbia's forests have market potential for use as vegetables or food seasoning. There are about twenty-three plants used for these products and there is an increasing interest in their use as food products, both commercial and personally. Although such wild herbs and vegetables not only add variety to diets but also can provide food substitutes for people with acute allergies, there is little information on this industry.

### 8.3.6 Landscaping Products

**Product Code:** None

**Description:** Use of native plants for landscaping is an increasing part of the botanical forest product industry. Entire trees, shrubs or herbs may be collected for personal landscaping or for commercial sale to nurseries and garden centres. Landscaping with native species is a preferred alternative to using cultivated species because these plants are naturally adapted to local conditions.

About fifty-three native plant species used for landscaping in British Columbia have been identified, both for individual use and for commercial harvesting supplying nurseries and garden centres.

**Scale**  
**Method(s):** As the industry evolves, methods of determining volumes will be established according to agreements between the harvesters and District Managers.

### 8.3.7 Craft Products

**Product Code:** None

**Description:** North Americans have a growing interest in craft products made from native plant species. Although the commercial potential for these types of craft products is increasing, relatively little data on the industry is available. Participants report that whole plants, leaves, bark, roots or wood may be used to manufacture craft products and about twenty-four different species are popular.

**Dimensions:** Highly variable.

**Scale Method(s):** Many of the products manufactured from wood fall into the classification of stakes and stocks (sticks) described in Section 8.2.2.1. Other wood products, if over 10 cm in diameter, are scales as logs. Any trees felled or damaged in the process of gathering craft products are scaled using the B.C. Metric Scale.

### 8.3.8 Miscellaneous Botanical Forest Products

**Description:** Several botanical forest products do not fit into any of the previous categories. These products include honey, beeswax, syrup, and smoke woods. At present, little is known about the commercial use of these products.

**Scale Method(s):** Smoke woods, commonly mountain alder and red alder, are scaled as stakes and stocks (sticks) described in Section 8.2.2.1. Pieces exceeding the diameters for sticks are scaled as logs.

## 8.4 Other Product Descriptions

Other products, not classified as Special Forest Products or botanical products, will enter the field of scaling as these products become commercially viable. This section introduces these products and suggests approaches for measuring and recording them where appropriate.

### 8.4.1 Wood Chips

Wood chips are not considered to be Special Forest Products for scaling purposes. Their measurement, however, may be the responsibility of the scaler.

Recent developments in chipping technology have seen the introduction of portable debarkers and chippers, which operate at roadsides, on a landing, or at a central processing yard. Under these circumstances, the scaler's responsibility is one of determining the volume, grade and timber mark of all timber processed by the chipper.

While the most reliable methods of accounting for timber processed by the chipper are through either piece scaling or weight scaling all logs prior to chipping, these methods are not often feasible. The scaler's task then is one of either weighing or measuring the compacted volume of all chips produced and then determining the volume of the timber required to produce the chips, while remembering that the species, grade(s) and timber mark(s) must also be accounted for.

The volume of timber required to produce the chips is known as a solid wood equivalent. It is estimated by using a sampling method or use of standard conversion factors. Standard conversion factors generally do not satisfy ministry requirements on three accounts:

1. All timber must be accounted for by species,
2. All timber must be graded because:
  - stumpage is determined on the basis of grade,
  - some grades are free of stumpage, and
  - some grades do not contribute to cut control volumes,
3. Chip moisture content (hence density) varies considerably.

As such, a sampling approach may be required. The basic components of a sampling approach include:

1. Randomly select truck or grapple loads for each timber mark,
2. Scale the load accounting for volume, grade and species,

3. Process the same load through the chipper,
4. Weigh the chip production,
5. Calculate the round wood volume/green chip weight conversion factor for each sample,
6. From all the samples taken, calculate the average factor (using the sum of all the sample weights and the sum of all the sample volumes), and
7. Calculate the firm wood volumes for each mark for billing purposes by applying the factor to the total production weight for a given period.

For example:

1. From all samples scaled, 57 m<sup>3</sup> of round wood produced 35 tonnes (35 000 kg) of green chips,
2. The conversion factor derived from dividing the volume by the weight,  $(57 \text{ m}^3/35 \text{ t}) = 1.628 \text{ m}^3$  of firm wood per tonne of chips, and
3. If during the month 1 200 tonnes of chips are produced, the round wood (or firm wood) volume for stumpage billing and cut control purposes is calculated as,  $1\,200 \text{ t} \times 1.628 = 1\,954.2 \text{ m}^3$ .

The above example is greatly simplified for conceptual purposes. In reality, because log grades and species must be accounted for, separate ratios must be developed for each species/grade combination. For example, using the same sample, if 20 m<sup>3</sup> of the sample is HE grade Z and 37 m<sup>3</sup> is HE grade X, the ratios are calculated as follows:

- HE Z ratio =  $20 \text{ m}^3/35 \text{ t} = 0.571 \text{ m}^3/\text{tonne}$ , and
- HE X ratio =  $37 \text{ m}^3/35 \text{ t} = 1.057 \text{ m}^3/\text{tonne}$ .

For recording and billing purposes, if 1 200 tonnes of chips were produced in a month from a mark, the volume would be calculated as follows:

- HE Z volume =  $0.571 \text{ m}^3/\text{t} \times 1\,200 \text{ t} = 685.7 \text{ m}^3$ , and
- HE X volume =  $1.057 \text{ m}^3/\text{t} \times 1\,200 \text{ t} = 1\,268.5 \text{ m}^3$ , a total volume of 1 954.2 m<sup>3</sup>.

As remote chipping grows in prominence, more standardized scaling and recording procedures will likely be implemented throughout the ministry.

## 8.5 General Requirements

### 8.5.1 Timber Marking

The timber marking requirements for Special Forest Products are the same as for timber. That is, all products must be conspicuously marked on the area of origin prior to any transportation off the area in accordance with the *Timber Marking & Transportation Policy* (see Chapter 2 for more detail on marking requirements). Exemptions to the marking requirements may be granted where practical, depending on the:

- type of forest product (i.e., is marking feasible or will the marking adversely effect the quality of the product?),
- the designated scale site (i.e., does the scale site receive products from several marks?),
- the geographic area (i.e., is there a risk of theft if the site is readily accessible?),
- the form of transport (i.e., will the product be water-borne?), and
- the type of licence (i.e., is it a cash sale licence or is it stumpage bearing).

Exemptions will not be issued if timber will be water-borne, subject to export, or transported out of a jurisdiction unless a different level of marking is approved by the receiving jurisdiction.

### 8.5.2 Scaling

All special forest products removed from Crown or private land are required to be scaled and recorded in a proper manner by an authorized scaler (see Chapter 11 for more information on scaling authorizations). Scaling may be performed at the harvest site or at another authorized scale site. If the product is transported off the harvest site prior to being manufactured into a special forest product, that is in log form, it must be scaled in log form and graded accordingly.

The underlying objective of special forest product measurement is to determine the net firmwood volume of the products. A notable exception is Christmas trees, which require a piece count by species and length category. Special forest products are not graded like other forms of timber.

Because of the size, shape, and often the number of pieces conventional piece scaling for special forest products is often not feasible. A number of other methods are in place to determine reliable volumes without the practical problems of scaling each piece. These include:

- the Piece Sampling method (applied mainly to round products),
- the Stacked method (applied mainly to split products), and
- the Piece Count (used only for Christmas trees).

Each method is described under Section 8.6.

The recommended method(s) are given in the section that describes each product. In consultation with the operator and scaler, the Forest Service will authorize the use of a method which is considered accurate and practical for the site. Once a method is determined, it must be applied consistently, and may not be changed without a change to the site and scaler authorizations.

### **8.5.3 Recording the Scale**

Recording the scale is a three step process:

- the scale results are recorded to a scaler's tally sheet,
- the tallies are summarized to a scale summary, and
- the documents are submitted to the ministry (see Chapter 7 for detailed information on forms completion and submission).

### **8.5.4 Transport Documentation**

Anyone transporting timber, Special Forest Products, recognized botanical products, and other forest products is required to carry documentation describing the product being transported. Every load must carry a manifest or bill of lading, which is provided for on the Christmas Tree Return (FS 200), the Record of Purchase of Special Forest Products (FS 222), or the Load Description Slip (FS 649) for products scaled in log form.

The purchaser of timber is responsible for obtaining and retaining documentation on proof of scale for material received at the purchaser's site. The purchaser may be responsible for payment of stumpage and any associated charges where the purchaser cannot prove that the timber was scaled previously.

### 8.5.5 Document Handling for Special Forest Products

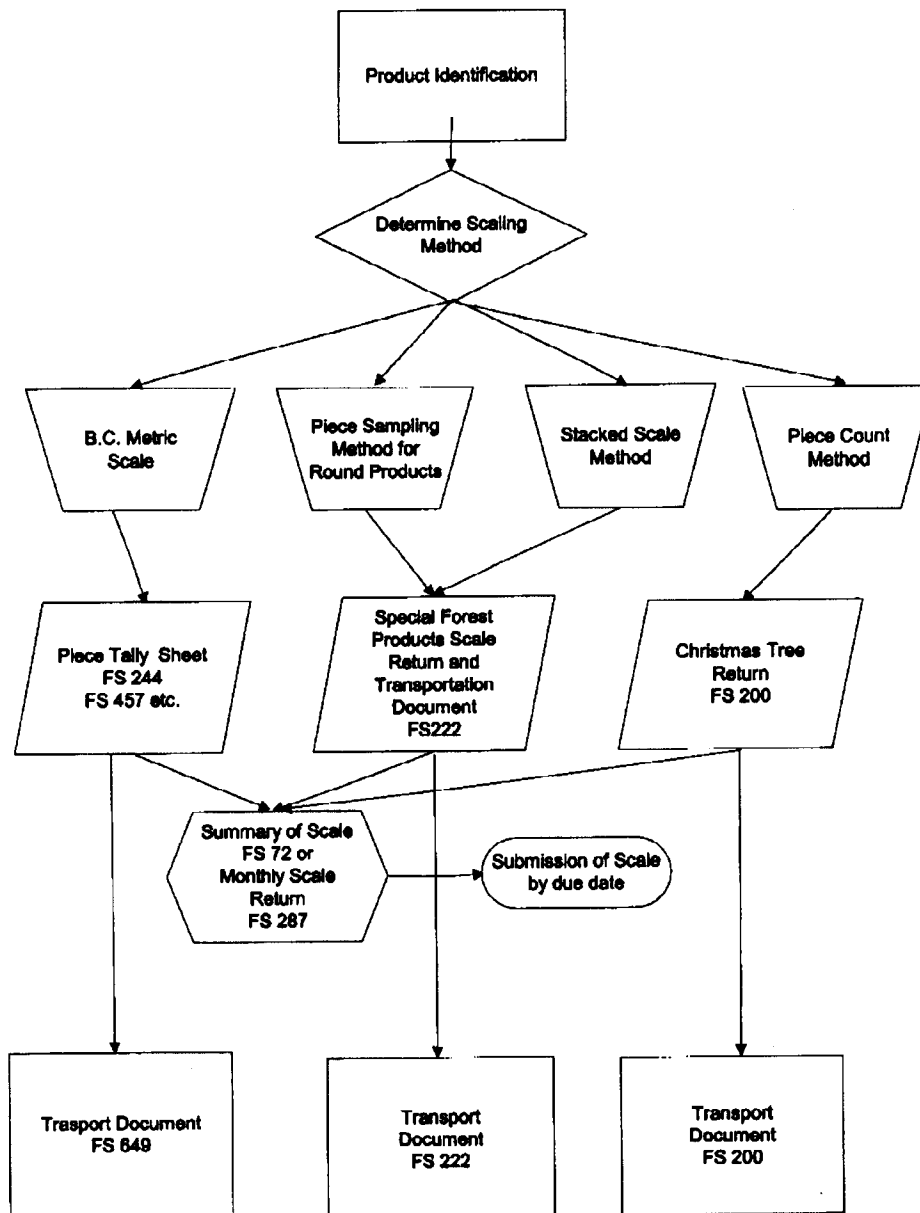


Figure 8.1 Flow diagram outlining selection of scaling methods and forms.

## 8.6 Special Forest Product Scaling Methods

When choosing a method of scaling Special Forest Products, the scaler (in consultation with a Forest Service scaling representative), must decide on a method to use to suit the product and the site conditions. Although method(s) are recommended in the product descriptions section for each product, it may be more practical to choose another method. Some guidelines are:

The Piece Sampling method is best for:

- uneven piles,
- product lengths exceeding 5 m,
- well sorted size classes,
- large numbers of smaller pieces, and
- round products, for example, round fence posts.

The Stacked method is best for:

- even piles,
- product lengths of 5 m or less,
- difficult to sort size classes,
- large numbers of very small pieces, and
- irregular shapes, for example, shake and shingle blocks.

The Piece Count is used only for Christmas trees.

The B.C. Metric Piece Scale is used for poles, pilings, and building logs, and where:

- material is not piled into units for sampling or stacked methods,
- material is not sorted into size, species and quality class, and
- another scaling method has not been authorized.

In consultation with the operator and scaler, the Forest Service will authorize the use of a method most accurate and practical for the site. Once a method is determined, it must be applied consistently, and may not be changed without a change to the scale site and scaler authorizations.

### **8.6.1 Round Piece Sampling Method**

This method of determining the net volume of a Special Forest Product is used for scaling round small diameter special forest products such as round fence posts, round rails, grape stakes, orchard props, and sticks. Chapters 9 and 10 provide a comprehensive overview of sampling techniques used in weight scaling, and the piece sampling process is similar. Section 8.6.5 illustrates a method to determine the number of samples required for a given group or population.

The steps are:

1. Sort the product to be scaled into species, standard length classes (increments of 0.1 m), and top size (increments of one rad class). Normally, most products will be sorted into dimension classes as part of the marketing process. If this sort includes dimensions exceeding the above increments, more samples will have to be taken to achieve an accurate scale.
2. Scale a number of representative pieces using the BC Metric Scale described in Chapter 5. A sufficient quantity of pieces must be scaled to establish an average volume with confidence. For example, if all of the pieces are nearly identical in length and diameter, fewer pieces would be sampled, but as the size variation increases within a pile, more samples are required. In all cases, a minimum number of samples may be set by the ministry.
3. Determine the average net volume per piece or the "volume factor" (to five significant figures) for each bundle or pile by dividing the total volume of the scaled pieces by the piece count of the scaled pieces.
4. Count the number of pieces in the bundle or pile.
5. Multiply the number of pieces in each bundle or pile by the volume factor to determine the net cubic volume of the bundle or pile.

## 8.6.1.1 Calculation of the Piece Sampling Method

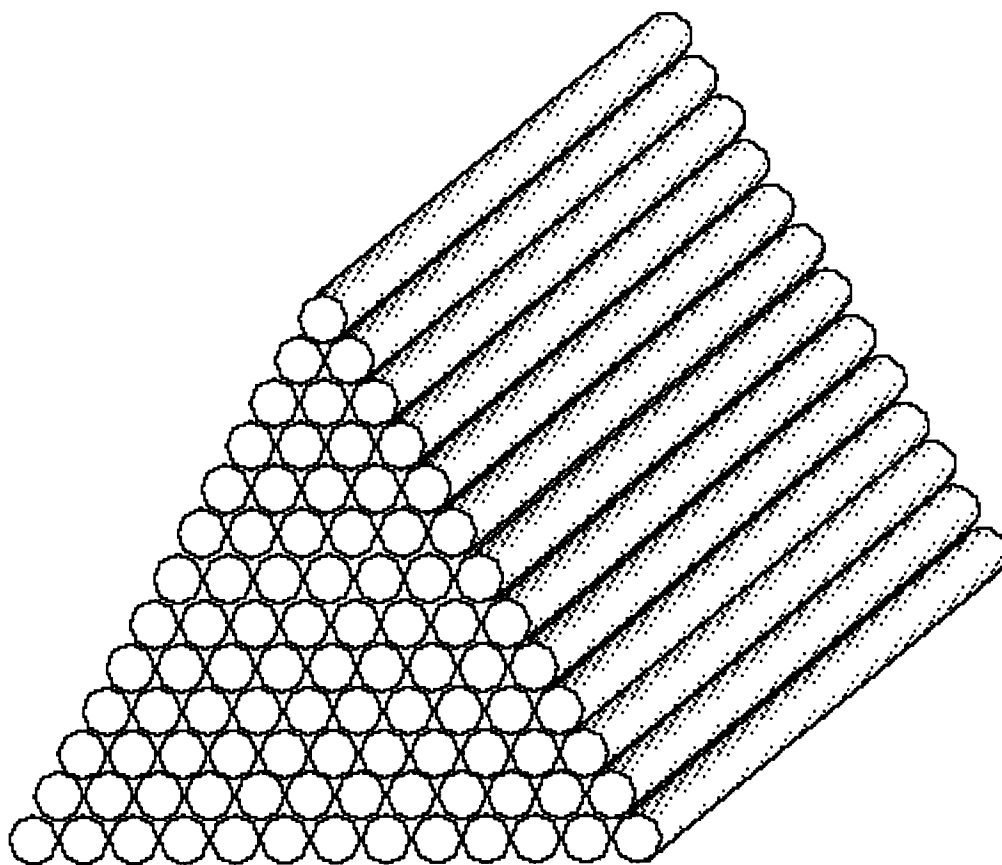


*Figure 8.2 A pile of posts sorted to size classes and ready for sampling.*

In determining the volume for 100 round fence posts 2.4 m long, five sample posts were measured.

| Post Number                 | Length | Top | Butt | Volume (dm <sup>3</sup> ) |
|-----------------------------|--------|-----|------|---------------------------|
| 1                           | 2.4    | 6   | 7    | 14 + 18 = 32              |
| 2                           | 2.4    | 6   | 6    | 14 + 14 = 28              |
| 3                           | 2.4    | 6   | 7    | 14 + 18 = 32              |
| 4                           | 2.4    | 7   | 7    | 18 + 18 = 36              |
| 5                           | 2.4    | 6   | 6    | <u>14 + 14 = 28</u>       |
| Total volume of five posts: |        |     |      | 0.156 m <sup>3</sup>      |

Average volume per post (factor):  $0.156 \text{ m}^3 \div 5 = 0.0312 \text{ m}^3$

Total volume of 100 posts:  $0.0312 \times 100 = 3.1 \text{ m}^3$

6. The measurements are recorded on the FS 222 in the following manner (Figure 8.3);

On the FS 222, clearly indicate the factor used. Refer to Chapter 7 for more details on completing this form.



**SPECIAL FOREST PRODUCTS  
SCALE RETURN AND  
TRANSPORTATION DOCUMENT**

|                                                  |  |                                                                                             |                       |                                                                          |              |
|--------------------------------------------------|--|---------------------------------------------------------------------------------------------|-----------------------|--------------------------------------------------------------------------|--------------|
| TIMBER MARK<br><b>33969</b>                      |  | GEOGRAPHIC LOCATION OF TIMBER ORIGIN<br><b>East Side</b>                                    |                       |                                                                          |              |
| CONTRACTOR<br><b>Mel Smith</b>                   |  | BLOCK / LANDING / SETTING<br><b>1 1</b>                                                     |                       | HAUL DISTANCE<br><b>38 km.</b>                                           |              |
| CARRIER COMPANY NAME<br><b>Ted's Trucking</b>    |  | VEHICLE LICENSE NO.<br><b>6251TX</b>                                                        |                       |                                                                          |              |
| TRANSPORT OPERATOR'S NAME<br><b>Ted Jones</b>    |  | TRANSPORT OPERATOR'S SIGNATURE<br><b>Theodore Jones</b>                                     |                       |                                                                          |              |
| DATE OF TRANSPORT<br>YY MM DD<br><b>02 01 30</b> |  | TIME<br><b>06:30 am.</b>                                                                    |                       | DESTINATION OF SPECIAL FOREST PRODUCTS<br><b>Acerville Wood Products</b> |              |
| PURCHASER<br><b>Acerville Wood Products</b>      |  | VENDOR OR AGENT'S SIGNATURE<br><b>Malbert Smith Esq.</b>                                    |                       |                                                                          |              |
| SCALER'S LICENSE #<br><b>429D</b>                |  | PLACE OF SCALING<br><b>33969 - Block 1, Ldg 1</b>                                           |                       |                                                                          |              |
| VENDOR<br><b>Mel Smith</b>                       |  | SCALER'S RETURN #<br><b>021</b>                                                             |                       | SCALER'S SIGNATURE<br><b>J. Scale</b>                                    |              |
| DATE OF SCALING<br>YY MM DD<br><b>02 01 29</b>   |  | IF PREVIOUSLY SCALED PROVIDE ORIGINAL SCALER'S<br>LICENCE # RETURN # DATE OF ORIGINAL SCALE |                       |                                                                          |              |
| DESCRIPTION                                      |  | LENGTH OR<br># SQUARES                                                                      | WIDTH OR<br># BUNDLES | HEIGHT OR<br># PIECES                                                    | FAC<br>TOR   |
| <b>Ld fence posts (PR)</b>                       |  |                                                                                             |                       | <b>100</b>                                                               | <b>.0312</b> |
|                                                  |  |                                                                                             |                       |                                                                          | <b>3.1</b>   |
|                                                  |  |                                                                                             |                       |                                                                          |              |
|                                                  |  |                                                                                             |                       |                                                                          |              |
|                                                  |  |                                                                                             |                       |                                                                          |              |

DISTRIBUTION: WHITE - MOF (copy of scale attached); CANARY - TRANSPORTER; PINK - VENDOR/CONTRACTOR; GREEN - REMAIN IN BOOKLET  
FS 222 HVA 01/05 Please be advised that this information may be released under the Freedom of Information and Protection of Privacy Act.

**Figure 8.3 Completed FS 222 for 100 round fence posts.**

7. At the end of the month of scaling, a Summary of Scale (FS 72) or a Monthly Scale Return (FS 287) is completed and submitted to the appropriate Forest Service district office on or before the prescribed submission time (Figure 8.4).

| PAGE                |  | LINE | TYPE | SCALER'S MEMBER | TALLY OR RIFT NO. | MONTHLY SCALE RETURN                                |  | 07639                                                   |  |
|---------------------|--|------|------|-----------------|-------------------|-----------------------------------------------------|--|---------------------------------------------------------|--|
| 0 0 0               |  | 0    | 0    | 0               | 4240059           |                                                     |  | CHARGED ON STUMPAGE INVOICE NUMBER                      |  |
| 1 2 3 4 5           |  |      |      |                 |                   | DATE OF RETURN<br>YEAR MO DAY<br>95 02 28           |  | PAYABLE BY<br>HARRY BOWLS                               |  |
| 6 7 8 9 10          |  |      |      |                 |                   | SECOND COPY TO                                      |  | HOW DELIVERED<br>TRUCK                                  |  |
| 11 12 13 14 15      |  |      |      |                 |                   | TOTAL PIECES<br>010021                              |  | CHARGES PAYABLE BY<br>ACERVILLE WOOD PRODUCTS           |  |
| 16 17 18 19 20      |  |      |      |                 |                   | SCALING STATION NUMBER                              |  |                                                         |  |
| 21 22 23 24 25      |  |      |      |                 |                   | PLACE OF SCALING                                    |  |                                                         |  |
| 26 27 28 29 30      |  |      |      |                 |                   | PLACE OF SCALING (cont.)                            |  | YARD                                                    |  |
| 31 32 33 34 35      |  |      |      |                 |                   | MARK                                                |  | 33969                                                   |  |
| 36 37 38 39 40      |  |      |      |                 |                   | NUMBER OF PIECES                                    |  | 0010060                                                 |  |
| 41 42 43 44 45      |  |      |      |                 |                   | PRODUCT CODE                                        |  | PR 0000031                                              |  |
| 46 47 48 49 50      |  |      |      |                 |                   | QUANTITY                                            |  | 0000031                                                 |  |
| 51 52 53 54 55      |  |      |      |                 |                   | RATE                                                |  |                                                         |  |
| 56 57 58 59 60      |  |      |      |                 |                   | SPECIAL FOREST PRODUCT CODES                        |  | COMPILED FROM TALLY SHEETS OR TALLY BOOK PAGES IN MONTH |  |
| 61 62 63 64 65      |  |      |      |                 |                   | NAME                                                |  | BL                                                      |  |
| 66 67 68 69 70      |  |      |      |                 |                   | GRADE                                               |  | CS                                                      |  |
| 71 72 73 74 75      |  |      |      |                 |                   | CODE                                                |  | 432751                                                  |  |
| 76 77 78 79 80      |  |      |      |                 |                   | BUILDING LOGS                                       |  | BL                                                      |  |
| 81 82 83 84 85      |  |      |      |                 |                   | CAR STAKES                                          |  | CS                                                      |  |
| 86 87 88 89 90      |  |      |      |                 |                   | CHRISTMAS TREES - 5 m                               |  | 1 XM                                                    |  |
| 91 92 93 94 95      |  |      |      |                 |                   | 3-5 m                                               |  | 2 XM                                                    |  |
| 96 97 98 99 100     |  |      |      |                 |                   | 1-3 m                                               |  | 3 XM                                                    |  |
| 101 102 103 104 105 |  |      |      |                 |                   | CRIBBING                                            |  | CR                                                      |  |
| 106 107 108 109 110 |  |      |      |                 |                   | FRUIT/POLETS (HARD)                                 |  | PR                                                      |  |
| 111 112 113 114 115 |  |      |      |                 |                   | FENCE POSTS (HARD)                                  |  | PR                                                      |  |
| 116 117 118 119 120 |  |      |      |                 |                   | FIREWOOD                                            |  | FW                                                      |  |
| 121 122 123 124 125 |  |      |      |                 |                   | GRAPE STAKES                                        |  | GS                                                      |  |
| 126 127 128 129 130 |  |      |      |                 |                   | HOP POLES                                           |  | HP                                                      |  |
| 131 132 133 134 135 |  |      |      |                 |                   | LUGGING SPLIT                                       |  | LA                                                      |  |
| 136 137 138 139 140 |  |      |      |                 |                   | MINING TIMBERS                                      |  | MT                                                      |  |
| 141 142 143 144 145 |  |      |      |                 |                   | ORCHARD PROPS                                       |  | OP                                                      |  |
| 146 147 148 149 150 |  |      |      |                 |                   | OTHER LOGS                                          |  | OL                                                      |  |
| 151 152 153 154 155 |  |      |      |                 |                   | POLETS OR PALING                                    |  | PL                                                      |  |
| 156 157 158 159 160 |  |      |      |                 |                   | PILING                                              |  | PP                                                      |  |
| 161 162 163 164 165 |  |      |      |                 |                   | POLES                                               |  | PO                                                      |  |
| 166 167 168 169 170 |  |      |      |                 |                   | RAILS (HARD)                                        |  | RR                                                      |  |
| 171 172 173 174 175 |  |      |      |                 |                   | RAILS (SOFT)                                        |  | RS                                                      |  |
| 176 177 178 179 180 |  |      |      |                 |                   | SHAKES                                              |  | SK                                                      |  |
| 181 182 183 184 185 |  |      |      |                 |                   | SHAKE BOLTS OR BLOCKS                               |  | SB                                                      |  |
| 186 187 188 189 190 |  |      |      |                 |                   | SHINGLE BOLTS OR BLOCKS                             |  | LB                                                      |  |
| 191 192 193 194 195 |  |      |      |                 |                   | STAKES AND STICKS                                   |  | SS                                                      |  |
| 196 197 198 199 200 |  |      |      |                 |                   | N.B.: LEAVE PRODUCT CODE BLANK WHEN REPORTING LOGS. |  |                                                         |  |
| 201 202 203 204 205 |  |      |      |                 |                   | COMPILED BY                                         |  | J. Scallie                                              |  |
| 206 207 208 209 210 |  |      |      |                 |                   | SCALER'S SIGNATURE                                  |  | J. Scallie                                              |  |
| 211 212 213 214 215 |  |      |      |                 |                   | CLERICAL                                            |  |                                                         |  |
| 216 217 218 219 220 |  |      |      |                 |                   | KEYED BY                                            |  | VERIFIED BY                                             |  |
| 221 222 223 224 225 |  |      |      |                 |                   |                                                     |  |                                                         |  |
| 226 227 228 229 230 |  |      |      |                 |                   |                                                     |  |                                                         |  |
| 231 232 233 234 235 |  |      |      |                 |                   |                                                     |  |                                                         |  |
| 236 237 238 239 240 |  |      |      |                 |                   |                                                     |  |                                                         |  |
| 241 242 243 244 245 |  |      |      |                 |                   |                                                     |  |                                                         |  |
| 246 247 248 249 250 |  |      |      |                 |                   |                                                     |  |                                                         |  |
| 251 252 253 254 255 |  |      |      |                 |                   |                                                     |  |                                                         |  |
| 256 257 258 259 260 |  |      |      |                 |                   |                                                     |  |                                                         |  |
| 261 262 263 264 265 |  |      |      |                 |                   |                                                     |  |                                                         |  |
| 266 267 268 269 270 |  |      |      |                 |                   |                                                     |  |                                                         |  |
| 271 272 273 274 275 |  |      |      |                 |                   |                                                     |  |                                                         |  |
| 276 277 278 279 280 |  |      |      |                 |                   |                                                     |  |                                                         |  |
| 281 282 283 284 285 |  |      |      |                 |                   |                                                     |  |                                                         |  |
| 286 287 288 289 290 |  |      |      |                 |                   |                                                     |  |                                                         |  |
| 291 292 293 294 295 |  |      |      |                 |                   |                                                     |  |                                                         |  |
| 296 297 298 299 300 |  |      |      |                 |                   |                                                     |  |                                                         |  |

FS 287 HVA 89/07 Please be advised that this information may be released under the Freedom of Information and Protection of Privacy Act.

Figure 8.4 Completed FS 287 - Monthly scale return summarizing the FS 222 in Figure 8.3.

### 8.6.2 Stacked Special Forest Products Method

The stacked method of scaling special forest products can be used for either split or round products.

#### Method

1. Stack the product so all the pieces are of one species and length. The stack should be of uniform length, width, and height.
2. Measure the length, width, and height of the stack to the nearest 0.02 m (2 cm). Refer to Figure 8.5 for the number of height measurements required to establish the average height of the stack.

|                      | Number of Height Measurements |                  |
|----------------------|-------------------------------|------------------|
| Pile Length (Metres) | Regular Stacks                | Irregular Stacks |
| 2                    | 2                             | 3                |
| 3                    | 2                             | 3                |
| 5                    | 3                             | 6                |
| 10                   | 6                             | 12               |
| 15                   | 8                             | 12               |
| 20                   | 10                            | 12               |
| 25                   | 10                            | 15               |

*Figure 8.5 Table of number of pile heights taken for various lengths.*

3. Multiply the measured length, width and average height of the stack to obtain the volume of the stack in cubic metres.
4. Multiply the stacked volume by a factor (Figure 8.6) to eliminate the volume of bark, air space, and defect in the stack and determine the net volume of the stack. The factor can vary depending of the amount of bark, length of material, and the compactness of the stack. Therefore, where appropriate, the scaler may request a Forest Service officer to authorize a more appropriate solid wood conversion factor.

| Product                      | Solid Wood Conversion Factor |
|------------------------------|------------------------------|
| Unpeeled round wood products | 0.65                         |
| Unpeeled split products      | 0.70                         |
| Peeled round wood products   | 0.75                         |
| Peeled split products        | 0.80                         |

*Figure 8.6 Table of solid wood conversion factors by product.*

5. The measurements will be recorded on the FS 222 in the following manner:

On the FS 222, clearly indicate the factor used.



BRITISH  
COLUMBIA



**SPECIAL FOREST PRODUCTS  
SCALE RETURN AND  
TRANSPORTATION DOCUMENT**

|                                                  |                        |                                                                                             |                       |                                                                      |                     |
|--------------------------------------------------|------------------------|---------------------------------------------------------------------------------------------|-----------------------|----------------------------------------------------------------------|---------------------|
| TIMBER MARK<br><b>WL211B</b>                     |                        | GEOGRAPHIC LOCATION OF TIMBER ORIGIN<br><b>Westside</b>                                     |                       |                                                                      |                     |
| CONTRACTOR<br><b>Tom Brown</b>                   |                        | BLOCK / LANDING / SETTING<br><b>2 1 -</b>                                                   |                       | HAUL DISTANCE<br><b>26 km</b>                                        |                     |
| CARRIER COMPANY NAME<br><b>Ted's Trucking</b>    |                        | VEHICLE LICENSE NO.<br><b>6251TX</b>                                                        |                       |                                                                      |                     |
| TRANSPORT OPERATOR'S NAME<br><b>Ted Smith</b>    |                        | TRANSPORT OPERATOR'S SIGNATURE<br><i>Ted Smith</i>                                          |                       |                                                                      |                     |
| DATE OF TRANSPORT<br>YY MM DD<br><b>02 01 31</b> |                        | TIME<br><b>10:15</b>                                                                        |                       | DESTINATION OF SPECIAL FOREST PRODUCTS<br><b>Epic Tonewoods Inc.</b> |                     |
| PURCHASER<br><b>Epic Tonewoods</b>               |                        | VENDOR OR AGENT'S SIGNATURE<br><i>Thomas H. Brown</i>                                       |                       |                                                                      |                     |
| SCALER'S LICENSE #<br><b>J. Scaler 0326</b>      |                        | PLACE OF SCALING<br><b>WL211B Landing</b>                                                   |                       |                                                                      |                     |
| VENDOR<br><b>Tom Brown</b>                       |                        | SCALER'S RETURN #<br><b>311</b>                                                             |                       | SCALER'S SIGNATURE<br><i>J. Scaler</i>                               |                     |
| DATE OF SCALING<br>YY MM DD<br><b>02 01 28</b>   |                        | IF PREVIOUSLY SCALED PROVIDE ORIGINAL SCALER'S<br>LICENCE # RETURN # DATE OF ORIGINAL SCALE |                       |                                                                      |                     |
| DESCRIPTION                                      | LENGTH OR<br># SQUARES | WIDTH OR<br># BUNDLES                                                                       | HEIGHT OR<br># PIECES | FAC<br>TOR                                                           | METRES <sup>3</sup> |
| <b>Cedar Shake Blocks</b>                        | <b>4.92</b>            | <b>2.44</b>                                                                                 | <b>3.24</b>           | <b>0.8</b>                                                           | <b>31.1</b>         |
|                                                  |                        |                                                                                             |                       |                                                                      |                     |
|                                                  |                        |                                                                                             |                       |                                                                      |                     |
|                                                  |                        |                                                                                             |                       |                                                                      |                     |
|                                                  |                        |                                                                                             |                       |                                                                      |                     |

DISTRIBUTION: WHITE - MOF (copy of scale attached); CANARY - TRANSPORTER; PINK - VENDOR/CONTRACTOR; GREEN - REMAIN IN BOOKLET  
FS 222 HVA 01/05 Please be advised that this information may be released under the Freedom of Information and Protection of Privacy Act.

**Figure 8.7 A completed FS 222 - with split product.**

6. At the end of the month of scaling, a Summary of Scale (FS 72) (Figure 8.8) or a Monthly Scale Return (FS 287) is completed and submitted to the appropriate Forest Service district office on or before the prescribed submission time.

| PAGE                                                                                                                                                                                   |   | SEQ. |   | TYPE |   | SCALER'S NUMBER |   | RETURN NUMBER |   | FYC DOMINANT MARK |   | NUMBER OF CHAINS |  | CAMP BOOM NUMBER |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|------|---|------|---|-----------------|---|---------------|---|-------------------|---|------------------|--|------------------|--|
| 0                                                                                                                                                                                      | 0 | 0    | 0 | 0    | 0 | 6               | 1 | 1             | 0 | 0                 | 1 | 8                |  |                  |  |
| TO BE COMPLETED BY THE SCALER TO SUMMARIZE A TALLY SHEET (FS 244) OR BY A CLERK TO CONSOLIDATE A RECORD OF PURCHASE (FS 222) AND FORWARDED FOR PROCESSING. SEE SECTION 7A.1 OF MANUAL. |   |      |   |      |   |                 |   |               |   |                   |   |                  |  |                  |  |
| SCALING ORDER NO.                                                                                                                                                                      |   |      |   |      |   |                 |   |               |   |                   |   |                  |  |                  |  |
| SCALER'S SIGNATURE<br><i>J. Scaler</i>                                                                                                                                                 |   |      |   |      |   |                 |   |               |   |                   |   |                  |  |                  |  |
| VENDOR<br><i>Tom Brown</i>                                                                                                                                                             |   |      |   |      |   |                 |   |               |   |                   |   |                  |  |                  |  |
| PAYABLE BY<br><i>Westside Cedar</i>                                                                                                                                                    |   |      |   |      |   |                 |   |               |   |                   |   |                  |  |                  |  |
| EXPENSES BREAKDOWN                                                                                                                                                                     |   |      |   |      |   |                 |   |               |   |                   |   |                  |  |                  |  |
| REMARKS<br><i>Cedar shake 50%<br/>FS 222#s 432753</i>                                                                                                                                  |   |      |   |      |   |                 |   |               |   |                   |   |                  |  |                  |  |
| OFFICIAL                                                                                                                                                                               |   |      |   |      |   |                 |   |               |   |                   |   |                  |  |                  |  |
| KEYED BY                                                                                                                                                                               |   |      |   |      |   |                 |   |               |   |                   |   |                  |  |                  |  |
| VERIFIED BY                                                                                                                                                                            |   |      |   |      |   |                 |   |               |   |                   |   |                  |  |                  |  |

| SEQ. | TYPE | MARK | UNIT | NUMBER OF PIECES | OTHER DESC. | QUANTITY m <sup>3</sup> | RATE |
|------|------|------|------|------------------|-------------|-------------------------|------|
| 0    | 0.2  | 429T |      | 000000CE         | SB          | 31.1                    |      |
| 0    | 0.3  |      |      |                  |             |                         |      |
| 0    | 0.4  |      |      |                  |             |                         |      |
| 0    | 0.5  |      |      |                  |             |                         |      |
| 0    | 0.6  |      |      |                  |             |                         |      |
| 0    | 0.7  |      |      |                  |             |                         |      |
| 0    | 0.8  |      |      |                  |             |                         |      |
| 0    | 0.9  |      |      |                  |             |                         |      |
| 0    | 1.0  |      |      |                  |             |                         |      |
| 0    | 1.1  |      |      |                  |             |                         |      |
| 0    | 1.2  |      |      |                  |             |                         |      |
| 0    | 1.3  |      |      |                  |             |                         |      |
| 0    | 1.4  |      |      |                  |             |                         |      |
| 0    | 1.5  |      |      |                  |             |                         |      |
| 0    | 1.6  |      |      |                  |             |                         |      |
| 0    | 1.7  |      |      |                  |             |                         |      |
| 0    | 1.8  |      |      |                  |             |                         |      |
| 0    | 1.9  |      |      |                  |             |                         |      |
| 0    | 2.0  |      |      |                  |             |                         |      |
| 0    | 2.1  |      |      |                  |             |                         |      |
| 0    | 2.2  |      |      |                  |             |                         |      |
| 0    | 2.3  |      |      |                  |             |                         |      |
| 0    | 2.4  |      |      |                  |             |                         |      |
| 0    | 2.5  |      |      |                  |             |                         |      |
| 0    | 2.6  |      |      |                  |             |                         |      |
| 0    | 2.7  |      |      |                  |             |                         |      |
| 0    | 2.8  |      |      |                  |             |                         |      |
| 0    | 2.9  |      |      |                  |             |                         |      |
| 0    | 3.0  |      |      |                  |             |                         |      |
| 0    | 3.1  |      |      |                  |             |                         |      |
| 0    | 3.2  |      |      |                  |             |                         |      |
| 0    | 3.3  |      |      |                  |             |                         |      |
| 0    | 3.4  |      |      |                  |             |                         |      |
| 0    | 3.5  |      |      |                  |             |                         |      |

FS 72 HVA 9907 Please be advised that this information may be released under the Freedom of Information and Protection of Privacy Act.

Figure 8.8 A completed FS 72 - summary of information from the FS 222 in Figure 8.7.

### 8.6.3 Christmas Tree Piece Count Method

The Christmas Tree Piece Count method is used for Christmas tree scaling.

#### Method

1. The Christmas trees are sorted by species and height category. The height categories are:

| Height Category |   |
|-----------------|---|
| Over 5 m        | 1 |
| 3 to 5 m        | 2 |
| Under 3 m       | 3 |

2. A piece count is taken for each species and grade.
3. The piece count is recorded on the FS 200, Christmas-Tree Return, as per the example in Figure 8.9.

The height category (i.e., 1, 2, or 3) is recorded under the grade field on the tally sheet.


**BRITISH COLUMBIA** Ministry of Forests
 
C

TREES MUST BE SCALED ON AREA OF ORIGIN. **CHRISTMAS-TREE RETURN**

|                                                             |                                              |                                             |                                                                                                      |                              |
|-------------------------------------------------------------|----------------------------------------------|---------------------------------------------|------------------------------------------------------------------------------------------------------|------------------------------|
| 1. DATE OF SCALING<br>Y M D<br><b>95 02 14</b>              |                                              | PLACE<br><b>14 km - HWY 16E - McBRIDE</b>   |                                                                                                      |                              |
| 2. AREA OF ORIGIN                                           | C.T.P. NO.                                   | LOT NO.                                     | LAND DISTRICT<br><b>5</b>                                                                            | TIMBER MARK<br><b>D67122</b> |
| 3. STUMPAGE OWNER'S NAME<br><b>TOM BRAUN</b>                |                                              | ADDRESS<br><b>BOX 219 - CHAMBERS, B.C.</b>  |                                                                                                      |                              |
| 4. CUTTER'S NAME<br><b>TOM BRAUN</b>                        |                                              | ADDRESS<br><b>BOX 219 - CHAMBERS, B.C.</b>  |                                                                                                      |                              |
| 5. SCALED FOR<br><b>TOM BRAUN</b>                           |                                              |                                             |                                                                                                      |                              |
| 6. CHARGES PAYABLE BY<br>(Please print)                     |                                              | (First name)<br><b>TOMAS</b>                |                                                                                                      | (Last name)<br><b>BRAUN</b>  |
| ADDRESS<br><b>BOX 219, CLINTON, B.C.</b>                    |                                              |                                             |                                                                                                      |                              |
| 7. TREES SCALED                                             |                                              |                                             |                                                                                                      |                              |
| SIZE                                                        | MERCHANTABLE TREES                           | CULLS                                       |                                                                                                      | COMMENTS (SPECIES, ETC.)     |
| LESS THAN 3 m                                               | <b>350</b>                                   |                                             |                                                                                                      |                              |
| 3 m TO 5 m                                                  |                                              |                                             |                                                                                                      |                              |
| MORE THAN 5 m                                               |                                              |                                             |                                                                                                      |                              |
| TOTALS                                                      | <b>350</b>                                   |                                             |                                                                                                      |                              |
| 8. CUTTER'S SIGNATURE<br><b>TIM BRAUN</b>                   |                                              | DATE<br>Y M D<br><b>95 02 14</b>            | 9. SCALER'S SIGNATURE<br><b>J. SCALP</b>                                                             |                              |
| 10. NUMBER OF TRUCKLOADS THIS MANIFEST COVERS<br><b>1</b>   | TRUCKER'S SIGNATURE<br><b>DAVE HANFUNKEL</b> |                                             | TRUCK LICENCE NUMBER<br><b>62-22-77</b>                                                              |                              |
| 11. DESTINATION OR SHIPPING POINT<br><b>VANCOUVER, B.C.</b> |                                              | 12. DATE HAULED<br>Y M D<br><b>95 02 14</b> | IS CUTTING COMPLETED ON AREA?<br><input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |                              |
| 13. COMMENTS                                                |                                              |                                             |                                                                                                      |                              |

DISTRIBUTION: WHITE - DISTRICT MANAGER, CANARY - DISTRICT MANAGER, PINK - BUYER, GREEN - CARRIED BY TRUCKER, BLUE - LAND-OWNER OR CUTTER.  
Spotted return forms must be left in the book with the word "cancelled" written thereon.

PLEASE BE ADVISED THAT THIS INFORMATION MAY BE RELEASED UNDER THE FREEDOM OF INFORMATION AND PROTECTION OF PRIVACY ACT.  
FS 200 HVA 10/11

**Figure 8.9 A completed FS 200 - Christmas tree return.**

4. At the end of the month of scaling, a Summary of Scale (FS 72) or a Monthly Scale Return (FS 287) is completed and submitted to the appropriate Forest Service district office on or before the prescribed submission time (Figure 8.10).

**MONTHLY SCALE RETURN**

BRITISH COLUMBIA

CHARTERED FORTYTHREE BROCKLE NUMBER

SCALERS TALLY OR NAME: 6117054

DATE OF RETURN: YEAR 99, MO 08, DAY 28

PAYABLE BY: TRUCK

SECOND CUPY TO: TOM BROWN

NON DELIVERED

UNPAID PAYABLE BY: TOM BROWN

PLACE OF SCALING: LOCAL AREA HANDSCALES

PLACE OF SCALING (DOT): McBRIDE

COMPLETED WITH TALLY SHEETS OR TALLY BOOK PAGES NUMBERED: 40624

COMPLETED BY: J. Scoble

SCALERS SIGNATURE: J. Scoble

CLERICAL:

KEYED BY: VERIFIED BY:

FS 287 (FPA 1997)

**Figure 8.10 A completed FS 287 - Monthly scale return which summarizes the information on the FS 200 in Figure 8.9.**

#### 8.6.4 Estimating Volumes of Tree Length Piles

Often, a scaler is required to estimate the volume of decks of tree length logs. It is not enough to simply look at a deck and "guesstimate" the volume without some means of measurement to demonstrate confidence that the estimate is based on valid principles. These estimates are used for inventory control, contractor advances, interim invoicing, and the like, but are not adequate for final scale submissions unless pre-authorized by the Regional Manager or District Manager. Piece scaling, weight scaling, and the two Special Forest Products methods (piece sampling and stacked) are the only approved scales for final billing.

Two approaches may be taken, both being a variation of either the round piece sampling method or the stacked method. The level of detail required will influence the scaler's choice of method.

#### 8.6.4.1 Sampling the Pile and Counting Pieces

This method will provide more information on species and grade, but will require enough sampling to develop confidence in the results. If the scaler is concerned with volumes only, then enough samples are taken to represent with confidence the diameter classes and lengths represented. If species and grade considerations are important, then correspondingly more samples must be taken.

1. Determine the number of samples required based on the level of information needed about the pile. Recognized sampling techniques are described in Chapters 9 and 10, but are more involved than necessary for this estimation process. For a more practical approach, select a sample area representative of the pile by estimation.
2. Scale every piece in the sample area as in Figure 8.11.

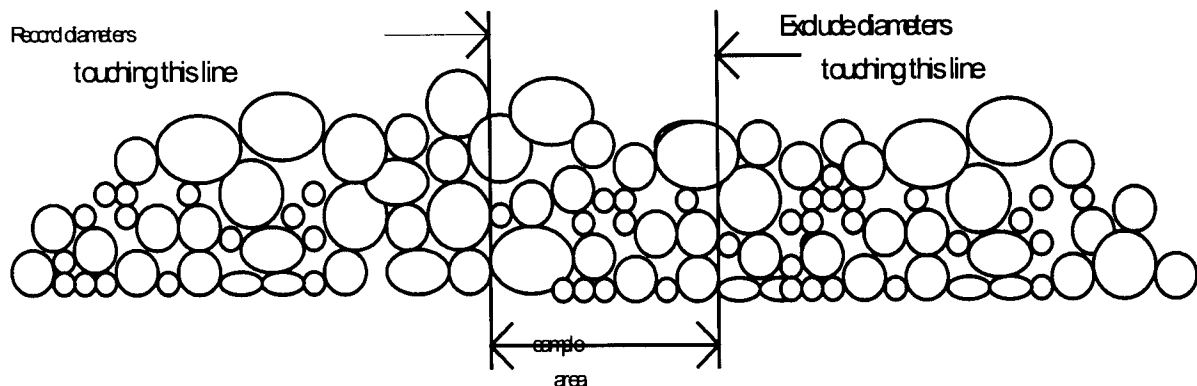


*Figure 8.11 Selecting a sample section from a log deck.*

3. Count the number of trees in the pile.
4. The frequency of each class in the sample is applied to the total count to determine the distribution of each class in the pile. For example, a sample area includes thirty six pieces. If nine pieces fall into species class BA, 20 pieces are SP and seven pieces are FI, then the BA distribution is  $36/9$  or 1 in 4, SP is  $36/20$  or 1 in 1.8, and FI is  $36/7$  or 1 in 5.1. If there are four hundred and twenty five pieces in the pile, there will be approximately  $425/4$  or 106 BA,  $425/1.8$  or 236 SP, and  $425/5.1$  or 83 FI. The same technique may be used for other classes, such as diameters, lengths, and grades.

5. If the piles can be tied into an existing weight scale population, that is, if it is known that the pile to be measured is from a production run that closely matches wood that has been previously sampled as part of a weight scale strata, the statistical values from that series of weight scale samples will provide a detailed profile of the characteristics of the pile. For example, an operator is delivering timber to a weight scale that is taking all production from that mark through stratum X of the mill's population. A deck of logs is left at a landing site because a bridge washed out, and the operator wishes to advance a payment to the contractor based on a good estimate of the volume left on the landing. The sample data gathered from all previously delivered loads through stratum X will provide enough information to apply previously derived factors to a piece count of that deck. In this case, there does not need to be any sampling done on the deck itself. If the piles cannot be tied to a weight scale population, cruise data may provide enough information.

#### 8.6.4.2 Measuring the Pile and Applying a Factor

This method will represent a volume with reasonable satisfaction but may not provide enough detail for species and grade combinations:

1. Measure the height of the pile at 2 m intervals within 0.1 m. If the pile contains lengths exceeding 5 m or is predominately sorted with butts one way, it is necessary to take height measurements down both sides of the pile. Height measurements and length measurements are related. (See item 3 and Figure 8.12).
2. Find the average height of the pile by dividing the sum of the pile measurements by the number of measurements.
3. Measure the length of the pile within 0.1 m. Length measurements and height measurements are related, (Figure 8.12). If the total length of the pile is measured, the heights must be taken throughout the full length of the pile. When the length measurement is less than full length, (i.e., "squaring up" the pile, Figure 8.14), height measurements are taken only inside the square.

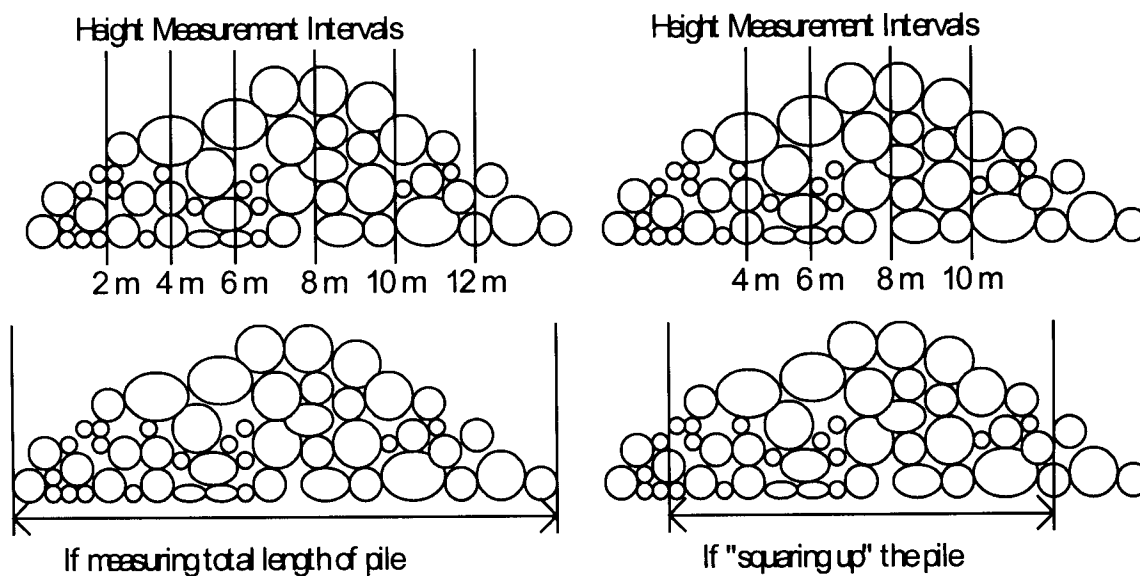


**Figure 8.12** Two methods of measuring the length and height of a pile.

4. Determine the average width of the pile by taking as many tree length measurements as possible and dividing the sum of the lengths by the number of measurements as in Figure 8.13.

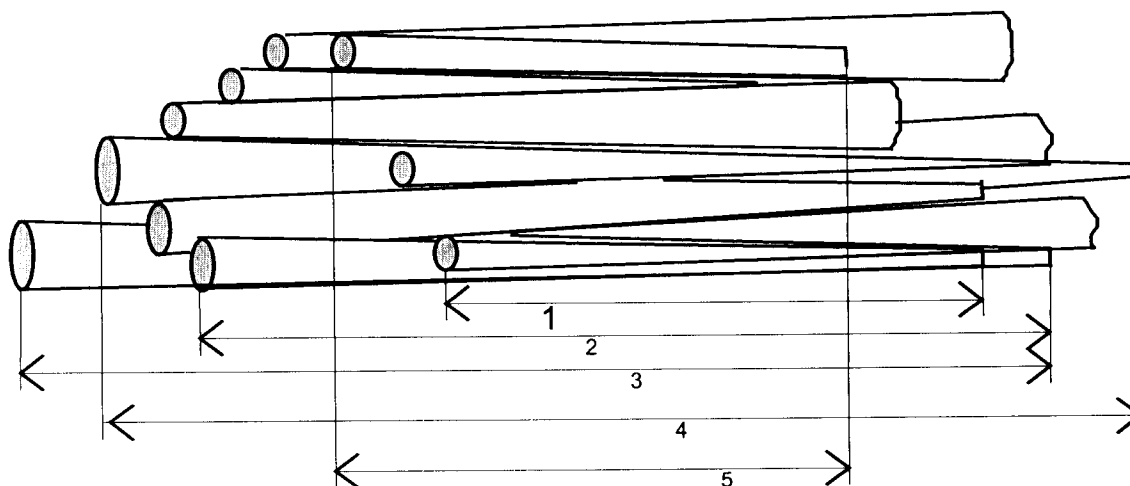


**Figure 8.13** Finding the average width of a pile by averaging five representative tree lengths.

5. Multiply the pile height by the pile width by the pile length to arrive at the enclosed volume of the pile.

6. Multiply the enclosed volume by a factor of 0.65 to arrive at the estimated firmwood volume of the pile.

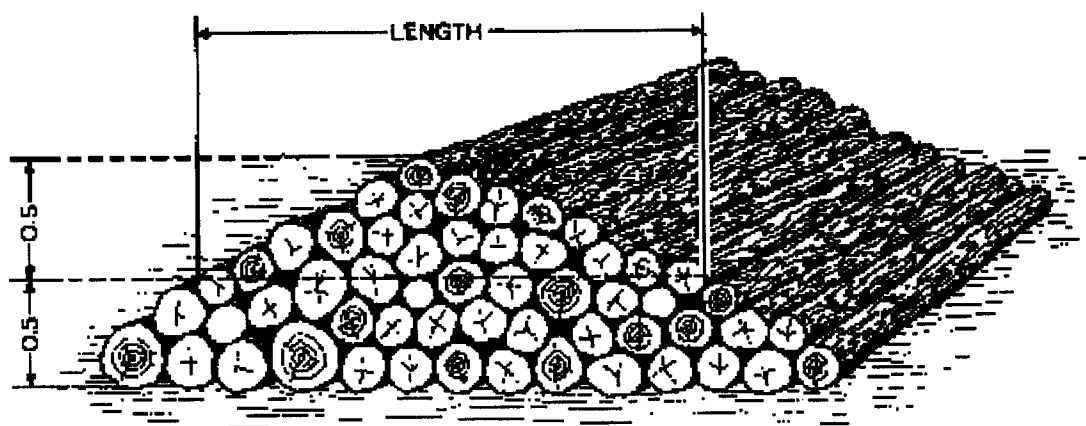


*Figure 8.14 Squaring up a pile by taking length measurement at exactly one-half the height of the pile.*

### 8.6.5 Finding Piece Sample Requirements

Where a sampling method is authorized under Section 7 of the *Scaling Regulation*, use the following method to determine the number of samples required to meet the required sampling error of  $\pm 1\%$ , 19 times out of 20. From this calculation, the scaler will know with certainty how many pieces must be scaled in a group to achieve statistical reliability.

Assuming a producer is planning to take an estimated 5 000 lodgepole pine fence posts from an operating area. This is the "population" to be sampled, and the scaler will determine the sampling requirements as follows:

1. Scale a number of representative pieces to come up with an average volume per piece, for example,

| Post Number                       | Length | Top | Butt | Volume (dm <sup>3</sup> )                       |
|-----------------------------------|--------|-----|------|-------------------------------------------------|
| 1                                 | 2.4    | 6   | 7    | 14 + 18 = 32                                    |
| 2                                 | 2.4    | 6   | 6    | 14 + 14 = 28                                    |
| 3                                 | 2.4    | 6   | 7    | 14 + 18 = 32                                    |
| 4                                 | 2.4    | 7   | 7    | 18 + 18 = 36                                    |
| 5                                 | 2.4    | 6   | 6    | 14 + 14 = 28                                    |
| Total volume of five posts:       |        |     |      | 0.156 m <sup>3</sup>                            |
| Average volume per post (factor): |        |     |      | $0.156 \text{ m}^3 \div 5 = 0.0312 \text{ m}^3$ |

2. Find the sample with the highest volume, in this case, 0.036 m<sup>3</sup>.

3. Find the standard deviation  $SD$  of the samples by subtracting the average piece volume from the piece with the highest volume and dividing by three,

$$SD = \frac{0.036 - 0.0312}{3} = 0.0016$$

4. Find the relative variance  $RV$  by dividing the square of the standard deviation by the square of the average piece volume,

$$RV = \frac{0.0016^2}{0.0312^2} = \frac{0.00000256}{0.00097344} = 0.0025683$$

5. From the total number of estimated pieces  $N$  (5 000) and the relative variance  $C$ , apply the formula described in Chapter 9 to arrive at the sample size  $n$ ,

$$n = \frac{N \times 2^2 \times RV}{(N \times 0.0001) + (4 \times RV)} = \frac{5000 \times 4 \times 0.0025683}{0.5 + 0.01027} = \frac{51.366}{0.51027} = 100.7$$

6. Divide the total number of estimated pieces  $N$  by the sample size  $n$  to find the sampling intensity  $SI$ ,

$$SI = \frac{N}{n} = \frac{5000}{101} = 49.5 = 50(\text{rounded})$$

7. Scale every 50th piece and add it to the sum of the volumes of all of the samples.
8. At the end of the sampling period, divide the total volume of all of the samples  $V_s$  by the total number of samples  $n$  to arrive at the average volume per piece  $A$ . The total number of samples will differ from the sample size calculation in step 5 because the actual production will not likely match the estimated production,

$$A = \frac{V_s}{n} = \frac{3.151}{101} = 0.0312$$

9. Multiply the actual piece count by the average volume per piece to find the total volume for the population,

$$\text{Volume} = 5\,000 \times 0.0312 = 156 \text{ m}^3$$

10. Prepare a final scale return. Because the sampling term will usually be longer than the required frequency of scale submissions (every month), it is necessary to make adjustments to the final billing. For example, if it takes a period of three months to produce the 5 000 fence posts, returns are prepared based on the average volume per piece available at the time,

|         | Production | Average Volume/Piece | Volume for month                  |
|---------|------------|----------------------|-----------------------------------|
| Month 1 | 2000 posts | 0.03202              | 64.04 m <sup>3</sup>              |
| Month 2 | 1800 posts | 0.0309               | 55.62 m <sup>3</sup>              |
| Month 3 | 1200 posts | 0.0312               | 37.44 m <sup>3</sup> (unadjusted) |
| Total   | 5000 posts |                      | 157.10 m <sup>3</sup>             |

The total volume in the final return must be adjusted to compensate for the use of an interim average volume per piece. Therefore, the sum of the first two interim monthly returns is subtracted from the total volume found in step 9 to arrive at the volume in the final return.

$$\text{Final return volume} = 156.00 - 64.04 - 55.62 = 36.34 \text{ m}^3.$$

## 8.7 Factors and Tables



### 8.7.1 Stacked Special Forest Products Factors

The solid wood conversion factors in the following table have been developed from many years of experience. Although the factors may be accurate in the average manufacturing process, they may not always be appropriate, due to diverging methods, equipment, and/or raw materials. Therefore, the scaler may request a Forest Service officer to authorize a more appropriate solid wood conversion factor.

| Product                      | Solid wood conversion factor |
|------------------------------|------------------------------|
| Unpeeled round wood products | 0.65                         |
| Unpeeled split products      | 0.70                         |
| Peeled round wood products   | 0.75                         |
| Peeled split products        | 0.80                         |

### 8.7.2 Condensed Table of Half Volumes

This table of half volumes is for the convenience of scalers and compilers to obtain volumes when other means are not available.

Volumes are expressed in cubic decimetres to avoid the use of a decimal point in the tables. All volumes may be readily changed from cubic decimetres to cubic metres by dividing by 1 000.

The half volumes are used rather than the full volumes of cylinders are used to simplify computation.

#### 8.7.2.1 Application of the Table

To determine the volume of a log from this table, find the half volumes for the following dimensions:

- Top diameter in rads and the length, and
- Butt diameter in rads and the length.

The sum of the half volumes will equal the volume of the log in  $\text{dm}^3$  and division by 1 000 will give the volume in  $\text{m}^3$ .

Only lengths in increments of 1 to 10 m are shown;

- To find the volume of a fraction of a metre, move the decimal place to the left by one point. For example, the volume for a length of 0.4 m is found by using the values in the 4 m column divided by 10.
- To find the volume of a log longer than 10 m, add the values in applicable columns. For example, for a 14 m log, add the 10 m half volumes to the 4 m half volumes for the given diameters.
- In combination, the volume of any length of log can be compiled. For example, the volume of a 14.4 m log is found by adding the half volumes of a 10 m log, the half volumes of a 4 m log, and for the 0.4 m, 1/10th of the half volumes of a 4 m log.

**Table 8.1 Table of Half Volumes of Cylinders in dm<sup>3</sup>**

| Diameter<br>rads | Length in Metres |     |     |      |      |      |      |      |      |      |
|------------------|------------------|-----|-----|------|------|------|------|------|------|------|
|                  | 1.0              | 2.0 | 3.0 | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 |
| 1                | 0                | 0   | 0   | 0    | 0    | 0    | 1    | 1    | 1    | 2    |
| 2                | 0                | 1   | 2   | 3    | 3    | 4    | 4    | 5    | 6    | 6    |
| 3                | 1                | 3   | 4   | 6    | 7    | 8    | 10   | 11   | 13   | 14   |
| 4                | 3                | 5   | 8   | 10   | 13   | 15   | 18   | 20   | 23   | 25   |
| 5                | 4                | 8   | 12  | 16   | 20   | 24   | 27   | 31   | 35   | 39   |
| 6                | 6                | 11  | 17  | 23   | 28   | 34   | 40   | 45   | 51   | 57   |
| 7                | 8                | 15  | 23  | 31   | 38   | 46   | 54   | 62   | 69   | 77   |
| 8                | 10               | 20  | 30  | 40   | 50   | 60   | 70   | 80   | 90   | 101  |
| 9                | 13               | 25  | 38  | 51   | 64   | 76   | 89   | 102  | 115  | 127  |
| 10               | 16               | 31  | 47  | 63   | 79   | 94   | 110  | 126  | 141  | 157  |
| 11               | 19               | 38  | 57  | 76   | 95   | 114  | 133  | 152  | 171  | 190  |
| 12               | 23               | 45  | 68  | 90   | 113  | 136  | 158  | 181  | 204  | 226  |
| 13               | 27               | 53  | 80  | 106  | 133  | 159  | 186  | 212  | 239  | 265  |
| 14               | 31               | 62  | 92  | 123  | 154  | 185  | 216  | 246  | 277  | 308  |
| 15               | 35               | 71  | 106 | 141  | 177  | 212  | 247  | 283  | 318  | 353  |
| 16               | 40               | 80  | 121 | 161  | 201  | 241  | 281  | 322  | 362  | 402  |
| 17               | 45               | 91  | 136 | 182  | 227  | 272  | 318  | 363  | 409  | 454  |
| 18               | 51               | 102 | 153 | 204  | 254  | 305  | 356  | 407  | 458  | 509  |
| 19               | 57               | 113 | 170 | 227  | 284  | 340  | 397  | 454  | 510  | 567  |
| 20               | 63               | 126 | 188 | 251  | 314  | 377  | 440  | 503  | 565  | 628  |
| 21               | 69               | 139 | 208 | 277  | 346  | 416  | 485  | 554  | 623  | 693  |
| 22               | 76               | 152 | 228 | 304  | 380  | 456  | 532  | 608  | 684  | 760  |
| 23               | 83               | 166 | 249 | 332  | 415  | 499  | 582  | 665  | 748  | 831  |
| 24               | 90               | 181 | 271 | 362  | 452  | 543  | 633  | 724  | 814  | 905  |
| 25               | 98               | 196 | 295 | 393  | 491  | 589  | 687  | 785  | 884  | 982  |
| 26               | 106              | 212 | 319 | 425  | 531  | 637  | 743  | 849  | 956  | 1062 |
| 27               | 115              | 229 | 344 | 458  | 573  | 687  | 802  | 916  | 1031 | 1145 |
| 28               | 123              | 246 | 369 | 493  | 616  | 739  | 862  | 985  | 1108 | 1232 |
| 29               | 132              | 264 | 396 | 528  | 661  | 793  | 925  | 1057 | 1189 | 1321 |
| 30               | 141              | 283 | 424 | 565  | 707  | 848  | 990  | 1131 | 1272 | 1414 |
| 31               | 151              | 302 | 453 | 604  | 755  | 906  | 1057 | 1208 | 1359 | 1510 |
| 32               | 161              | 322 | 483 | 643  | 804  | 965  | 1126 | 1287 | 1448 | 1608 |
| 33               | 171              | 342 | 513 | 684  | 855  | 1026 | 1197 | 1368 | 1540 | 1711 |
| 34               | 182              | 363 | 545 | 726  | 908  | 1090 | 1271 | 1453 | 1634 | 1816 |
| 35               | 192              | 385 | 577 | 770  | 962  | 1155 | 1347 | 1539 | 1732 | 1924 |
| 36               | 204              | 407 | 611 | 814  | 1018 | 1221 | 1425 | 1629 | 1832 | 2036 |
| 37               | 215              | 430 | 645 | 860  | 1075 | 1290 | 1505 | 1720 | 1935 | 2150 |
| 38               | 227              | 454 | 680 | 907  | 1134 | 1361 | 1588 | 1815 | 2041 | 2268 |
| 39               | 239              | 478 | 717 | 956  | 1195 | 1434 | 1672 | 1911 | 2150 | 2389 |
| 40               | 251              | 503 | 754 | 1005 | 1257 | 1508 | 1759 | 2011 | 2262 | 2513 |
| 41               | 264              | 528 | 792 | 1056 | 1320 | 1584 | 1848 | 2112 | 2376 | 2641 |
| 42               | 277              | 554 | 831 | 1108 | 1385 | 1663 | 1940 | 2217 | 2494 | 2771 |
| 43               | 290              | 581 | 871 | 1162 | 1452 | 1743 | 2033 | 2324 | 2614 | 2904 |
| 44               | 304              | 608 | 912 | 1216 | 1521 | 1825 | 2129 | 2433 | 2737 | 3041 |
| 45               | 318              | 636 | 954 | 1272 | 1590 | 1909 | 2227 | 2545 | 2863 | 3181 |

| Diameter<br>rads | Length in Metres |      |      |      |      |      |      |       |       |       |
|------------------|------------------|------|------|------|------|------|------|-------|-------|-------|
|                  | 1.0              | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0   | 9.0   | 10.0  |
| 46               | 332              | 665  | 997  | 1330 | 1662 | 1994 | 2327 | 2659  | 2991  | 3324  |
| 47               | 347              | 694  | 1041 | 1388 | 1735 | 2082 | 2429 | 2776  | 3123  | 3470  |
| 48               | 362              | 724  | 1086 | 1448 | 1810 | 2171 | 2533 | 2895  | 3257  | 3619  |
| 49               | 377              | 754  | 1131 | 1509 | 1886 | 2263 | 2640 | 3017  | 3394  | 3771  |
| 50               | 393              | 785  | 1178 | 1571 | 1963 | 2356 | 2749 | 3142  | 3534  | 3927  |
| 51               | 409              | 817  | 1226 | 1634 | 2043 | 2451 | 2860 | 3269  | 3677  | 4086  |
| 52               | 425              | 849  | 1274 | 1699 | 2124 | 2548 | 2973 | 3398  | 3823  | 4247  |
| 53               | 441              | 882  | 1324 | 1765 | 2206 | 2647 | 3089 | 3530  | 3971  | 4412  |
| 54               | 458              | 916  | 1374 | 1832 | 2290 | 2748 | 3206 | 3664  | 4122  | 4580  |
| 55               | 475              | 950  | 1425 | 1901 | 2376 | 2851 | 3326 | 3801  | 4276  | 4752  |
| 56               | 493              | 985  | 1478 | 1970 | 2463 | 2956 | 3448 | 3941  | 4433  | 4926  |
| 57               | 510              | 1021 | 1531 | 2041 | 2552 | 3062 | 3572 | 4083  | 4593  | 5104  |
| 58               | 528              | 1057 | 1585 | 2114 | 2642 | 3170 | 3699 | 4227  | 4756  | 5284  |
| 59               | 547              | 1094 | 1640 | 2187 | 2734 | 3281 | 3828 | 4374  | 4921  | 5468  |
| 60               | 565              | 1131 | 1696 | 2262 | 2827 | 3393 | 3958 | 4524  | 5089  | 5655  |
| 61               | 584              | 1169 | 1753 | 2338 | 2922 | 3507 | 4091 | 4676  | 5260  | 5845  |
| 62               | 604              | 1208 | 1811 | 2415 | 3019 | 3623 | 4227 | 4831  | 5434  | 6038  |
| 63               | 623              | 1247 | 1870 | 2494 | 3117 | 3741 | 4364 | 4988  | 5611  | 6234  |
| 64               | 643              | 1287 | 1930 | 2574 | 3217 | 3860 | 4504 | 5147  | 5791  | 6434  |
| 65               | 664              | 1327 | 1991 | 2655 | 3318 | 3982 | 4646 | 5309  | 5973  | 6637  |
| 66               | 684              | 1368 | 2053 | 2737 | 3421 | 4105 | 4790 | 5474  | 6158  | 6842  |
| 67               | 705              | 1410 | 2115 | 2821 | 3526 | 4231 | 4936 | 5641  | 6346  | 7051  |
| 68               | 726              | 1453 | 2179 | 2905 | 3632 | 4358 | 5084 | 5811  | 6537  | 7263  |
| 69               | 748              | 1496 | 2244 | 2991 | 3739 | 4487 | 5235 | 5983  | 6731  | 7479  |
| 70               | 770              | 1539 | 2309 | 3079 | 3848 | 4618 | 5388 | 6158  | 6927  | 7697  |
| 71               | 792              | 1584 | 2376 | 3167 | 3959 | 4751 | 5543 | 6335  | 7127  | 7918  |
| 72               | 814              | 1629 | 2443 | 3257 | 4072 | 4886 | 5700 | 6514  | 7329  | 8143  |
| 73               | 837              | 1674 | 2511 | 3348 | 4185 | 5022 | 5860 | 6697  | 7534  | 8371  |
| 74               | 860              | 1720 | 2581 | 3441 | 4301 | 5161 | 6021 | 6881  | 7742  | 8602  |
| 75               | 884              | 1767 | 2651 | 3534 | 4418 | 5301 | 6185 | 7069  | 7952  | 8836  |
| 76               | 907              | 1815 | 2722 | 3629 | 4536 | 5444 | 6351 | 7258  | 8166  | 9073  |
| 77               | 931              | 1863 | 2794 | 3725 | 4657 | 5588 | 6519 | 7451  | 8382  | 9313  |
| 78               | 956              | 1911 | 2867 | 3823 | 4778 | 5734 | 6690 | 7645  | 8601  | 9557  |
| 79               | 980              | 1961 | 2941 | 3921 | 4902 | 5882 | 6862 | 7843  | 8823  | 9803  |
| 80               | 1005             | 2011 | 3016 | 4021 | 5027 | 6032 | 7037 | 8042  | 9048  | 10053 |
| 81               | 1031             | 2061 | 3092 | 4122 | 5153 | 6184 | 7214 | 8245  | 9275  | 10306 |
| 82               | 1056             | 2112 | 3169 | 4225 | 5281 | 6337 | 7393 | 8450  | 9506  | 10562 |
| 83               | 1082             | 2164 | 3246 | 4328 | 5411 | 6493 | 7575 | 8657  | 9739  | 10821 |
| 84               | 1108             | 2217 | 3325 | 4433 | 5542 | 6650 | 7758 | 8867  | 9975  | 11084 |
| 85               | 1135             | 2270 | 3405 | 4540 | 5675 | 6809 | 7944 | 9079  | 10214 | 11349 |
| 86               | 1162             | 2324 | 3485 | 4647 | 5809 | 6971 | 8132 | 9294  | 10456 | 11618 |
| 87               | 1189             | 2378 | 3567 | 4756 | 5945 | 7134 | 8323 | 9511  | 10700 | 11889 |
| 88               | 1216             | 2433 | 3649 | 4866 | 6082 | 7299 | 8515 | 9731  | 10948 | 12164 |
| 89               | 1244             | 2488 | 3733 | 4977 | 6221 | 7465 | 8710 | 9954  | 11198 | 12442 |
| 90               | 1272             | 2545 | 3817 | 5089 | 6362 | 7634 | 8906 | 10179 | 11451 | 12723 |

| Diameter<br>rads | Length in Metres |      |      |      |      |      |       |       |       |       |
|------------------|------------------|------|------|------|------|------|-------|-------|-------|-------|
|                  | 1.0              | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0   | 8.0   | 9.0   | 10.0  |
| 91               | 1301             | 2602 | 3902 | 5203 | 6504 | 7805 | 9105  | 10406 | 11707 | 13008 |
| 92               | 1330             | 2659 | 3989 | 5318 | 6648 | 7977 | 9307  | 10636 | 11966 | 13295 |
| 93               | 1359             | 2717 | 4076 | 5434 | 6793 | 8151 | 9510  | 10869 | 12227 | 13586 |
| 94               | 1388             | 2776 | 4164 | 5552 | 6940 | 8328 | 9716  | 11104 | 12492 | 13880 |
| 95               | 1418             | 2835 | 4253 | 5671 | 7088 | 8506 | 9924  | 11341 | 12759 | 14176 |
| 96               | 1448             | 2895 | 4343 | 5791 | 7238 | 8686 | 10134 | 11581 | 13029 | 14476 |
| 97               | 1478             | 2956 | 4434 | 5912 | 7390 | 8868 | 10346 | 11824 | 13302 | 14780 |
| 98               | 1509             | 3017 | 4526 | 6034 | 7543 | 9052 | 10560 | 12069 | 13577 | 15086 |
| 99               | 1540             | 3079 | 4619 | 6158 | 7698 | 9237 | 10777 | 12316 | 13856 | 15395 |
| 100              | 1571             | 3142 | 4712 | 6283 | 7854 | 9425 | 10996 | 12566 | 14137 | 15708 |

**8.7.3 Table of Full Volumes for Round Fence Posts**

The following table is provided for obtaining volumes of round fence posts in a stack or pile. When sampling a stack, it is often very difficult to match the top and butt of inner posts. By measuring only the top diameter and the length of a post, the table will provide the full volume of the post in cubic metres, using known taper curves to accurately estimate the butt diameter. The scaler should sample a number of pieces where both tops and butt can be measured before using this table, so that the validity of the taper factor is proven in a particular application.

**Table 8.2 Table of Full Volume (m<sup>3</sup>) for Top Measured Round Fence Posts**

| Top Diameter                          | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    | 11    |
|---------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Assumed Taper in rads per Metre 0.500 |       |       |       |       |       |       |       |       |       |       |
| Lengths                               | Vol.  | Vol.  | Vol.  | Vol.  | Vol.  | Vol.  | Vol.  | Vol.  | Vol.  | Vol.  |
| 0.1                                   | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.002 | 0.002 | 0.003 | 0.003 | 0.004 |
| 0.2                                   | 0.000 | 0.000 | 0.001 | 0.002 | 0.002 | 0.003 | 0.004 | 0.005 | 0.006 | 0.008 |
| 0.3                                   | 0.000 | 0.000 | 0.002 | 0.002 | 0.003 | 0.005 | 0.006 | 0.008 | 0.010 | 0.012 |
| 0.4                                   | 0.000 | 0.001 | 0.002 | 0.003 | 0.005 | 0.006 | 0.008 | 0.010 | 0.013 | 0.015 |
| 0.5                                   | 0.000 | 0.002 | 0.003 | 0.004 | 0.006 | 0.008 | 0.010 | 0.013 | 0.016 | 0.019 |
| 0.6                                   | 0.000 | 0.002 | 0.003 | 0.005 | 0.007 | 0.010 | 0.013 | 0.016 | 0.019 | 0.023 |
| 0.7                                   | 0.001 | 0.002 | 0.004 | 0.006 | 0.008 | 0.011 | 0.015 | 0.019 | 0.023 | 0.027 |
| 0.8                                   | 0.001 | 0.003 | 0.004 | 0.007 | 0.010 | 0.013 | 0.017 | 0.021 | 0.026 | 0.032 |
| 0.9                                   | 0.001 | 0.003 | 0.005 | 0.008 | 0.011 | 0.015 | 0.019 | 0.024 | 0.030 | 0.036 |
| 1.0                                   | 0.002 | 0.003 | 0.006 | 0.009 | 0.012 | 0.017 | 0.021 | 0.027 | 0.033 | 0.040 |
| 1.1                                   | 0.002 | 0.004 | 0.006 | 0.010 | 0.014 | 0.018 | 0.024 | 0.030 | 0.037 | 0.044 |
| 1.2                                   | 0.002 | 0.004 | 0.007 | 0.011 | 0.015 | 0.020 | 0.026 | 0.033 | 0.040 | 0.048 |
| 1.3                                   | 0.002 | 0.005 | 0.008 | 0.012 | 0.016 | 0.022 | 0.028 | 0.036 | 0.044 | 0.052 |
| 1.4                                   | 0.002 | 0.005 | 0.008 | 0.013 | 0.018 | 0.024 | 0.031 | 0.039 | 0.047 | 0.057 |
| 1.5                                   | 0.003 | 0.005 | 0.009 | 0.014 | 0.019 | 0.026 | 0.033 | 0.041 | 0.051 | 0.061 |
| 1.6                                   | 0.003 | 0.006 | 0.010 | 0.015 | 0.021 | 0.028 | 0.036 | 0.044 | 0.054 | 0.065 |
| 1.7                                   | 0.003 | 0.006 | 0.011 | 0.016 | 0.022 | 0.030 | 0.038 | 0.048 | 0.058 | 0.070 |
| 1.8                                   | 0.004 | 0.007 | 0.011 | 0.017 | 0.024 | 0.032 | 0.040 | 0.051 | 0.062 | 0.074 |
| 1.9                                   | 0.004 | 0.007 | 0.012 | 0.018 | 0.025 | 0.033 | 0.043 | 0.054 | 0.066 | 0.079 |
| 2.0                                   | 0.004 | 0.008 | 0.013 | 0.019 | 0.027 | 0.035 | 0.046 | 0.057 | 0.069 | 0.083 |
| 2.1                                   | 0.004 | 0.008 | 0.014 | 0.020 | 0.028 | 0.038 | 0.048 | 0.060 | 0.073 | 0.088 |
| 2.2                                   | 0.005 | 0.009 | 0.015 | 0.021 | 0.030 | 0.040 | 0.051 | 0.063 | 0.077 | 0.092 |
| 2.3                                   | 0.005 | 0.009 | 0.015 | 0.023 | 0.031 | 0.042 | 0.053 | 0.066 | 0.081 | 0.097 |
| 2.4                                   | 0.005 | 0.010 | 0.016 | 0.024 | 0.033 | 0.044 | 0.056 | 0.070 | 0.085 | 0.102 |
| 2.5                                   | 0.006 | 0.011 | 0.017 | 0.025 | 0.035 | 0.046 | 0.059 | 0.073 | 0.089 | 0.106 |
| 2.6                                   | 0.006 | 0.011 | 0.018 | 0.026 | 0.036 | 0.048 | 0.061 | 0.076 | 0.093 | 0.111 |
| 2.7                                   | 0.006 | 0.012 | 0.019 | 0.028 | 0.038 | 0.050 | 0.064 | 0.080 | 0.097 | 0.116 |
| 2.8                                   | 0.007 | 0.012 | 0.020 | 0.029 | 0.040 | 0.053 | 0.067 | 0.083 | 0.101 | 0.121 |
| 2.9                                   | 0.007 | 0.013 | 0.021 | 0.030 | 0.042 | 0.055 | 0.070 | 0.087 | 0.105 | 0.126 |
| 3.0                                   | 0.008 | 0.014 | 0.022 | 0.032 | 0.043 | 0.057 | 0.073 | 0.090 | 0.109 | 0.131 |
| 3.1                                   | 0.008 | 0.014 | 0.023 | 0.033 | 0.045 | 0.059 | 0.076 | 0.094 | 0.114 | 0.136 |
| 3.2                                   | 0.009 | 0.015 | 0.024 | 0.034 | 0.047 | 0.062 | 0.078 | 0.097 | 0.118 | 0.141 |
| 3.3                                   | 0.009 | 0.016 | 0.025 | 0.036 | 0.049 | 0.064 | 0.081 | 0.101 | 0.122 | 0.146 |
| 3.4                                   | 0.009 | 0.017 | 0.026 | 0.037 | 0.051 | 0.067 | 0.084 | 0.104 | 0.127 | 0.151 |
| 3.5                                   | 0.010 | 0.017 | 0.027 | 0.039 | 0.053 | 0.069 | 0.087 | 0.108 | 0.131 | 0.156 |
| 3.6                                   | 0.010 | 0.018 | 0.028 | 0.040 | 0.055 | 0.072 | 0.091 | 0.112 | 0.135 | 0.161 |
| 3.7                                   | 0.011 | 0.019 | 0.029 | 0.042 | 0.057 | 0.074 | 0.094 | 0.115 | 0.140 | 0.166 |
| 3.8                                   | 0.011 | 0.020 | 0.030 | 0.043 | 0.059 | 0.077 | 0.097 | 0.119 | 0.144 | 0.172 |
| 3.9                                   | 0.012 | 0.021 | 0.031 | 0.045 | 0.061 | 0.079 | 0.100 | 0.123 | 0.149 | 0.177 |
| 4.0                                   | 0.013 | 0.021 | 0.033 | 0.046 | 0.063 | 0.082 | 0.103 | 0.127 | 0.153 | 0.182 |
| 4.1                                   | 0.013 | 0.022 | 0.034 | 0.048 | 0.065 | 0.084 | 0.106 | 0.131 | 0.158 | 0.188 |
| 4.2                                   | 0.014 | 0.023 | 0.035 | 0.050 | 0.067 | 0.087 | 0.110 | 0.135 | 0.163 | 0.193 |
| 4.3                                   | 0.014 | 0.024 | 0.036 | 0.051 | 0.069 | 0.090 | 0.113 | 0.139 | 0.167 | 0.199 |
| 4.4                                   | 0.015 | 0.025 | 0.038 | 0.053 | 0.071 | 0.092 | 0.116 | 0.143 | 0.172 | 0.204 |
| 4.5                                   | 0.016 | 0.026 | 0.039 | 0.055 | 0.074 | 0.095 | 0.120 | 0.147 | 0.177 | 0.210 |

| Top Diameter                    | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    | 11    |
|---------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Assumed Taper in rads per Metre | 0.500 |       |       |       |       |       |       |       |       |       |
| 4.6                             | 0.016 | 0.027 | 0.040 | 0.057 | 0.076 | 0.098 | 0.123 | 0.151 | 0.182 | 0.215 |
| 4.7                             | 0.017 | 0.028 | 0.042 | 0.058 | 0.078 | 0.101 | 0.126 | 0.155 | 0.186 | 0.221 |
| 4.8                             | 0.018 | 0.029 | 0.043 | 0.060 | 0.080 | 0.104 | 0.130 | 0.159 | 0.191 | 0.227 |
| 4.9                             | 0.018 | 0.030 | 0.044 | 0.062 | 0.083 | 0.106 | 0.133 | 0.163 | 0.196 | 0.232 |
| 5.0                             | 0.019 | 0.031 | 0.046 | 0.064 | 0.085 | 0.109 | 0.137 | 0.167 | 0.201 | 0.238 |
| 5.1                             | 0.020 | 0.032 | 0.047 | 0.066 | 0.087 | 0.112 | 0.140 | 0.172 | 0.206 | 0.244 |
| 5.2                             | 0.021 | 0.033 | 0.049 | 0.068 | 0.090 | 0.115 | 0.144 | 0.176 | 0.211 | 0.250 |
| 5.3                             | 0.021 | 0.034 | 0.050 | 0.070 | 0.092 | 0.118 | 0.148 | 0.180 | 0.216 | 0.256 |
| 5.4                             | 0.022 | 0.035 | 0.052 | 0.071 | 0.095 | 0.121 | 0.151 | 0.185 | 0.222 | 0.262 |
| 5.5                             | 0.023 | 0.036 | 0.053 | 0.073 | 0.097 | 0.124 | 0.155 | 0.189 | 0.227 | 0.268 |
| 5.6                             | 0.024 | 0.038 | 0.055 | 0.076 | 0.100 | 0.128 | 0.159 | 0.194 | 0.232 | 0.274 |
| 5.7                             | 0.025 | 0.039 | 0.056 | 0.078 | 0.102 | 0.131 | 0.163 | 0.198 | 0.237 | 0.280 |
| 5.8                             | 0.026 | 0.040 | 0.058 | 0.080 | 0.105 | 0.134 | 0.167 | 0.203 | 0.243 | 0.286 |
| 5.9                             | 0.026 | 0.041 | 0.060 | 0.082 | 0.108 | 0.137 | 0.170 | 0.207 | 0.248 | 0.292 |
| 6.0                             | 0.027 | 0.042 | 0.061 | 0.084 | 0.110 | 0.140 | 0.174 | 0.212 | 0.254 | 0.299 |
| 6.1                             | 0.028 | 0.044 | 0.063 | 0.086 | 0.113 | 0.144 | 0.178 | 0.217 | 0.259 | 0.305 |
| 6.2                             | 0.029 | 0.045 | 0.065 | 0.088 | 0.116 | 0.147 | 0.182 | 0.221 | 0.265 | 0.311 |
| 6.3                             | 0.030 | 0.046 | 0.066 | 0.090 | 0.118 | 0.150 | 0.186 | 0.226 | 0.270 | 0.318 |
| 6.4                             | 0.031 | 0.048 | 0.068 | 0.093 | 0.121 | 0.154 | 0.190 | 0.231 | 0.276 | 0.324 |
| 6.5                             | 0.032 | 0.049 | 0.070 | 0.095 | 0.124 | 0.157 | 0.195 | 0.236 | 0.281 | 0.331 |
| 6.6                             | 0.033 | 0.050 | 0.072 | 0.097 | 0.127 | 0.161 | 0.199 | 0.241 | 0.287 | 0.337 |
| 6.7                             | 0.034 | 0.052 | 0.074 | 0.100 | 0.130 | 0.164 | 0.203 | 0.246 | 0.293 | 0.344 |
| 6.8                             | 0.035 | 0.053 | 0.076 | 0.102 | 0.133 | 0.168 | 0.207 | 0.251 | 0.299 | 0.351 |
| 6.9                             | 0.037 | 0.055 | 0.077 | 0.104 | 0.136 | 0.171 | 0.211 | 0.256 | 0.304 | 0.357 |
| 7.0                             | 0.038 | 0.056 | 0.079 | 0.107 | 0.139 | 0.175 | 0.216 | 0.261 | 0.310 | 0.364 |
| 7.1                             | 0.039 | 0.058 | 0.081 | 0.109 | 0.142 | 0.179 | 0.220 | 0.266 | 0.316 | 0.371 |
| 7.2                             | 0.040 | 0.059 | 0.083 | 0.112 | 0.145 | 0.182 | 0.225 | 0.271 | 0.322 | 0.378 |
| 7.3                             | 0.041 | 0.061 | 0.085 | 0.114 | 0.148 | 0.186 | 0.229 | 0.276 | 0.328 | 0.385 |
| 7.4                             | 0.042 | 0.063 | 0.088 | 0.117 | 0.151 | 0.190 | 0.234 | 0.282 | 0.334 | 0.392 |
| 7.5                             | 0.044 | 0.064 | 0.090 | 0.120 | 0.154 | 0.194 | 0.238 | 0.287 | 0.341 | 0.399 |
| 7.6                             | 0.045 | 0.066 | 0.092 | 0.122 | 0.158 | 0.198 | 0.243 | 0.292 | 0.347 | 0.406 |
| 7.7                             | 0.046 | 0.068 | 0.094 | 0.125 | 0.161 | 0.202 | 0.247 | 0.298 | 0.353 | 0.413 |
| 7.8                             | 0.048 | 0.069 | 0.096 | 0.128 | 0.164 | 0.206 | 0.252 | 0.303 | 0.359 | 0.420 |
| 7.9                             | 0.049 | 0.071 | 0.098 | 0.130 | 0.168 | 0.210 | 0.257 | 0.309 | 0.366 | 0.428 |
| 8.0                             | 0.050 | 0.073 | 0.101 | 0.133 | 0.171 | 0.214 | 0.261 | 0.314 | 0.372 | 0.435 |
| 8.1                             | 0.052 | 0.075 | 0.103 | 0.136 | 0.174 | 0.218 | 0.266 | 0.320 | 0.378 | 0.442 |
| 8.2                             | 0.053 | 0.077 | 0.105 | 0.139 | 0.178 | 0.222 | 0.271 | 0.325 | 0.385 | 0.450 |
| 8.3                             | 0.055 | 0.078 | 0.107 | 0.142 | 0.181 | 0.226 | 0.276 | 0.331 | 0.391 | 0.457 |
| 8.4                             | 0.056 | 0.080 | 0.110 | 0.145 | 0.185 | 0.230 | 0.281 | 0.337 | 0.398 | 0.465 |
| 8.5                             | 0.057 | 0.082 | 0.112 | 0.148 | 0.188 | 0.234 | 0.286 | 0.343 | 0.405 | 0.472 |
| 8.6                             | 0.059 | 0.084 | 0.115 | 0.151 | 0.192 | 0.239 | 0.291 | 0.348 | 0.411 | 0.480 |
| 8.7                             | 0.061 | 0.086 | 0.117 | 0.154 | 0.196 | 0.243 | 0.296 | 0.354 | 0.418 | 0.487 |
| 8.8                             | 0.062 | 0.088 | 0.120 | 0.157 | 0.199 | 0.247 | 0.301 | 0.360 | 0.425 | 0.495 |
| 8.9                             | 0.064 | 0.090 | 0.122 | 0.160 | 0.203 | 0.252 | 0.306 | 0.366 | 0.432 | 0.503 |
| 9.0                             | 0.065 | 0.092 | 0.125 | 0.163 | 0.207 | 0.256 | 0.311 | 0.372 | 0.439 | 0.511 |
| 9.1                             | 0.067 | 0.094 | 0.127 | 0.166 | 0.211 | 0.261 | 0.317 | 0.378 | 0.446 | 0.519 |
| 9.2                             | 0.069 | 0.096 | 0.130 | 0.169 | 0.214 | 0.265 | 0.322 | 0.384 | 0.453 | 0.527 |
| 9.3                             | 0.070 | 0.099 | 0.133 | 0.173 | 0.218 | 0.270 | 0.327 | 0.391 | 0.460 | 0.535 |
| 9.4                             | 0.072 | 0.101 | 0.135 | 0.176 | 0.222 | 0.274 | 0.333 | 0.397 | 0.467 | 0.543 |

| Top Diameter                    | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    | 11    |
|---------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Assumed Taper in rads per Metre |       |       | 0.500 |       |       |       |       |       |       |       |
| 9.5                             | 0.074 | 0.103 | 0.138 | 0.179 | 0.226 | 0.279 | 0.338 | 0.403 | 0.474 | 0.551 |
| 9.6                             | 0.076 | 0.105 | 0.141 | 0.183 | 0.230 | 0.284 | 0.344 | 0.409 | 0.481 | 0.559 |
| 9.7                             | 0.078 | 0.108 | 0.144 | 0.186 | 0.234 | 0.289 | 0.349 | 0.416 | 0.488 | 0.567 |
| 9.8                             | 0.079 | 0.110 | 0.147 | 0.189 | 0.238 | 0.293 | 0.355 | 0.422 | 0.496 | 0.575 |
| 9.9                             | 0.081 | 0.112 | 0.149 | 0.193 | 0.242 | 0.298 | 0.360 | 0.429 | 0.503 | 0.584 |
| 10.0                            | 0.083 | 0.115 | 0.152 | 0.196 | 0.247 | 0.303 | 0.366 | 0.435 | 0.511 | 0.592 |
| 10.1                            | 0.085 | 0.117 | 0.155 | 0.200 | 0.251 | 0.308 | 0.372 | 0.442 | 0.518 | 0.601 |
| 10.2                            | 0.087 | 0.120 | 0.158 | 0.203 | 0.255 | 0.313 | 0.377 | 0.448 | 0.526 | 0.609 |
| 10.3                            | 0.089 | 0.122 | 0.161 | 0.207 | 0.259 | 0.318 | 0.383 | 0.455 | 0.533 | 0.618 |
| 10.4                            | 0.091 | 0.125 | 0.164 | 0.211 | 0.264 | 0.323 | 0.389 | 0.462 | 0.541 | 0.626 |
| 10.5                            | 0.093 | 0.127 | 0.168 | 0.215 | 0.268 | 0.328 | 0.395 | 0.469 | 0.549 | 0.635 |
| 10.6                            | 0.095 | 0.130 | 0.171 | 0.218 | 0.273 | 0.333 | 0.401 | 0.475 | 0.556 | 0.644 |
| 10.7                            | 0.098 | 0.132 | 0.174 | 0.222 | 0.277 | 0.339 | 0.407 | 0.482 | 0.564 | 0.653 |
| 10.8                            | 0.100 | 0.135 | 0.177 | 0.226 | 0.282 | 0.344 | 0.413 | 0.489 | 0.572 | 0.662 |
| 10.9                            | 0.102 | 0.138 | 0.180 | 0.230 | 0.286 | 0.349 | 0.419 | 0.496 | 0.580 | 0.670 |
| 11.0                            | 0.104 | 0.140 | 0.184 | 0.234 | 0.291 | 0.355 | 0.425 | 0.503 | 0.588 | 0.679 |
| 11.1                            | 0.106 | 0.143 | 0.187 | 0.238 | 0.295 | 0.360 | 0.432 | 0.510 | 0.596 | 0.689 |
| 11.2                            | 0.109 | 0.146 | 0.190 | 0.242 | 0.300 | 0.366 | 0.438 | 0.518 | 0.604 | 0.698 |
| 11.3                            | 0.111 | 0.149 | 0.194 | 0.246 | 0.305 | 0.371 | 0.444 | 0.525 | 0.612 | 0.707 |
| 11.4                            | 0.113 | 0.152 | 0.197 | 0.250 | 0.310 | 0.377 | 0.451 | 0.532 | 0.620 | 0.716 |
| 11.5                            | 0.116 | 0.155 | 0.201 | 0.254 | 0.314 | 0.382 | 0.457 | 0.539 | 0.629 | 0.725 |
| 11.6                            | 0.118 | 0.158 | 0.204 | 0.258 | 0.319 | 0.388 | 0.464 | 0.547 | 0.637 | 0.735 |
| 11.7                            | 0.121 | 0.160 | 0.208 | 0.262 | 0.324 | 0.394 | 0.470 | 0.554 | 0.645 | 0.744 |
| 11.8                            | 0.123 | 0.164 | 0.211 | 0.267 | 0.329 | 0.399 | 0.477 | 0.562 | 0.654 | 0.754 |
| 11.9                            | 0.126 | 0.167 | 0.215 | 0.271 | 0.334 | 0.405 | 0.483 | 0.569 | 0.662 | 0.763 |
| 12.0                            | 0.128 | 0.170 | 0.219 | 0.275 | 0.339 | 0.411 | 0.490 | 0.577 | 0.671 | 0.773 |