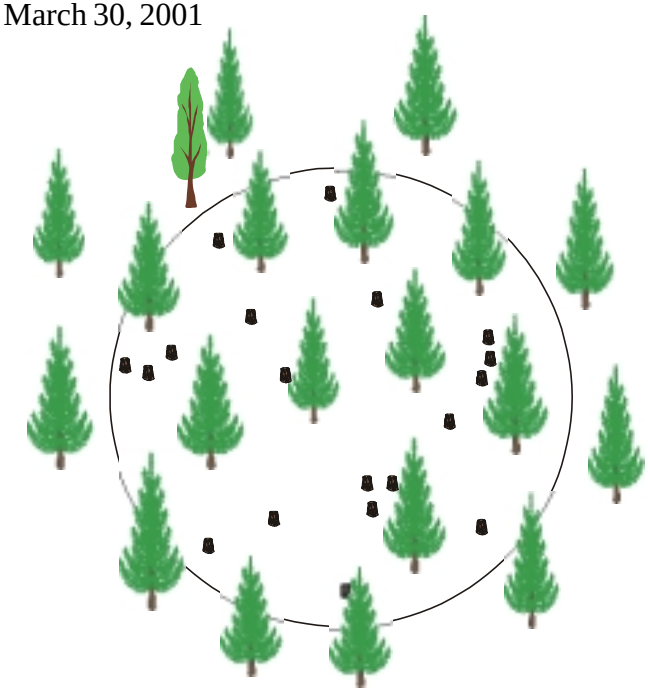
JUVENILE SPACING QUALITY INSPECTION

March 30, 2001



FS251 HFP 01/03/20

This document is being distrubuted as an operational draft. The final version will be published in booklet style on or before March 31, 2001. At that time, the document will also be available electronically in a read-only format.

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Introduction

The juvenile spacing quality inspection system is a procedure intended to be used to determine the quality of treatment and the subsequent payment percentage of the work performed on a juvenile spacing project.

A standardized inspection procedure is required so that all parties involved in juvenile spacing projects understand how the success of the project will be measured. The “rules” for measuring the success of juvenile spacing projects are found in the Stand Management Prescription (SMP), in the contract and in this document.

It is important to follow the procedures described in this document to ensure that proper implementation of the “rules” are applied consistently to all juvenile spacing projects.

The juvenile spacing quality inspection procedures involve the establishment of sample plots within the work area. The plot data are then used in mathematical calculations to determine the Performance Quality, commonly referred to as the Quality of Work. This Performance Quality is then used to determine a Payment Percent. The bid price per hectare multiplied by the Payment Percent determines the final amount that the contractor will be paid for the work completed.

The intent of these juvenile spacing quality inspection procedures is to determine how closely the work completed corresponds to the standards stated in the SMP and in the contract. If the quality of work completed is below 92.6%, then payment is reduced based on a graduated payment system.

This update of the juvenile spacing quality inspection procedures introduces new concepts to deal with the natural variation commonly found within young forested stands and promotes the selection of the best crop trees.

Survey Principles

The juvenile spacing quality inspection procedure is a sampling process that uses circular sample plots. The total tree and crop tree densities, as well as the faults found in the plots are assumed to be representative of the work area in and around the plot locations.

Circular plots with a known radius are the key to the sampling procedures. We know that a plot with a radius of 3.99 metres (m) has an area of 50 m^2. This is determined using the formula for calculating the area of a circle. A hectare is 10 000 m^2. This means a 3.99 metre circular plot represents 1/200 of a hectare. The plot multiplier is determined by dividing 10 000 m^2 by 50 m^2. Therefore, the plot multiplier is 200. For example, if you have 7 crop trees within a plot, you can calculate that there are 1400 crop trees per hectare by multiplying 7 crop trees by 200.

The same mathematical principles can be applied to a plot radius of 5.64 m. The plot multiplier is 100. Therefore, the average density per hectare is equal to the average number of crop trees in a plot multiplied by 100.

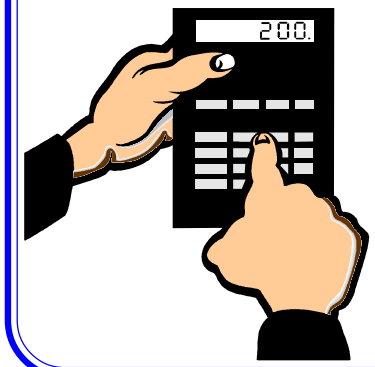
The most common sampling methodology involves the positioning of plots along predetermined strip lines. Plots are positioned at regular intervals along the strip lines. Many people refer to this as a “grid pattern”.

This systematic method is only one of the possible methodologies. Any method that produces a non-biased, systematic random sample is acceptable.

Sample Plots

Area of a plot (circle) = πr^2
3.14 x (3.99 m)^2 = 50 m^2

Area of a hectare
1 hectare = 100 m x 100 m = 10 000 m^2



Plot Multiplier
10 000 m^2 ÷ 50 m^2 = 200

1 tree in a plot represents 200 trees per ha

1 error in a plot represents 200 errors per ha

The number of plots to be established is not regulated. The contract may specify the sampling intensity. However, over the years an accepted standard of 1 plot per hectare has become quite common. When considering how many plots to establish, one should consider the following;

- the variation in stand density prior to treatment,
- visual impressions of the consistency of the treatment,
- confidence with the historic quality of work performed by the Contractor.

Less than one plot per hectare can often provide the desired precision required for determining payment.

Choosing a Plot Radius

All plots established within a single stratum must use the same plot radius. The radius is chosen to result in an optimum number of crop trees in the plot. On average, for statistical purposes, the optimum number of crop trees within each plot is 7 - 10. This would accurately represent the quality of the juvenile spacing treatment completed.

In the interior of the province, a plot radius of 3.99 metres is commonly used. On the coast, a larger plot radius of 5.64 metres is commonly used. A larger plot radius may be selected for special situations, such as cluster treatments in interior Douglas fir stands. The following table shows different density ranges and the corresponding plot radii and multipliers.

Density Range for 7 to 10 trees	**Plot Radius**	**Plot Multiplier**
3500 - 5000tr/ha	2.52m	500
1400 - 2000	3.99	200
700 - 1000	5.64	100
350 - 500	7.98	50
140 - 200	11.28	20

Survey Methodology and Data Collection

Quality inspection plots should be evenly distributed throughout the work area. Establish the plot centre and mark its location in the field according to the specifications described in the contract. Record the plot number, bearing and distance on the plot card.

Trees which fall on the plot boundary are considered borderline trees.

Borderline trees are also tallied as “in” the plot if the tree’s point of germination is within the plot.

The Inspector then records every uncut, live coniferous and broadleaf tree in the plot, tallied by species and size class, and totals them in the total tree column. Refer to the size class table below for recommended inventory size classes. The total number of crop trees in the plot is recorded in the total crop trees column.

The Inspector then records the number of reworkable errors, non reworkable errors, and voids. An inventory label and sample tree data, including average crop tree height and average crop tree age, should be recorded at every fourth plot. A minimum of three inventory labels and three sample trees per stratum or per block are recommended. Inventory labels and sample tree data should be collected consistent with the methodologies described in the Silviculture Suveys Guidebook.

Any instances of non-compliance with other specifications applicable to the work area must also be recorded.

The following table describes the standard Inventory and Growth and Yield Size Classes.

Size Classes	**Midpoint of Size Class**
0 - 1.3 m in height	R (regen)
1.3 m in height - 7.4 cm	5
7.5 cm - 12.4 cm	10
12.5 cm - 17.4 cm	15
17.5 cm - 22.4 cm	20
22.5 cm - 27.4 cm	25

These size classes are optional. Size classes should be chosen to suit the site and stand characteristics, and tailored to meet the objectives in the SMP.

Juvenile spacing plots can be used to declare a stand free growing if all of the requirements of a free growing survey report are met and submitted upon request to the District Manager.

Conventions Used in this Document

The data below is for the sample plots within this document *only* and do not represent provincial default standards.

The plots shown in this document are not drawn to scale, and are for demonstration purposes only. All examples are based on:

- a plot radius of 3.99 metres, 1/200 of a hectare;
- a target number of 1800 crop trees per hectare, or 9 crop trees within a plot;
- a minimum number of 1600 crop trees per hectare, or 8 crop trees within a plot;
- a maximum number of 2000 crop trees per hectare, or 10 crop trees within a plot;
- an inter-tree distance of 2.5 metres;
- a minimum inter-tree distance of 1.0 metre;
- no conifers less than 1.0 metre in height shall be cut;
- no conifers greater than 10.0 cm in diameter, measured at breast height shall be cut (leave tree);
- broadleaf species, greater than 1.5 metres in distance, measured from the stem of the conifer to the stem of the broadleaf tree, are not to be cut.

Throughout this document, we have referenced all prescriptions as 'Stand Management Prescriptions' (SMP's). Juvenile spacing is normally carried out under a SMP. These inspection procedures are recommended for juvenile spacing carried out on Crown land in British Columbia.

A **Crop Tree** is defined as a preferred or acceptable species; equal to or greater than the minimum inter-tree distance from any other crop tree; equal to or greater than a specified minimum cutting height; equal to or less than the maximum diameter.

A **Leave Tree** is defined as a tree other than a crop tree that is specified not to be cut. Leave trees are left standing even if they are less than the minimum inter-tree distance from any other crop tree or leave tree. Leave trees are considered to be "ghost" trees and are ignored by the Contractor. They are tallied in the total tree column on the plot card, but not in the total crop tree column.

Inter-tree Distance is defined as the horizontal distance between two trees on a centre to centre basis, calculated or measured to the nearest 1/10 of a metre, unless otherwise specified in the contract.

The FS 749 found on page 22 is a conceptual proof, only available in this document at this time.

Correlation between Pre Stand Tending Surveys, SMPs and Juvenile Spacing Treatments

Pre stand tending surveys should be done using the same survey parameters as the intended juvenile spacing treatment. Otherwise, the post spacing objectives prescribed in the SMP may not be possible to achieve.

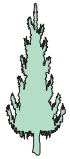
The SMP must prescribe a wide variation in the inter-tree distance between crop trees in stands with high variability in density. This is key in allowing the Contractor to choose the optimum crop tree. Without this flexibility, the optimum crop trees may be sacrificed because of a specified inter-tree distance. If Contractors do not choose the optimum crop tree(s), the "chainsaw effect" will likely occur. **Chainsaw effect** is described as a reduction in the top height of a stand resulting from improper crop tree selection. This lowers the timber production capacity and decreases the average diameter of the stand. The loss of optimum crop trees also reduces the expressed site index and decreases the potential volume at the next rotation.

Plot Legend

Crop Tree

Crop Tree of another species

Crop Tree that could have been left



Stump

Broadleaf Tree

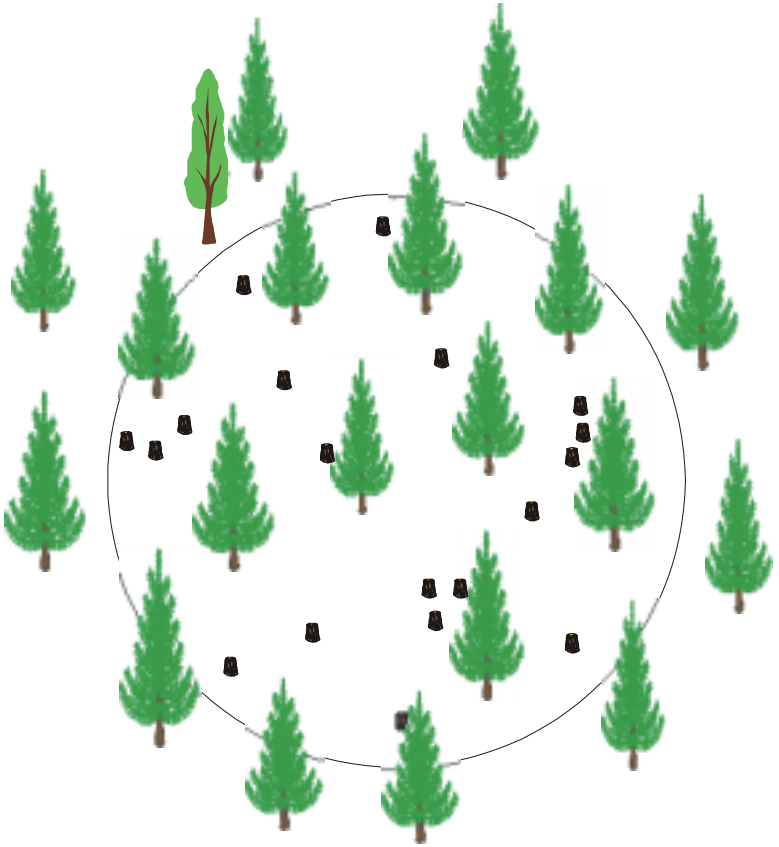
Wildlife Tree

Plot 1 - Plot in an Evenly Spaced Stand

This plot is commonly found when the trees prior to juvenile spacing are fairly evenly distributed, are of similar quality and there are a number of choices of suitable crop trees present.

This plot is one where:

- the number of crop trees tallied in the plot are all greater than the minimum inter-tree distance apart,
- the number of crop trees tallied in the plot are within the minimum and maximum density prescribed in the SMP,
- there are no reworkable or non reworkable errors or voids found within the plot.



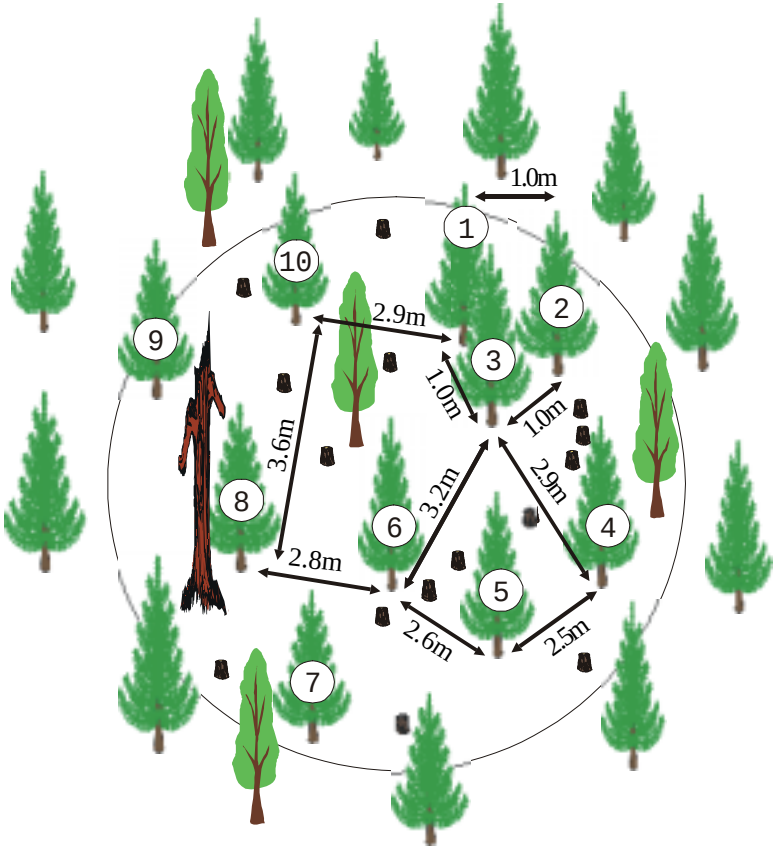
PLOT NO. / BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS R	5	10	15	20	25	Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
1	Pl		5	4				9	9	0	0	0		
	Sx													
N	Fd													
100m														

Plot 2 - Variation in the Inter-Tree Distance

This plot shows an example of the variation in the inter-tree spacing distance that should be prescribed in the SMP to allow the Contractor to choose the optimum crop trees.

The inter-tree distance between crop trees #1, #2 and #3 is 1.0 metre. This distance is the minimum inter-tree distance used in the examples provided in this document. The remainder of the crop trees within the plot are spaced slightly wider; however, the number of crop trees left in the plot in this example is within the minimum and maximum density specified in the SMP. The rationale of having a small minimum inter-tree distance is to allow the Contractor the flexibility to chose the optimum crop trees throughout the entire work area.

This plot has 10 crop trees. The 10 crop trees chosen are the best quality and the largest crop trees. The trees that were cut down were of poor quality, with significant forest health factors noted on a number of them. There are no excess faults assessed to the Contractor, as the maximum number of crop trees per hectare has not been exceeded. No other faults have been assessed to the Contractor as there were no reworkable or non reworkable faults noted in this plot.



PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS R	5	10	15	20	25	Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
2	Pl		4	6				12	10	0	0	0		
	Sx													
N	Fd													
100m	At			2										

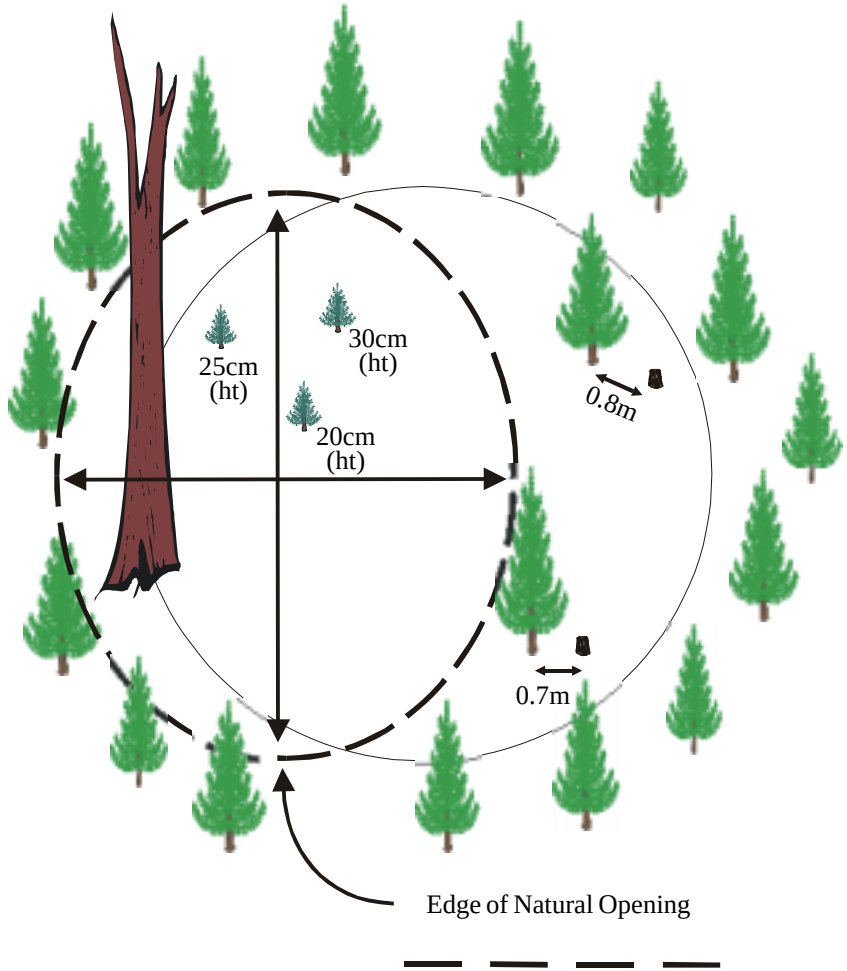
Plot 3 - Natural Openings in the Plot

If a portion or all of a quality plot falls within a natural opening, the plot is assessed where it falls. The plot is not to be moved to another location. The Contractor is not faulted for 'creating' a void, as the opening is considered a natural opening; there are no cut stumps as a result of the juvenile spacing treatment. The two trees within the plot that were cut were less than the minimum inter-tree distance from the remaining crop trees. Therefore, no faults are assessed to the Contractor.

The three trees which are less than the minimum cutting height (20 cm, 25 cm, and 30 cm) are included in the total tree column, but are not tallied as crop trees. They are tallied on the plot card as regen (R).

A **Natural Opening** is defined as an area in the original stand that has no trees above the specified minimum cutting height, and has an average diameter greater than twice the target inter-tree distance.

The SMP should describe the procedures to follow if a root rot centre is within the work area. If root rot treatment procedures are not described in the SMP, and the Contractor finds root rot within the work area, the Contractor should stop working in that particular area and bring the findings to the attention of the Inspector. Root rot centres may be considered as natural openings. The SMP must be referenced to determine if the appropriate treatment is to increase the density around the opening or to decrease the density around the opening (bridge tree removal).



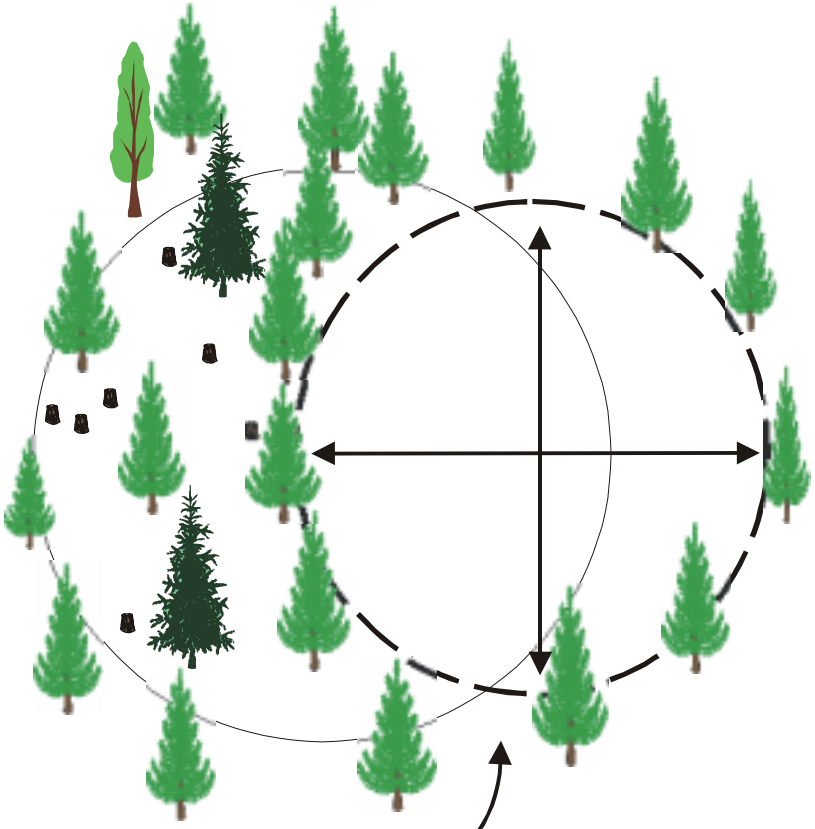
PLOT NO. / BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS						Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
		R	5	10	15	20	25							
3	Pl	3	1	1				5	2	0	0	0		
	Sx													
N	Fd													
100m														

Plot 4 - Natural Opening and Reducing the Inter-Tree Distance

When the target number of crop trees per plot cannot be achieved due to a natural opening, the inter-tree distance should be reduced to the specified minimum inter-tree distance, or another specified distance, but only around the perimeter of the natural opening. Reducing the inter-tree distance is encouraged throughout the entire work area to ensure the best crop tree is chosen; however, the maximum density prescribed in the SMP should not be exceeded.

Plot 4 shows crop trees that are spaced at close to 1.0 meter around the perimeter of the natural opening in order to achieve the density prescribed in the SMP.

If the minimum inter-tree distance is preventing the Contractor from choosing the best crop tree and achieving the target density prescribed in the SMP, the Contractor must stop work before the density is reduced below the minimum prescribed in the SMP. A recommendation should be made to reduce the minimum inter-tree distance to suit the site and stand characteristics.



PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS R	5	10	15	20	25	Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
4	Pl		4	3				9	9	0	0	0	4.1	12
	Sx		1	1										
N 100m	Fd													

P I 10-13-4.2-4 %

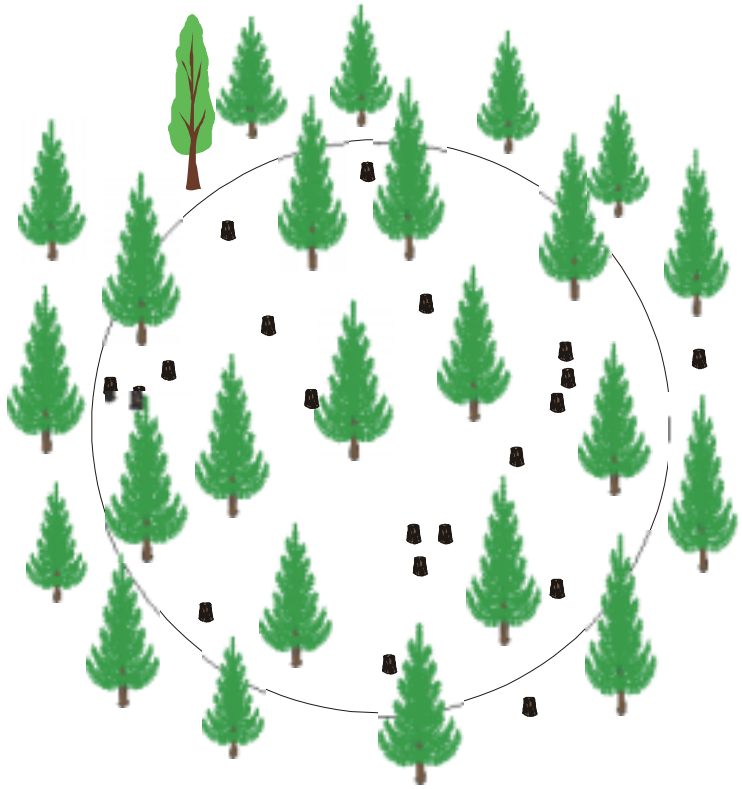
Plot 5 - Excess Trees

In this plot, the Contractor has spaced all of the crop trees greater than the minimum inter-tree distance. The maximum density prescribed in the SMP is 2000 crop trees per hectare, which is 10 crop trees in a plot. The Contractor has left 11 crop trees in the plot. This number exceeds the maximum density prescribed in the SMP. If the density in the area surrounding the plot is greater than 2000 crop trees per hectare, the Contractor is faulted for 1 excess tree. This is recorded as 1 R1, (one excess tree). If the density in the area surrounding the plot and within the work area in general, is less than the maximum density specified in the SMP, the Contractor is not faulted for the excess tree.

Additional density plots may be required to verify the density in the area surrounding the plot. Refer to page 19 for confirming density and establishing density plots. Experienced Inspectors may be able to economize on the establishment of density plots based on ocular estimates as well as data collected at and between plots. For example; where every plot has a high density, it may be obvious that excess trees are a concern. In all cases, the decisions made by the Inspector must be verifiable on the ground.

If there is an area greater than 1/10 of a hectare in size, that is greater than the maximum density specified in the SMP, the Inspector has the discretion to request the Contractor to rework that area to lower the density to within the range specified in the SMP. Allowing a rework of an area is at the discretion of the Inspector, and is contingent upon the potential for successfully reworking the area. Alternatively, the Inspector may chose to mark out the area as a separate stratum and pay for that area at a reduced rate applicable to the quality of treatment within the stratum.

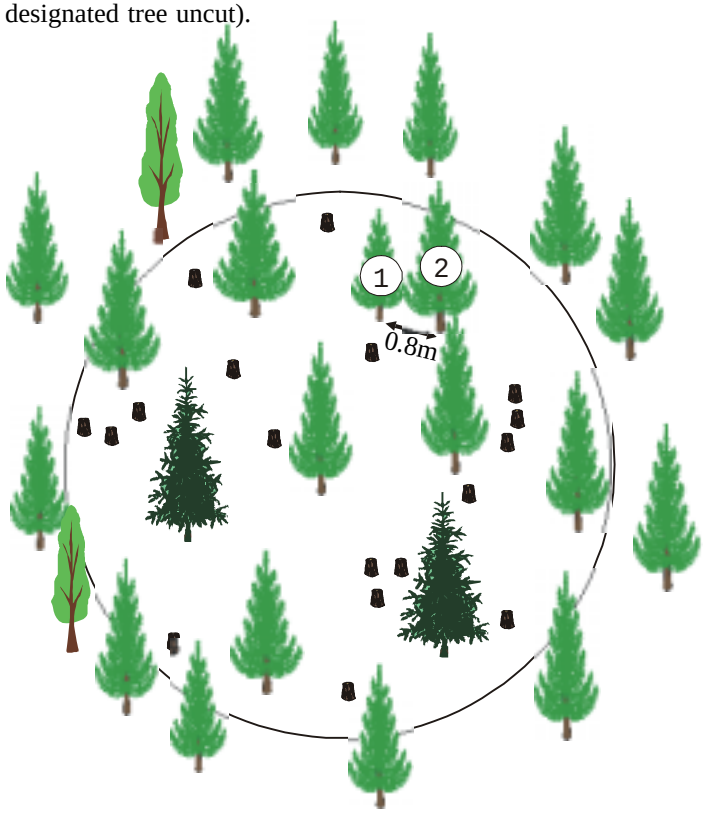
If the average density in the area surrounding the plot is less than the maximum density specified in the SMP, no excess tree fault is recorded.



PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS R	5	10	15	20	25	Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
5	Pl		6	5				11	10	1	0	0		
N	Sx									R 1				
100m	Fd													

Plot 6 - Designated Tree Uncut

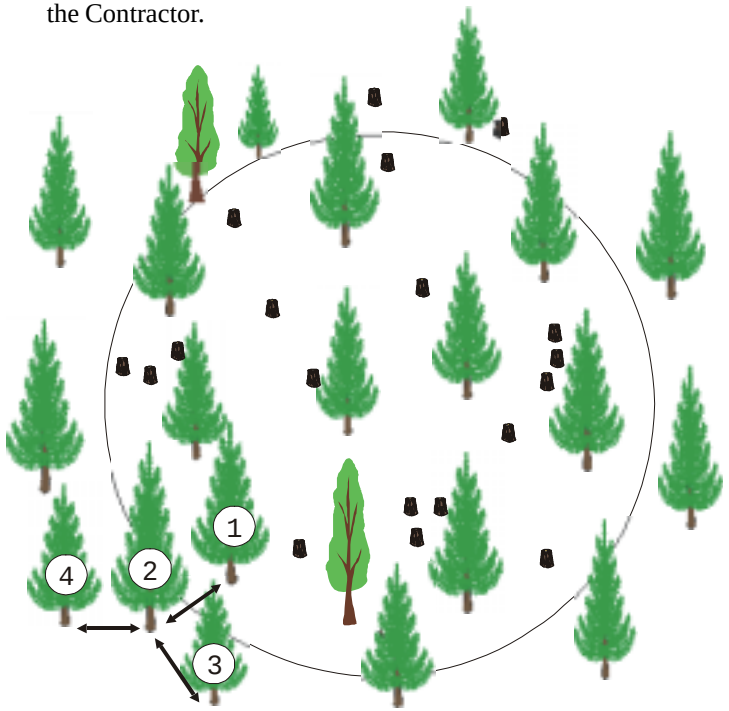
In this plot, the Contractor has left crop trees #1 and #2, at 0.8 metres apart. This distance is less than the minimum inter-tree distance allowed. Therefore, only 9 crop trees are suitable to be in the plot. The fault is recorded on the plot card as 1 R7, (one designated tree uncut).



PLOT NO. / BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS R	5	10	15	20	25	Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
6	Pl		3	5				10	9	1	0	0		
	Sx		1	1						R 7				
N	Fd													
100m														

Plot 7 - Close Spacing – Inside or Outside the Plot Boundary

Plot 7 and 8 illustrate two situations of close spacing. Plot 7 describes one situation. Crop tree #1 is inside the plot and is less than the minimum inter-tree distance from crop tree #2, located outside the plot. If crop tree #2 is less than the minimum inter-tree distance from crop trees #1, #3, and #4, then crop tree #2 is the obvious fault tree. No fault is assessed to the Contractor.

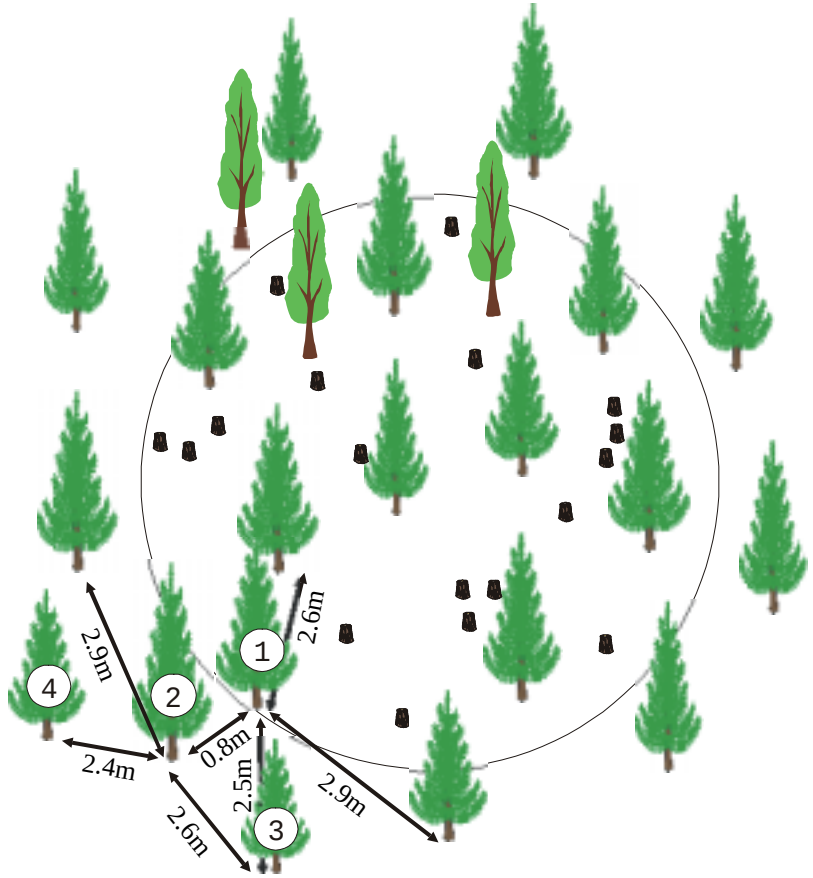


PLOT NO. / BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS R	5	10	15	20	25	Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
7	Pl		5	4				10	9	0	0	0		
	Sx													
N	Fd													
100m	At			1										

Plot 8 - Close Spacing – Inside or Outside the Plot Boundary

Plot 8 describes the second situation that can occur regarding the faulting of crop trees inside or outside the plot boundary. Crop tree #1 and crop tree #2 are less than the minimum inter-tree distance apart. All of the neighbouring trees that surround crop trees #1 and #2 are spaced greater than the minimum inter-tree distance prescribed. The removal of either crop tree #1 or crop tree #2 would solve the problem. When it is not clear which crop tree is incorrectly spaced, the crop tree outside the plot is considered the fault tree. The benefit of the doubt in this situation would go to the Contractor.

If crop tree #1 is half the height or of poorer quality than crop tree #2, then a fault is assessed to the Contractor. This would result in 8 total crop trees in the plot. The fault is recorded on the plot card as 1 R7 (one designated tree uncut).



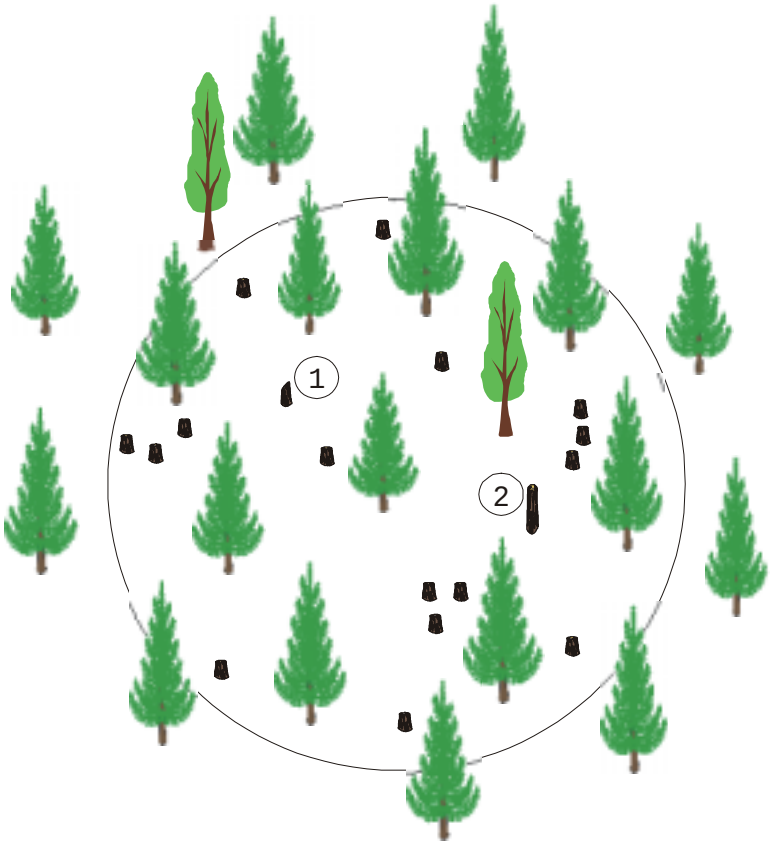
PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS R	5	10	15	20	25	Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
8	Pl		5	4				11	9	0	0	0	4.4	13
	Sx													
E	Fd													
100m	Ep		1	1										

Pl 9 Sx 1-12-4. 1-5 %

Plot 9 - Reworkable Errors

This plot describes two examples of reworkable errors that can occur in a plot. Stump #1 has a stump cut angle greater than the allowable stump cut angle specified in the contract. This fault is recorded on the plot card as 1 R5, (one stump cut angle).

Stump #2 is taller than the allowable stump height specified in the contract. This fault is recorded on the plot card as 1 R6, (one high stump).



PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS R	5	10	15	20	25	Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
9	Pl		8	1				10	9	1 R 5 1 R 6	0	0		
S 100m	Sx													
	Fd													
	At		1											

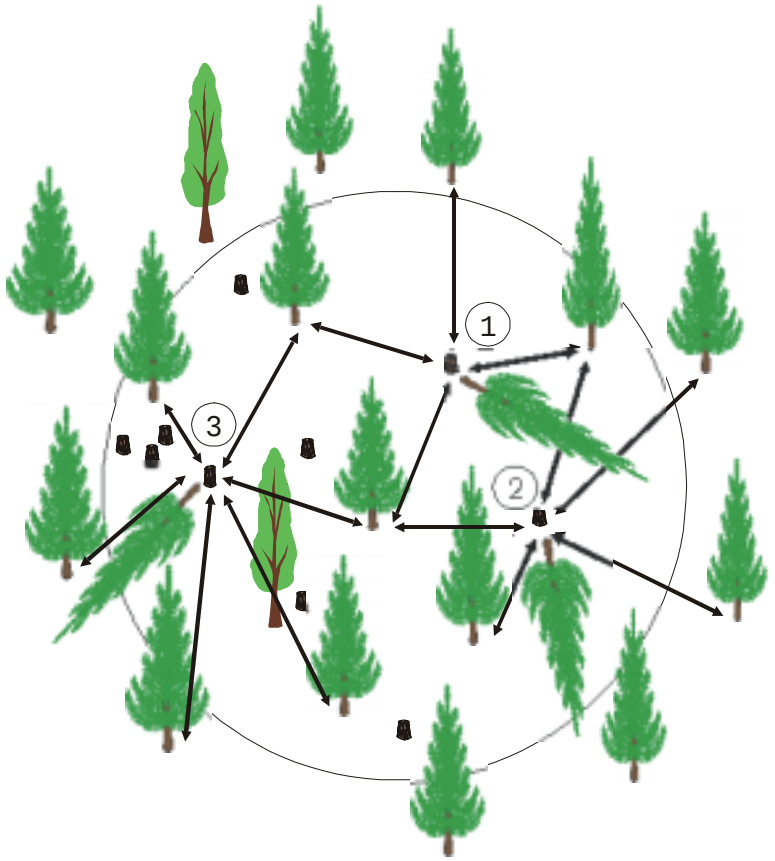
Plot 10 - Over Cutting

When assessing over cutting, reference the applicable SMP to determine the minimum number and target number of crop trees per hectare. If the minimum density prescribed is not achieved, the plot will be re-assessed to the target number of crop trees per hectare, using the minimum inter-tree distance.

When assessing the plot, the Inspector must confirm the species' acceptability and the quality of the crop trees cut. In this example, the three crop trees cut are acceptable species and are superior quality crop trees. The Contractor has left only 6 crop trees in the plot. The target density prescribed is 1800 stems per hectare, which equates to 9 crop trees in the plot. The remaining crop trees and the cut stumps are all spaced at a distance greater than the minimum inter-tree distance prescribed. The three trees cut, trees #1, # 2, and #3, are considered non reworkable errors and recorded on the plot card as 3 NR1, (three cutting or damaging crop trees).

Additional density plots are one method suggested to assist the Inspector in determining the extent of over cutting. Refer to page 19 for an additional discussion on confirming density and establishing density plots.

If the average density in the area surrounding the plot is less than the target density prescribed in the SMP, the Contractor is faulted for the number of non reworkable errors in the original plot. If the area of over cutting is a contiguous area greater than the minimum specified in the contract, this area is stratified out separately, along with the plots. The Contractor will receive no payment for this area. Over cutting is considered a very serious fault, as it results in lost productivity of the stand and is not reworkable.



PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS R	5	10	15	20	25	Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
10 S 100m	Pl		3	3				7	6	0	3 NR1	0		
	Sx													
	Fd													
	At		1											

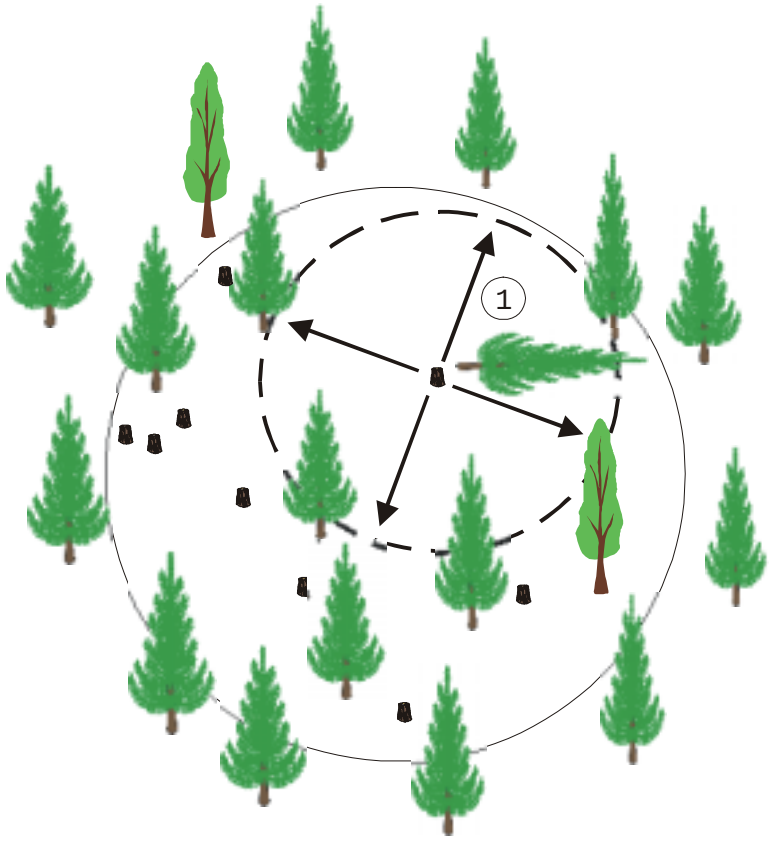
Plot 11- Over Cutting and Creating a Void

If the Contractor cuts too many trees, a void may occur.

A **Void** is an area within a spaced stand that, as a result of over cutting, has no crop trees within the target inter-tree distance measured in a circle from the stump of the tree that was cut.

In this case, the void was created when tree #1 was cut, because this tree was greater than the target inter-tree distance away from any other crop tree. In this example, tree #1 was an acceptable species and a superior quality crop tree. This fault is considered a non reworkable error and recorded on the plot card as 1 NR1, (one cutting or damaging crop tree). One void is also recorded on the plot card.

Voids result in the reduction of potential volume. Creating a void results in a payment deduction for the Contractor. Refer to the contract for the actual assessment amount.



Arrows represent target inter-tree distance

PLOT NO. / BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS R	5	10	15	20	25	Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
11 / S 100m	Pl		4	2				7	6	0	1 NR1	1		
	Sx													
	Fd													
	Ep			1										

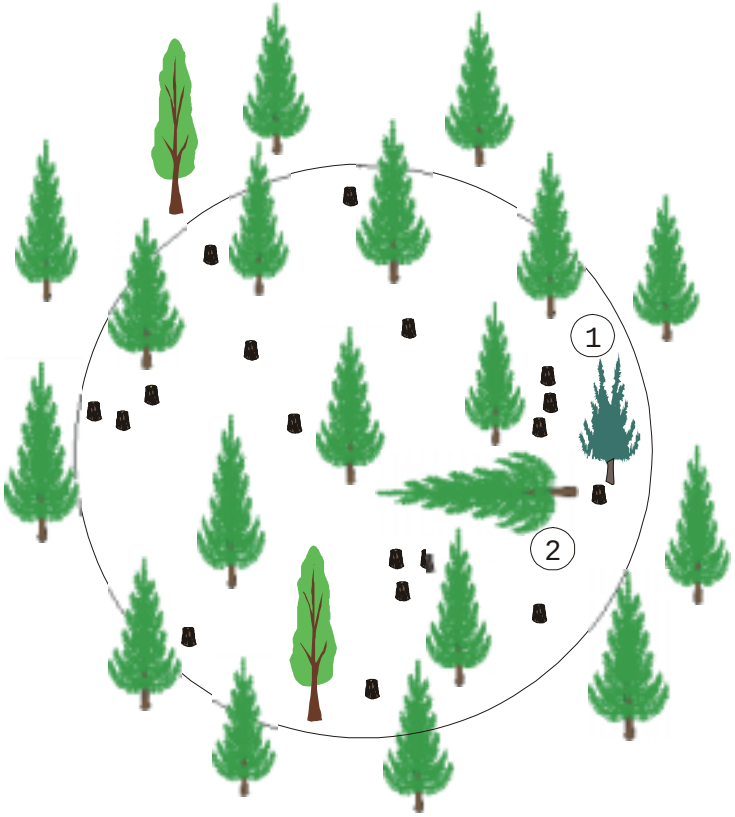
Plot 12 - Improper Crop Tree Selection

Plot 12 and 13 describe improper crop tree selection. Improper crop tree selection results in reduced productivity of the stand.

Plot 12 describes one procedure to follow when assessing improper crop tree selection. Crop tree #1 (smaller, and forked more than 5 years ago) was left in the plot and tree #2 was cut. Tree #2 should have been left, as it was a taller, superior tree than crop tree #1.

If crop tree #1 was short and not forked, the same fault would be assessed, since crop tree # 2 was the superior crop tree. The fault should be recorded on the plot card as 1 NR 3, (one improper crop tree selection).

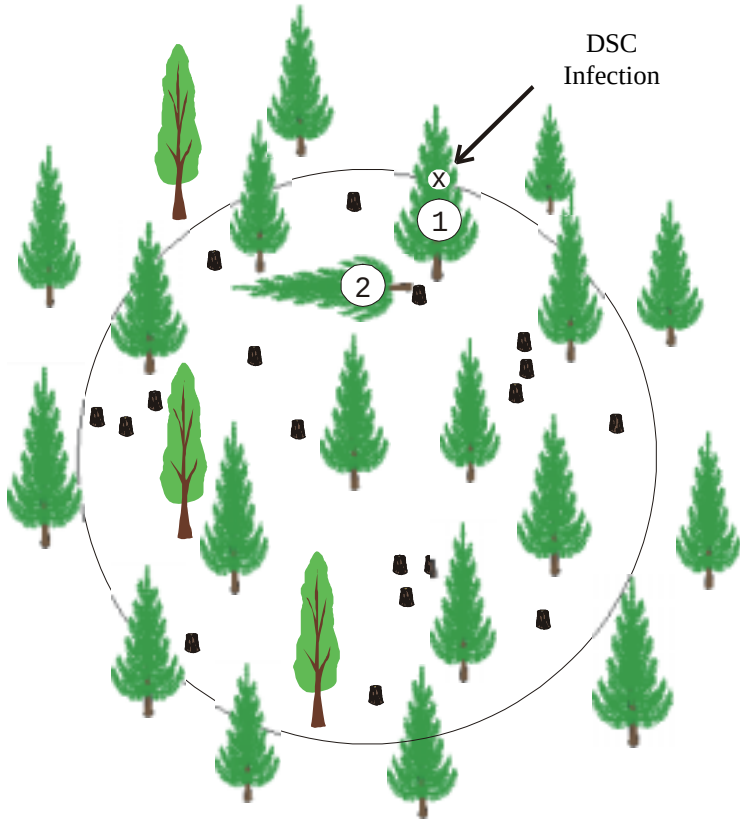
All other things being equal, the largest trees should always be left as the crop trees.



PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS R	5	10	15	20	25	Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
12	Pl		4	5				10	8	0	1	0	4.4	14
	Sx										NR3			
S	Fd													
100m	At		1						P I10-13-4.3-5 %					

Plot 13 - Improper Crop Tree Selection

Plot 13 describes another situation when assessing improper crop tree selection. Crop tree #1 was left in the plot. However, it has a stem infection of commandra blister rust (DSC). Tree #2 was cut, but it should have been left, as it is not infected. The fault should be recorded on the plot card as 1 NR 3, (one improper crop tree selection).



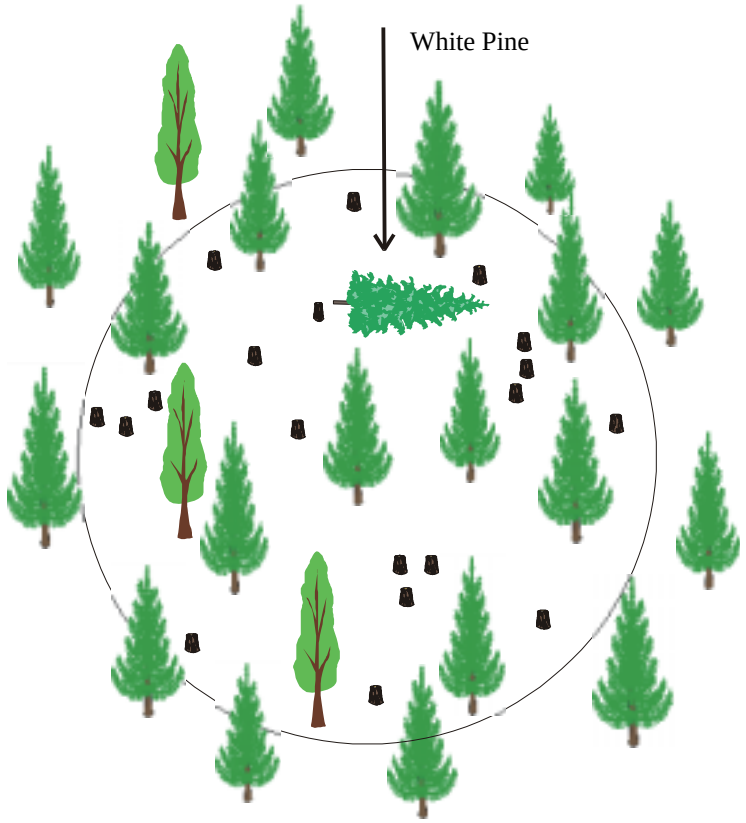
PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS R	5	10	15	20	25	Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
13	Pl		4	5				11	8	0	1 NR3	0	4.4	14
S 100m	Sx													
	Fd													
	At		1	1										

Plot 14 - Cutting or Damaging Leave Trees

SMP's often specify trees that must not be cut. It is common to have a statement in the SMP indicating that trees larger than a specified diameter, or of a certain species, must not be cut. White pine is an example of a species often specified as a leave tree.

Leave trees are left standing even if they are less than the minimum inter-tree distance from any other crop tree or leave tree. Leave trees are considered to be "ghost" trees and are ignored by the Contractor. However, leave trees are tallied in the total tree column.

In this plot, white pine was prescribed as a leave tree. However the Contractor cut it down. The fault is recorded as 1 NR2, (cutting or damaging leave trees).



PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS R	5	10	15	20	25	Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
14 S 100m	Pl		4	5				11	9	0	1 NR2	0	4.4	14
	Sx													
	Fd													
	At		1	1										

Procedures for Confirming Density and Establishing Density Plots

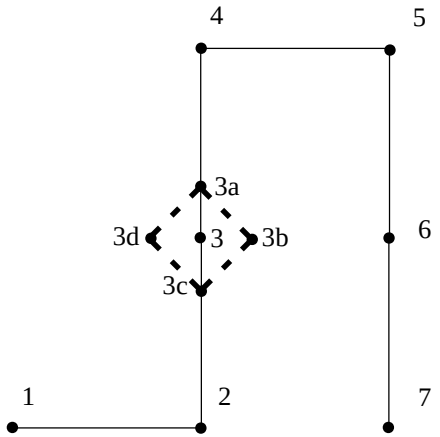
Where densities in a plot fall outside the range of the minimum or maximum density prescribed, there are a number of methods that can be employed to confirm the densities. One method is conducting a visual assessment, another method could be establishing a larger radius plot at the same plot center, and a third method is described here. Density plots are only done when the incorrect density is caused by the Contractor, not due to natural variation in the stand. Density plots are established to determine the extent of the over cutting or the excess tree situation. They are not used in the quality calculations. Any reasonable method to determine and confirm the density is suitable as long as it is verifiable on the ground.

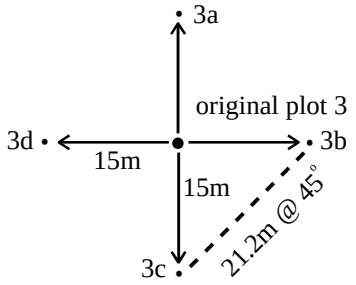
The following is a description of a suitable method for confirming density in the area surrounding a plot.

Density plots should be established 15 metres, or another pre-determined distance from the center of the original plot, along each of the cardinal bearings (N, S, E, W).

If a combination of all of the density plots and the original plot indicate a low density caused by the Contractor, the area of low density should be ribboned out, and traversed. If the area is larger than the minimum specified in the contract, the Contractor will not be paid for that area. Despite any minimum specifications in the contract, the Contractor is expected to achieve the densities prescribed throughout the entire work area.

If a combination of all of the density plots and the original plot indicate a high density caused by the Contractor, the Inspector has the discretion, based on site and stand characteristics, to:
1) request that the Contractor rework the area,
2) ribbon out and traverse the high density area as a separate stratum and reduce the payment for the contiguous area of unsatisfactory performance.





Reworkable Errors

Reworkable errors are those errors that can be corrected. Reworkable errors can include any of the following faults:

Excess Trees

Additional trees over and above the prescribed amount that are left within a plot. Excess trees are not recorded as excess unless the excess trees are also found in the immediate adjacent area. Refer to Plot 5 for a detailed description of excess trees. These faults are recorded on the plot card as R1, (excess tree).

Hinged Tree

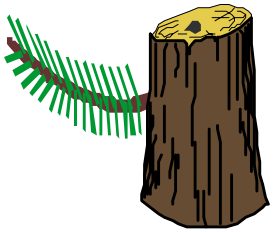
A tree that is still partially attached to the stump due to an incomplete cut. There must be some cambium still attached to the stump to be considered a hinged tree. A hinged tree may continue to grow and to compete with crop trees. These faults are recorded on the plot card as R2, (hinged tree).

Leaner

A tree that has been cut and which is leaning on a crop tree is considered a “leaner”. Leaning trees can damage crop trees, reducing the crop tree’s potential growth. These faults are recorded on the plot card as R3, (leaner).

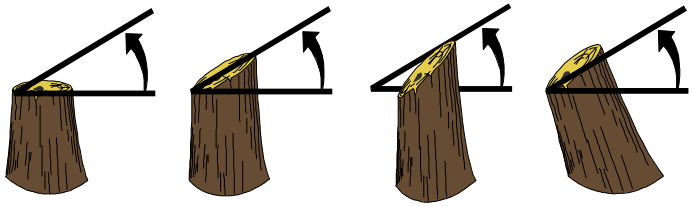
Live Branches

Trees are to be cut below the lowest live branch. Live branches are commonly referred to as ‘live limbs’. These live branches may turn up and continue to grow. These faults are recorded on the plot card as R4, (live branches).



Stump Cut Angle

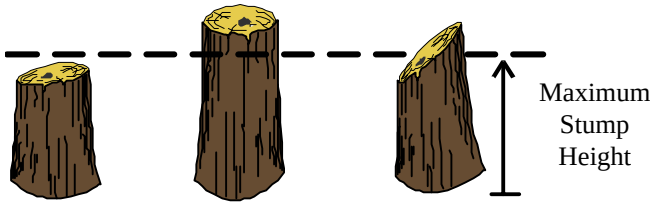
The rise of the stump should be no more than presribed in either the SMP, or the contract. Excessive sharp angles may pose a hazard for wildlife and recreational users of the forest. These faults are recorded on the plot card as R5, (stump angle).



Acceptable Marginal Unacceptable Unacceptable

High Stump

Stumps are to be cut at a height less than specified in the SMP. High stumps may pose a hazard for wildlife and recreational users of the forest. These faults are recorded on the plot card as R6, (high stump).



Acceptable Unacceptable Unacceptable

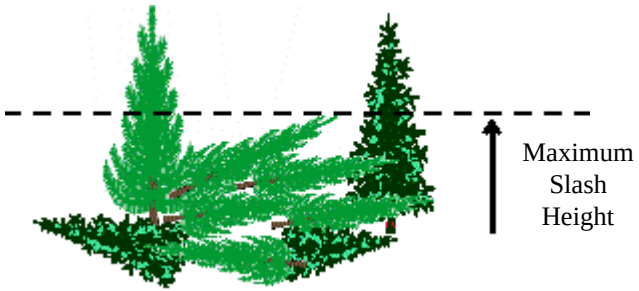
* Flexibility should be exercised when assessing high stumps which are adjacent to obstacles such as rocks, other crop trees, or large pieces of debris.

Designated Tree Uncut

Any conifer, broadleaf or diseased tree that should have been cut but was not, is considered a designated tree uncut. For example, a lodgepole pine with western gall rust on its stem that should have been cut, but was not, is considered a designated tree uncut. These faults are recorded on the plot card as R7, (designated tree uncut).

Unsatisfactory Slash Disposal

The contract states the maximum height of slash resulting from the treatment that can be left. The closer the slash is to the ground, the faster the rate of decomposition and the lower the hazard to wildlife, range and recreational users of the forest. These faults are recorded on the plot card as R8, (unsatisfactory slash disposal).



Other

This category is used for other reworkable faults that may occur within the plot. An example of this type of fault would be slash resulting from the treatment leaning against a fence, or across game or cattle trails. These faults are recorded on the plot card as R9, (other).

Non Reworkable Errors

Non reworkable errors are faults which damage the stand or crop trees, and cannot be corrected. These may include any of the following errors:

Cutting or Damaging Crop Trees

Cutting a crop tree down results in a loss of productive growing space. Damaging a crop tree by nicking it with a saw may also result in a loss of productivity or act as an entry point for insects and disease. These faults are recorded on the plot card as NR1, (cutting or damaging crop trees).

Cutting or Damaging Leave Trees

Some conifers and/or broadleaf trees may be specified in the SMP, or the contract, to be reserved. If any one of these leave species are cut or damaged, these are considered faults. These faults are recorded on the plot card as NR2, (cutting or damaging leave trees).

Improper Crop Tree Selection

Prior to faulting for improper crop tree selection, the cut crop trees must be assessed to determine if they would have been more suitable than the crop trees left. Examples of improper crop tree selection are:

- a shorter crop tree is favoured over an adjacent, taller crop tree,
- a crop tree of a less desirable species is favoured over a more desirable species,
- a diseased tree is favoured over a healthy crop tree,
- a tree of poor form and vigor is favoured over a healthy crop tree.

These faults are recorded on the plot card as NR3, (improper crop tree selection).

Juvenile Spacing Quality Inspection Plot Card

BRITISH COLUMBIA

JUVENILE SPACING QUALITY INSPECTION

PROJECT IDENTIFICATION	PROJECT UNIT	MAPSHEET & OPENING NO.	
LICENCE NO.	CP NO.	BLOCK NO.	ATU or STRATUM
SURVEYOR NAME			DATE YY MM DD
SPACING CONTRACTOR			PAGE OF
PRESCRIPTION DETAILS/ SURVEY PARAMETERS			PLOT RADIUS m

PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS						Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
.....														
.....														
.....														
.....														

FS 749 HSP (Prifor 2001/2/15)

PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS						Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
.....														
.....														
.....														
.....														
.....														
TOTALS ALL PLOTS													Avg. Ht.	Avg. Age
TOTAL / ha														

NOTES

FAULT CODES

REWORKABLE ERRORS		NON-REWORKABLE ERRORS
R1 - Excess trees	R6 - High stump	NR1 - Cutting or damaging crop trees
R2 - Hinged tree	R7 - Designated tree uncut	NR2 - Cutting or damaging leave trees
R3 - Leaner	R8 - Unsatisfactory slash disposal	NR3 - Improper crop tree selection
R4 - Live branches		
R5 - Stump cut angle	R9 - Other	

Sample Juvenile Spacing Quality Inspection Plot Card

BRITISH COLUMBIA

JUVENILE SPACING QUALITY INSPECTION

PROJECT IDENTIFICATION: JS 2002DHO001	PROJECT UNIT: 1	MAPSHEET & OPENING NO.: 92N 053-013	
LICENCE NO.: FL A25135	CP NO.: 002	BLOCK NO.: 1	ATU or STRATUM: A
SURVEYOR NAME: B. Turtle		DATE (YY MM DD): 01 10 31	
SPACING CONTRACTOR: Super Spacing Ltd.		PAGE: 1 OF: 1	
PRESCRIPTION DETAILS/ SURVEY PARAMETERS		PLOT RADIUS: 3.99 m	

9 trees/plot (min. 8, max. 10)

inter-tree dist. = 2.5m (min. 1.0m)

1.0m min. cut height, >10cm DBH = leave tree

PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS R	5	10	15	20	25	Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
1 N 100m	Pl		5	4				9	9	0	0	0		
	Sx													
	Fd													
2 N 100m	Pl		4	3				12	10	0	0	0	5.1	15
	Sx			3										
	Fd													
	At			2				Pl9Sx1(Fd)-17-5.5-5%						
3 N 100m	Pl	3						5	2	0	0	0		
	Sx		1											
	Fd		1											
								Natural opening - no fault						
4 N 100m	Pl		2	5				11	10	1 R1	0	0	4.9	14
	Sx		2											
	Fd		2											
								Pl8Sx1Fd1-16-5.3-5%						

FS 749 HSP (Prifor 2001/2/15)

PLOT NO. BRG/ DIST.	SPP	TOTAL TREES BY SIZE CLASS R	5	10	15	20	25	Total Trees	Total Crop Trees	Rework. Errors	Non-rework. Errors	Voids	Avg. Ht. (m)	Avg. Age
5 W 100m	Pl		3	3				7	6	0	3 NR1	0		
	Sx													
	Fd													
	At			1				Visual assessment confirmed over cutting in area						
6 S 100m	Pl		3	5				10	9	1 R7	0	0	5.2	16
	Sx		1											
	Fd			1										
								Pl8Sx1Fd1-18-5.0-5%						
TOTALS ALL PLOTS		3	2	5	2	6		54	46	2	3	0	Avg. Ht.	Avg. Age
TOTAL / ha		100	83	33	67			1800	1533	67	100		5.1	15

NOTES: Crop tree densities below minimum due to natural opening in plot 3 and over cutting by contractor in plot 5.

FAULT CODES

REWORKABLE ERRORS		NON-REWORKABLE ERRORS
R1 - Excess trees	R6 - High stump	NR1 - Cutting or damaging crop trees
R2 - Hinged tree	R7 - Designated tree uncut	NR2 - Cutting or damaging leave trees
R3 - Leaner	R8 - Unsatisfactory slash disposal	NR3 - Improper crop tree selection
R4 - Live branches	R9 - Other	
R5 - Stump cut angle		

Payment Calculations

The payment for juvenile spacing projects is based on a graduated payment system. Payment percentage increases as the quality of work increases. One hundred percent payment is reached when the quality of work is greater than or equal to 92.6%. If the quality of work drops below 85% and the quality of work can be increased by reworking the treatment area, reworking should be enforced.

For all juvenile spacing projects, the quality of work begins at 100%. To calculate Quality of Work, subtract the reworkable and non reworkable error percentages from 100%. To determine the error percentages of reworkable and non reworkable errors, the following mathematical calculations are done:

$$\text{Reworkable error \%} = \frac{\text{Total No. of Reworkable Errors}}{\text{(No. of Plots X target No. Crop Trees / plot)}} \times 100$$

$$\text{Non reworkable error \%} = \frac{\text{Total No. of Non Reworkable Errors}}{\text{(No. of Plots X target No. Crop Trees / plot)}} \times 200$$

Juvenile Spacing Payment Calculation Card

BRITISH COLUMBIA

JUVENILE SPACING PAYMENT CALCULATION

PROJECT IDENTIFICATION	PROJECT UNIT	MAPSHEET & OPENING NO.	
LICENCE NO.	CP NO.	BLOCK NO.	ATU or STRATUM
SURVEYOR NAME			DATE YY MM DD
SPACING CONTRACTOR			PAGE OF

REWORKABLE ERRORS %:

(REWORKABLE ERRORS ÷ (TOTAL NUMBER OF PLOTS x TARGET NUMBER OF CROP TREES PER PLOT)) x 100 =

(_____ ÷ (_____ x _____)) x 100 =

START WITH 100% QUALITY OF WORK

MINUS _____%

NON-REWORKABLE ERRORS %:

(NON-REWORKABLE ERRORS ÷ (TOTAL NUMBER OF PLOTS x TARGET NUMBER OF CROP TREES PER PLOT)) x 200 =

(_____ ÷ (_____ x _____)) x 200 =

MINUS _____%

REFER TO JUVENILE SPACING PAYMENT QUICK REFERENCE GUIDE FOR % PAYMENT

_____% ←

EQUALS FINAL QUALITY OF WORK

_____%

SPACING CONTRACTOR'S SIGNATURE: _____

SURVEYOR'S SIGNATURE: _____

(Prifor 749A 2000/6/15)

Sample Juvenile Spacing Payment Calculation Card

BRITISH COLUMBIA — **JUVENILE SPACING PAYMENT CALCULATION**

PROJECT IDENTIFICATION: JS 2002DHO001	PROJECT UNIT: 1	MAPSHEET & OPENING NO.: 92N 053-013	
LICENCE NO.: FL A25135	CP NO.: 002	BLOCK NO.: 1	ATU or STRATUM: A
SURVEYOR NAME: B. Turtle			DATE (YY MM DD): 01 10 31
SPACING CONTRACTOR: Super Spacing Ltd.			PAGE: 1 OF 1

REWORKABLE ERRORS %:

(REWORKABLE ERRORS ÷ (TOTAL NUMBER OF PLOTS x TARGET NUMBER OF CROP TREES PER PLOT)) x 100 =

(2 ÷ (6 x 9)) x 100 = 3.70 %

START WITH 100% QUALITY OF WORK

MINUS 3.70 %

NON-REWORKABLE ERRORS %:

(NON-REWORKABLE ERRORS ÷ (TOTAL NUMBER OF PLOTS x TARGET NUMBER OF CROP TREES PER PLOT)) x 200 =

(3 ÷ (6 x 9)) x 200 = 11.11 %

MINUS 11.11 %

REFER TO JUVENILE SPACING PAYMENT QUICK REFERENCE GUIDE FOR % PAYMENT: 83.40 % ←

EQUALS FINAL QUALITY OF WORK: 85.19 %

SPACING CONTRACTOR'S SIGNATURE: G. Green

SURVEYOR'S SIGNATURE: B. Turtle

(Prifor 749A 2000/6/15)

Juvenile Spacing Payment Quick Reference Guide

Quality of Work %	Pay %	Quality of Work %	Pay %	Quality of Work %	Pay %
100.00	100.00	90.50	97.10	87.40	90.46
99.00	100.00	90.40	96.93	87.30	90.20
98.00	100.00	90.30	96.76	87.20	89.94
96.00	100.00	90.20	96.58	87.10	89.67
95.00	100.00	90.10	96.40	87.00	89.40
94.00	100.00	90.00	96.22	86.90	89.13
93.00	100.00	89.90	96.03	86.80	88.85
92.90	100.00	89.80	95.85	86.70	88.57
92.80	100.00	89.70	95.66	86.60	88.29
92.70	100.00	89.60	95.46	86.50	88.01
92.60	100.00	89.50	95.27	86.40	87.72
92.50	99.90	89.40	95.07	86.30	87.43
92.40	99.79	89.30	94.86	86.20	87.14
92.30	99.67	89.20	94.66	86.10	86.84
92.20	99.55	89.10	94.45	86.00	86.54
92.10	99.43	89.00	94.24	85.00	83.40
92.00	99.31	88.90	94.02	84.00	79.96
91.90	99.18	88.80	93.81	83.00	76.22
91.80	99.05	88.70	93.59	81.00	67.89
91.70	98.92	88.60	93.36	80.00	63.28
91.60	98.78	88.50	93.14	79.00	58.38
91.50	98.65	88.40	92.91	78.00	53.19
91.40	98.50	88.30	92.68	77.00	47.71
91.30	98.36	88.20	92.44	76.00	41.94
91.20	98.21	88.10	92.21	75.00	35.88
91.10	98.06	88.00	91.96	74.00	29.52
91.00	97.91	87.90	91.72	73.00	22.87
90.90	97.75	87.80	91.48	72.00	15.93
90.80	97.60	87.70	91.23	71.00	8.70
90.70	97.43	87.60	90.97	70.00	1.18
90.60	97.27	87.50	90.72	69.00	0.00

Inter-Tree Distances and Corresponding Stand Densities

Inter-tree Distance (m)	Density in SPH	No. of Trees in 0.01ha (5.64m)	No. of Trees in 0.005ha (3.99m)
1.96	3000	30	15
2.0	2800	28	14
2.1	2600	26	13
2.2	2400	24	12
2.3	2200	22	11
2.4	2000	20	10
2.5	1800	18	9
2.7	1600	16	8
2.9	1400	14	7
3.1	1200	12	6
3.4	1000	10	5
3.8	800	8	4
3.93	750	7	3
4.4	600	6	3
4.8	500	5	2
5.4	400	4	2

To calculate inter-tree distances for values not listed in the above table use the following formula:

$$\sqrt{\frac{11\,547}{\text{minimum \# preferred \& acceptable well-spaced tph}}}$$