The Forestry Corp.

Strip Cut Understory Protection Monitoring Protocol and Field Manual

Prepared for the Mixedwood Management Association

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1. Monitoring Protocol Objectives

The objectives of the Mixedwood Management Association's Strip Cut Understory Protection (SCUP) Monitoring Protocol are to provide:

1. A measurement protocol to collect statistically valid data for describing the *Block*[1]-level stand performance following *Strip Cut Understory Protection* harvesting;
2. A protocol that is sufficiently flexible in order to be used by numerous companies, and to account for operational differences in the application of Strip Cut Understory Protection systems;
3. Re-measured data to quantitatively describe the post-harvest development of stands after Strip Cut Understory Protection harvest treatments;
4. Information required for growth model development and/or model calibration, with the potential for future use in process-based modelling; and
5. A monitoring protocol that is acceptable to the Alberta Sustainable Resource Development, Land and Forest Division, for use in monitoring and yield curve validation.

The protocol is intended for *Single-Pass* Strip Cut Understory Protection systems only. Three different areas have been identified for sampling. The *Extraction Trail* is defined as the area within which all trees have been harvested, to provide access for harvesting equipment. The *Removal Strip* is defined as the area subjected to overstory removal (generally aspen (*Populus tremuloides* Michx.)), for the purpose of releasing understory conifers (generally white spruce (*Picea glauca* (Moench) Voss)). The *Buffer Strip* is defined as a "leave" area, within which the overstory is retained to reduce windthrow effects on release trees in the Removal Strip. Each of the three areas are considered a discrete population or *Stratum* for the purposes of measurement *(Extraction Stratum*, *Removal Stratum* and *Buffer Stratum)*. An example of a Strip Cut Understory Protection Block is provided in Figure 1.

When pooled, the data can be used to describe post-harvest response to Strip Cut Understory Protection systems, including estimation of average stand development trajectories for each

[1] All words presented in italics are the first time that they appear in the text and are defined in the Appendix I.

sampled Stratum and comparison of differences in growth between Strata. However, the protocol is not intended as a designed experiment and will not allow testing of hypotheses or undertaking of statistical comparisons between Strata. The protocol is not intended to assess the level of release, relative to non-release, since randomized, untreated controls are not part of the sampling protocol.

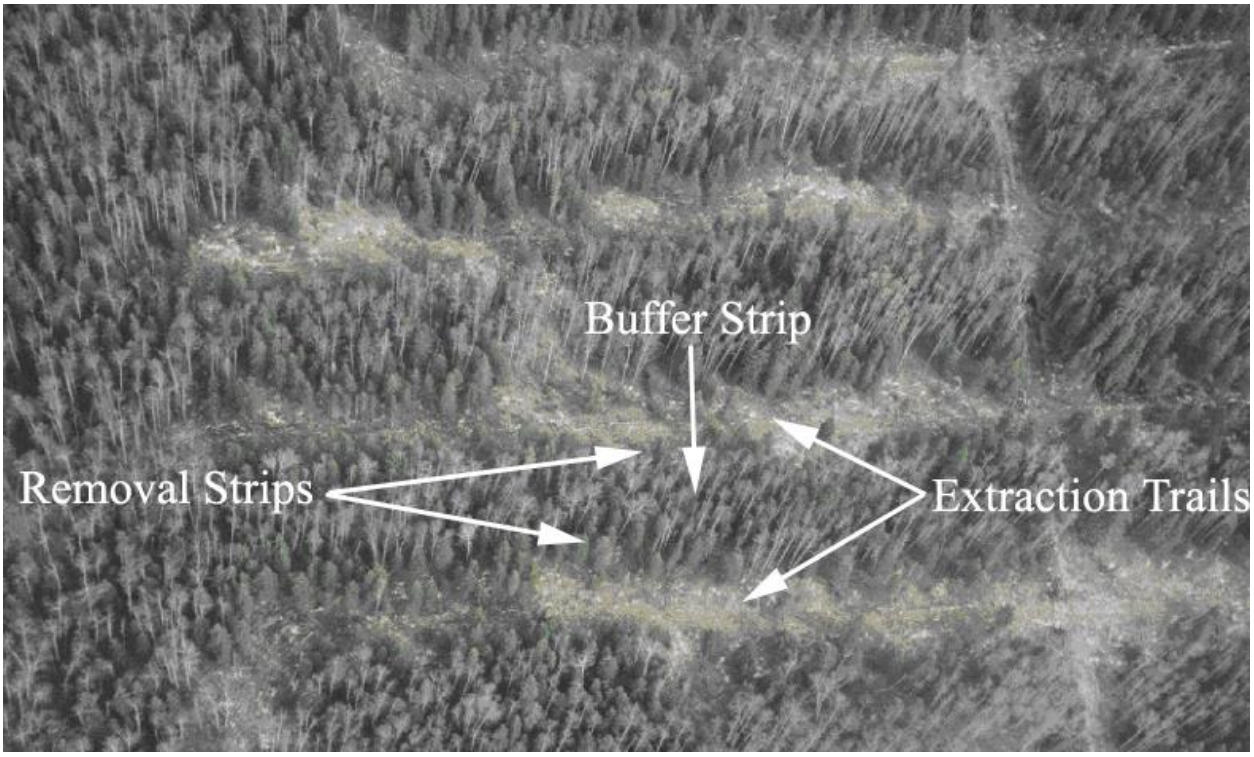


Figure 1. Example of a Single Pass Strip Cut Understory Protection Block.
(Photo: Gitte Grover)

2. Sampling Design

For a field protocol to be efficient, plot location methods should be unbiased and easy to apply. Establishment methods should not be overly complex (*e.g.*, consistency in plot layout), and remeasurement methods should account for changes in stands over time. The sampling design for the Strip Cut Understory Protection Monitoring Protocol was developed by the Mixedwood Management Association (MWMA) and The Forestry Corp, in consultation with Dr. Jim Flewelling and Dr. Mike Bokalo. The sampling design is considered appropriate relative to the objectives of sampling.

2.1 Plot Cluster Overview

Strip Cut Understory Protection Blocks will be sampled using a *Plot Cluster* design. A Plot Cluster consists of a series of adjacent plots, which are located perpendicular to the predominant orientation of Extraction Trails (Figure 2 and Figure 3). Each plot within the Plot Cluster will sample a different Stratum. *Extraction Plots* sample Extraction Trails, *Removal Plots* sample Removal Strips and *Buffer Plots* sample Buffer Strips.

A total of six Plot Clusters will be sampled in each eligible Block. The "center" of each Plot Cluster is situated at the center of the Extraction Trail. A centerline runs perpendicular to the general orientation of Extraction Trails, bisecting the Plot Cluster. Where the treatment includes a buffer, each Plot Cluster either begins or ends with the Buffer Plot. Therefore, the Plot Cluster sequence is either Buffer-Removal-Extraction-Removal or Removal-Extraction-Removal-Buffer. If the treatment has no buffers the Plot Cluster will only have two plots: Removal and Extraction (Figure 3). The Removal Plot includes both Removal A and Removal B plots into a single Plot.

For the purposes of plot layout, *Plot Width* is the dimension of the Plot Cluster along its centerline perpendicular to the orientation of the Extraction Trail, and *Plot Length* is the dimension of the Plot Cluster parallel to the orientation of the Extraction Trail (see Figure 2).

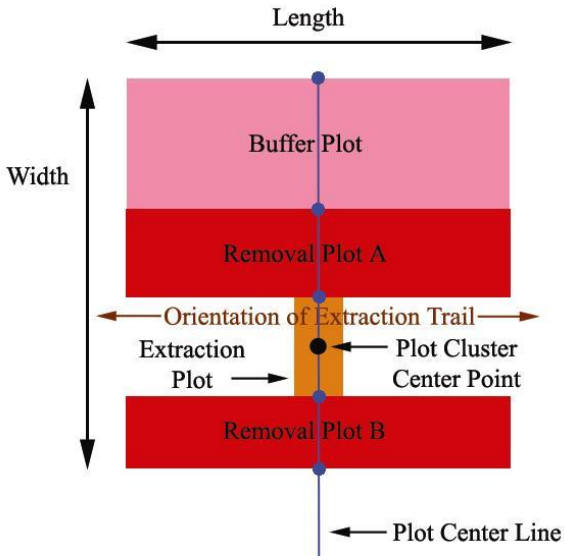


Figure 2. Sample Plot Cluster layout with Buffer.

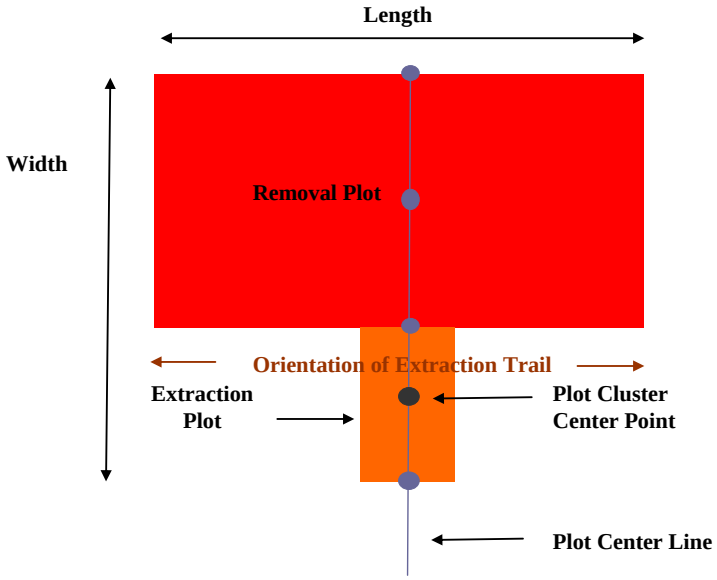


Figure 3. Sample Plot Cluster without Buffer

Individual plot width is set equal to the width of the stratum (*e.g.*, Extraction Trail plot width = width of the Extraction Trail). Where Buffer is present, plot length depends on the width of the Buffer Strip (Table 1). Based on measured Buffer Strip width (measured along the Plot Cluster centerline), Removal and Buffer Plot length will be either 8 m or 16 m. Extraction Plot length is always 2 m.

Table 1. Plot lengths based on Buffer Strip width.

Buffer Strip Width	Buffer Plot Length	Removal Plot Length	Extraction Plot Length
5-10 m	16 m	16 m	2 m
11-20 m	8 m	8 m	2 m

For designs where no buffer is present, the length of the plot is determined by the width of the Removal Plot measured between the two adjacent Extraction trails as shown in Table 2. Where no buffer is present, a single Removal Plot will be established on either side of the Extraction Trail.

Table 2. Plot lengths based on the Removal Strip width.

Removal Strip Width	Removal Plot Length	Extraction Plot Length
< 20 m	16 m	2 m
≥ 20 m	8 m	2 m

All plots within a Plot Cluster must be connected. The Buffer and Removal Plots are established first, with their plot boundaries (running parallel to strip orientation) defining the location of the Extraction Plot's boundaries.

Plot clusters are established and measured in the spring following harvest (t = 0 or prior to the commencement of the growing season). All plots in the Cluster (including the Buffer) are re-measured at five-year intervals up to and including 20 years post-treatment, after which a 10-year re-measurement schedule is followed. Re-measurement should always occur prior to the commencement of the growing season.

3. Block Selection

3.1 Selecting Eligible Blocks

The sample population includes all Single Pass Strip Cut Understory Protection Blocks harvested in one winter. In order to be considered an eligible Block (*i.e.*, within the sampling population), establishment and first measurement must be able to occur in the spring prior to the first growing season after harvest. For winter harvesting, eligible Blocks are best identified in the fall prior to harvest, so that arrangements for aerial photography may be made in advance.

The recommended strip widths for eligible Blocks are:

- ✓ 4-8 m for Extraction Trails
- ✓ 6-10 m for Removal Strips (12-20 m if there is no Buffer Strip between Removal Strips)
- ✓ No buffer up to 20 m for Buffer Strips

To be eligible, Blocks must be large enough to accommodate six Plot Clusters within their boundaries, and must have a minimum of five eligible Extraction Trails. The first and the last Extraction Trail along Block edges will not be considered eligible. Extraction Trails must be long enough to allow for a 30 m buffer at either end of each Extraction Trail, with a minimum distance of 100 m between Plot Clusters. Therefore, the following standards apply:

Eligible Block if:

- ✓ t = 0 (prior to the first growing season after harvesting)
- ✓ number of eligible Extraction Trails ≥ 5
- ✓ Single Pass harvesting design

Eligible Extraction Trail if:

- ✓ not the first or last Extraction Trail on the Block (along Block edges)
- ✓ there is a Buffer on at least one side of Extraction Trail (where treatment includes a buffer)
- ✓ A minimum eligible Extraction Trail length ≥ 120 m for all Blocks
- ✓ The total minimum length of the eligible extraction trails ≥ 720 m in order to allow for the establishment of 6 plot clusters.

A *Sampling Matrix* has been designed to ensure a range of stand conditions are sampled (Table 2). An initial sampling intensity of 5 to 10 Blocks per matrix cell is recommended (combined total for participating MWMA members). Each operator will classify eligible Strip Cut Understory Protection Blocks into this matrix. Blocks will be randomly selected from within matrix cells.

Table 3. Recommended target number of Blocks for initial sampling.

Natural Subregion	Pre-Harvest Understory Density		
	300-600 sph	600-1000 sph	>1000 sph
Central Mixedwood	5-10	5-10	5-10
Dry Mixedwood	5-10	5-10	5-10
Other	5-10	5-10	5-10

3.2 Gathering Block Information

Available Block information should be recorded on the **Block Form (Side 1)** prior to field sampling.

BLOCK HEADER INFORMATION

- ✓ FMU
- ✓ Township
- ✓ Range
- ✓ Meridian
- ✓ SCUP Block ID (MWMA-Company Code-SCUP-Harvest Block Number)
- ✓ Natural subregion
- ✓ Measurement date (yyyy/mm/dd)
- ✓ Crew Initials (up to three crew members)
- ✓ Measurement number (measurement number at establishment = 001)

BLOCK INFORMATION

Missing Block information should be treated in **one of two ways**: cross out fields where information is not available; leave these fields blank if the information was not collected prior to field sampling. An example is provided in Appendix III.

- ✓ Pre-Harvest Block Information
    a. Prescribed stratum widths
    b. Harvest completion date (yyyy/mm/dd)
    c. Ecosite (from pre-harvest assessment, if available)

- ✓ Aerial Photo Information
    a. Project number
    b. Date of photography (yyyy/mm/dd)
    c. Line number
    d. Photo number
- ✓ Crew Initials

4. Locating Plot Clusters

Two methods of determining Plot Cluster locations are presented here. If aerial photos or detailed harvest maps (which include locations of extraction trails) are available, use the Plot Cluster pre-location method (Section 4.1). Where this information is not available, use the alternate Plot Cluster location method (Section 4.2).

4.1 Pre-Location Method Using Aerial Photos/Detailed Harvest Maps (Preferred Method)

Where available, aerial photography (preferably 1:15,000 scale) or detailed harvest maps will be used to randomly pre-locate six Plot Cluster center points within the eligible Extraction Trails.

4.1.1 Select Eligible Extraction Trails for Sampling

The selection of Extraction Trails will be systematic with a random start. An example is provided in Figure 3.

1. ***Determine the number of eligible Extraction Trails:*** Number all eligible Extraction Trails 1 through X, starting from west to east or north to south depending on layout. An Extraction Trail is considered eligible if:
    a. It is not the first or last Extraction Trail within the Block (to control edge effect);
    b. There is a Buffer on at least one side of the Extraction Trail (where treatment includes a buffer);
    c. It is ≥ 120 m in length; and
    d. It has a minimum of 720 m of eligible extraction trail.
2. ***Randomly select the first eligible Extraction Trail for sampling:*** Flip a coin to determine the starting eligible Extraction Trail (Extraction Trail 1 or 2).
3. ***Systematically select the rest of the eligible Extraction Trails for sampling:*** Select alternating eligible Extraction Trails for sampling (*i.e.* if starting with eligible Extraction Trail 2, use 2, 4, 6, 8 *etc.*; starting with eligible Extraction Trail 1, use 1, 3, 5, 7 *etc.*).

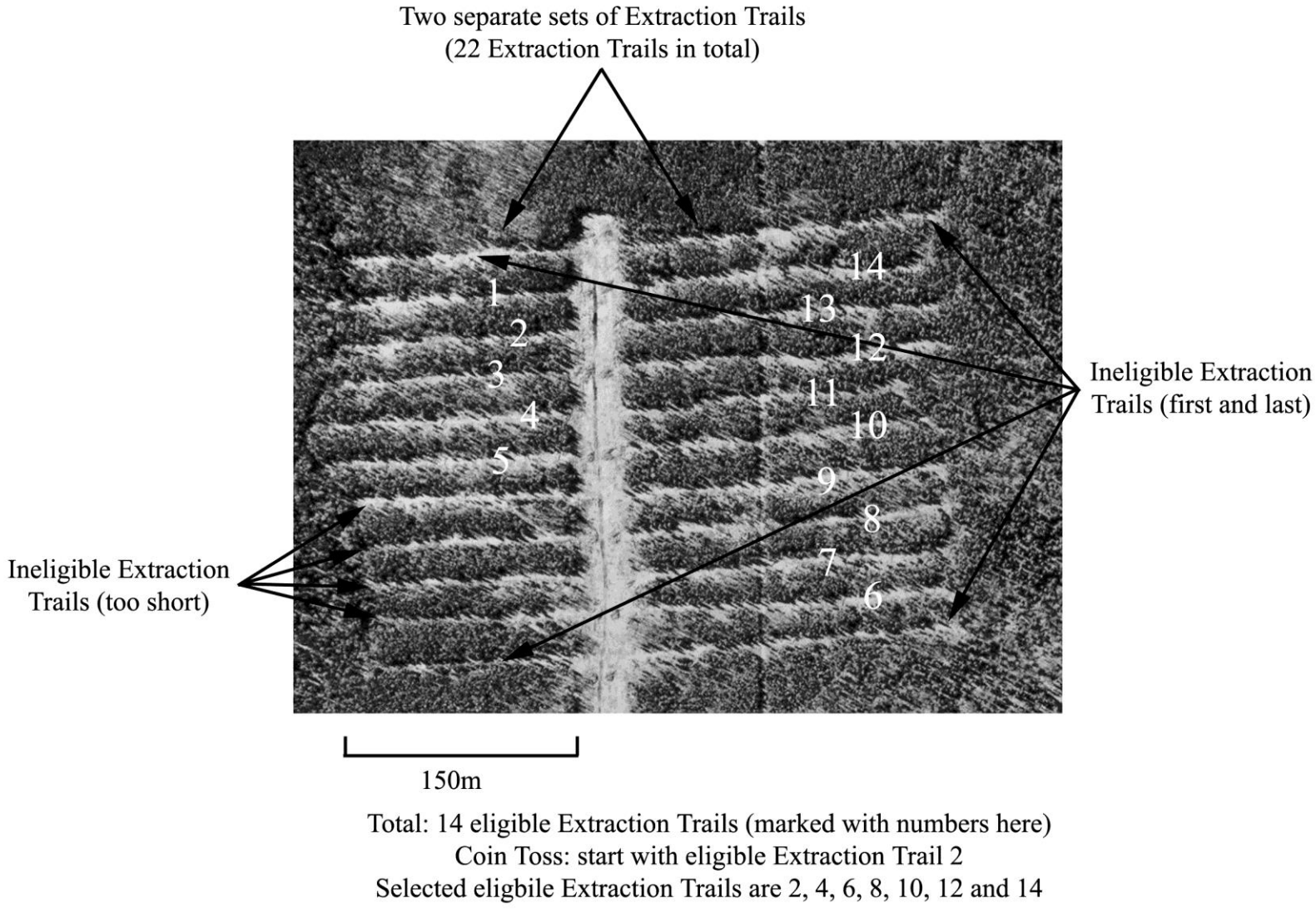


Figure 4. Example of selection of eligible Extraction Trails for sampling.

4.1.2 Pre-Locate Plot Clusters on Eligible Extraction Trails

Plot Clusters will be pre-located using a fixed distance with a random start. An example is provided in Figure 4, using the eligible Extraction Trails from Figure 3. The calculations are described in detail at the bottom of the page.

1. ***Determine the length of each selected eligible Extraction Trail:*** Measure the length of each selected Extraction Trail (L_i) in m.
2. ***Determine the total sampling length:*** Sum the individual selected eligible Extraction Trail lengths ($L_{total} = L_1 + L_2 \ldots + L_i$) in m.
3. ***Determine the fixed distance between Plot Clusters:*** Divide the total sampling length by 6 ($D_{fixed} = L_{total}/6$) and round down to the nearest m.
4. ***Select a random start distance for the first Plot Cluster location:*** Select a random number between 0 and 1, multiply it by the fixed distance between Plot Clusters ($D_{start}=D_{fixed}$*random) and round down to the nearest m.
5. ***Locate the first Plot Cluster:*** Locate the first Plot Cluster at D_{start} m along the first selected Extraction Trail (either 1 or 2 depending on results from Step 2, Section 4.1.1) using a tie point at the intersection of the Extraction Trail with the *Haul Road* (tie point 2 in this example).
6. ***Locate the second Plot Cluster:*** Proceed along the selected eligible Extraction Trail a distance equal to D_{fixed}. When the end of one selected Extraction Trail is reached, proceed to the next selected Extraction Trail and continue until D_{fixed} is reached (heading in the opposite direction than the first Extraction Trail). The fixed distance will be the sum of the two distances along the Extraction Trails in question; the distance between Extraction Trails is not measured.
7. ***Locate subsequent Plot Clusters:*** Repeat step 6 until all six Plot Clusters are pre-located.
8. ***Offset Plot Clusters located within buffers:*** Once the six Plot Clusters are pre-located, determine whether any Plot Clusters within 30 m of the beginning or end of the Extraction Trails. These Plot Clusters must be offset (to avoid edge effect). Offset the Plot Cluster by moving it 30 m inwards; that is, away from the end of the Extraction Trail. This step must be done after all Plot Clusters are pre-located, and will not affect the location of the remaining Plot Clusters.

Example:

An example Plot Cluster pre-location process is described here. See Table 3 and Figure 4 for additional details. From Figure 3, the selected eligible Extraction Trails are 2, 4, 6, 8, 10, 12 and 14. The total sampling length (L_{total}) of selected eligible Extraction Trails (see Table 3) is 1443 m. The fixed distance (D_{fixed}) between Plot Clusters is therefore 1443/6, which rounds down to 240 m. The random starting distance to the first Plot Cluster is calculated as 240*RAND, in this case, 143 m.

The first Plot Cluster is located 143 m along the first selected eligible Extraction Trail measured from the tie point. The second Plot Cluster is located 240 m further along. Since the distance remaining on Extraction Trail 2 is 17 m, proceed to Extraction Trail 4. This trail is 183 m long, so a distance of only 200 m has been measured so far (since the distance between Extraction Trails is not considered). Proceed to Extraction Trail 6, and measure an additional 40 m to bring the total distance to 240 m, where Plot Cluster 2 is located. Continues until all six Plot Clusters are pre-located. Because Plot Cluster 1 falls within 30 m from the end of the Extraction Trail, offset the Plot Cluster 30 m inwards, to 113 m from tie point2 rather than 143 m. Number the Plot Clusters from one to six in the order that they will be measured.

Table 4. Extraction Trail lengths for Plot Cluster pre-location example.

Selected Eligible Extraction Trail	Total Length (m)
2	160
4	183
6	218
8	220
10	217
12	226
14	219
Total	1443

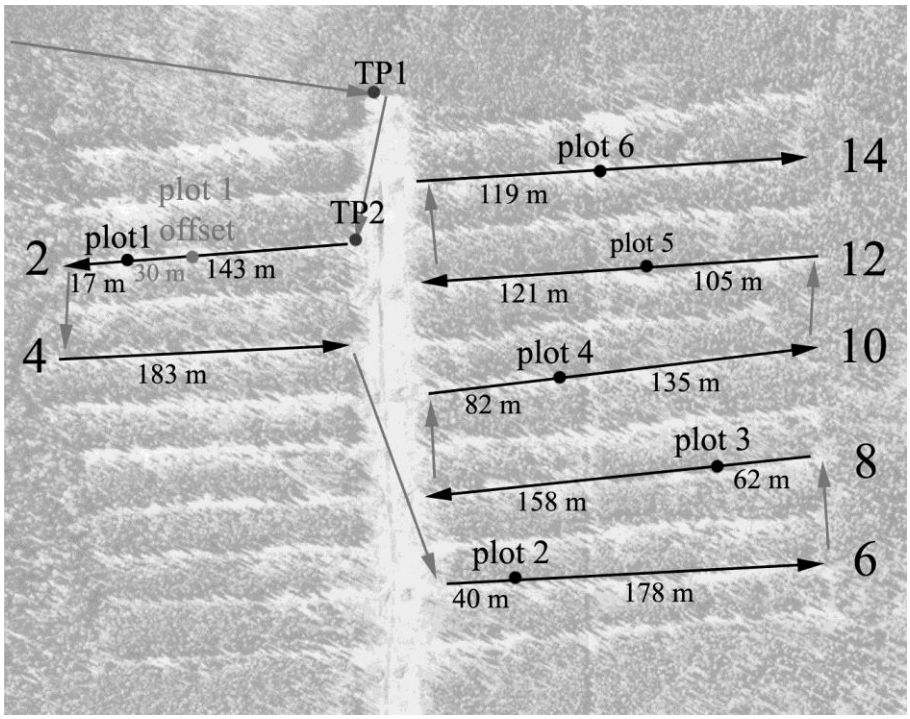


Figure 5. Plot pre-location process.
Measured distances are shown in black.
Grey arrows indicate the path to be taken for Plot Cluster layout.

4.2 Field Location Method (Alternate Method)

If aerial photos are not available, Plot Clusters may be located in the field using this alternate method.

1. ***Determine the number of Haul Roads with <u>eligible</u> extraction trails:*** Either walk the Block to determine the number of Haul Roads or use harvest maps. See Section 3.1. for information on how to determine eligible extraction trails. Haul roads along the edge of the Block count as a single Haul Road.
2. ***Determine the number of Plot Clusters to be established on each Haul Road:*** The number of Plot Clusters to be established will depend on length of each Haul Road. For each Haul Road, divide the length of the Haul Road by the total length of Haul Roads and multiply by 6 (N_{plots}=round((L_{haul_1}/ L_{haul_tot})*6)). This is the number of Plot Clusters to be established on each Haul Road. The total should be 6. If, due to rounding, the total is not 6, assign additional Plot Clusters based on fractions. For example, there are three Haul Roads with lengths of 656, 624 and 320 m. Total Haul Road length is 1600 m. Using the above formula, the number of Plot Clusters per road is calculated as 2.46, 2.34, and 1.20 Plot Clusters per road, respectively, which round to 2, 2, and 1 Plot Clusters (total of 5 Plot Clusters). Since the first Haul Road was the closest to rounding up, adjust the numbers to 3, 2 and 1, respectively.
3. ***Select a random distance for each Plot Cluster:*** For each Plot Cluster, calculate a random distance along the Haul Road (multiply a random number between 0 and 1 by the Haul Road length in m, *e.g.*, D_{start}=L_{haul}*random, and round to the nearest m). Walk along the Haul Road to the calculated distance, then select the extraction trail closest to the Haul Road at that point. If the extraction trail extends on both sides of the Haul Road, as in Figure 3, flip a coin to determine whether to proceed to the left or right (rather than treat these as individual Extraction Trails, as in Section 4.1).
4. ***Locate the Plot Cluster center:*** Determine the length of the selected extraction trail. Calculate a random distance along the extraction trail (multiply a random number between 0 and 1 by the extraction trail length in m). Proceed from the Haul Road along the extraction trail for that distance. Establish the center of the Plot Cluster at the center of the Extraction Trail.
5. ***Offset Plot Clusters located within buffers:*** If the Plot Cluster center is within 30 m of the beginning or end of the Extraction Trail, the Plot Cluster must be offset (to avoid edge effect). Offset the Plot Cluster center by moving it 30 m inwards; that is, away from the end of the Extraction Trail.
6. ***Locate subsequent Plot Clusters:*** repeat the previous steps until all 6 Plot Clusters are located. In the event that the same extraction trail is randomly selected to have more than one Plot Cluster, reselect a different random number (sampling without replacement). Where there less then six eligible Extraction Trails, one Extraction Trail may have two Plot Clusters; however, these must be at least 100 m apart.

5. Directions and Navigation

Sufficient documentation is required to allow both Quality Control (QC) crews and subsequent re-measurement crews to relocate both the Block and the Plot Clusters.

5.1 Directions to the Block

Field crews must record detailed field notes for navigation, starting along a major highway or road and ending at the first starting point. For example, include distances (to the nearest 0.1 km) along the main road from a recognizable road intersection or other anthropogenic or land feature to the turnoff from this road. From this point, provide directions along the road(s) leading to the main Haul Road associated with the Block. Directions should include distances along roads, required turns at road intersections, and notes on important navigation features (anthropogenic or land features) encountered en route. Note whether or not vehicle (truck) access continues into the Block, or whether access by foot or ATV is required. Directions should be recorded on the **Block Form (Side 1)**. Either a map to the Block should be attached to this form or a hand drawn map should be included on the front of the **Block Form (Side 1)**. Appendix III shows a sample.

Directions to the Block end at the Starting Point. The starting point is placed at the intersection of the primary Haul Road with the first extraction trail which occurs along this road. Flag the location on the left or right side of the road next to a well-established tree (*i.e.*, expected that the tree will persist for some time).

- ✓ Establish a **blue post** at the selected starting point, place 3 **blue ribbons** at eye level on a tree closest to the starting point and paint a blue circle around the bole at breast height.
- ✓ Place an aluminum tag on the starting post, recording:
  - MWMA - Company Code – SCUP - Harvest Block Identifier – SP
  - Azimuth and distance to first tie point

> **example:** **MWMA-ALPA-SCUP-16751-SP**
> **192 m @ 90° to TP1**

5.2 Directions within the Block

5.2.1 Tie Points Marking Plot Clusters

Tie points must be placed at the intersection of the Haul Road with each extraction trail containing a Plot Cluster (see example Figure 5 or Appendix III). Locate the tie point on the left or right side of the extraction trail, depending on which side the Plot Cluster is located.

- ✓ Establish a **blue post** at each tie point, place 3 **blue ribbons** at eye level on a tree closest to the tie point.
- ✓ Place a tag on each tie post, recording
  - MWMA - Company Code – SCUP - Harvest Block Identifier – TP#
  - Distance and azimuth to Plot Cluster center
  - Distance and azimuth to next tie point, if applicable

example: **MWMA-ALPA-SCUP-16751-TP4**
116 m @ 72° to PC3 / 139 m @ 322° to TP5

5.2.2 Tie Points for Block Navigation

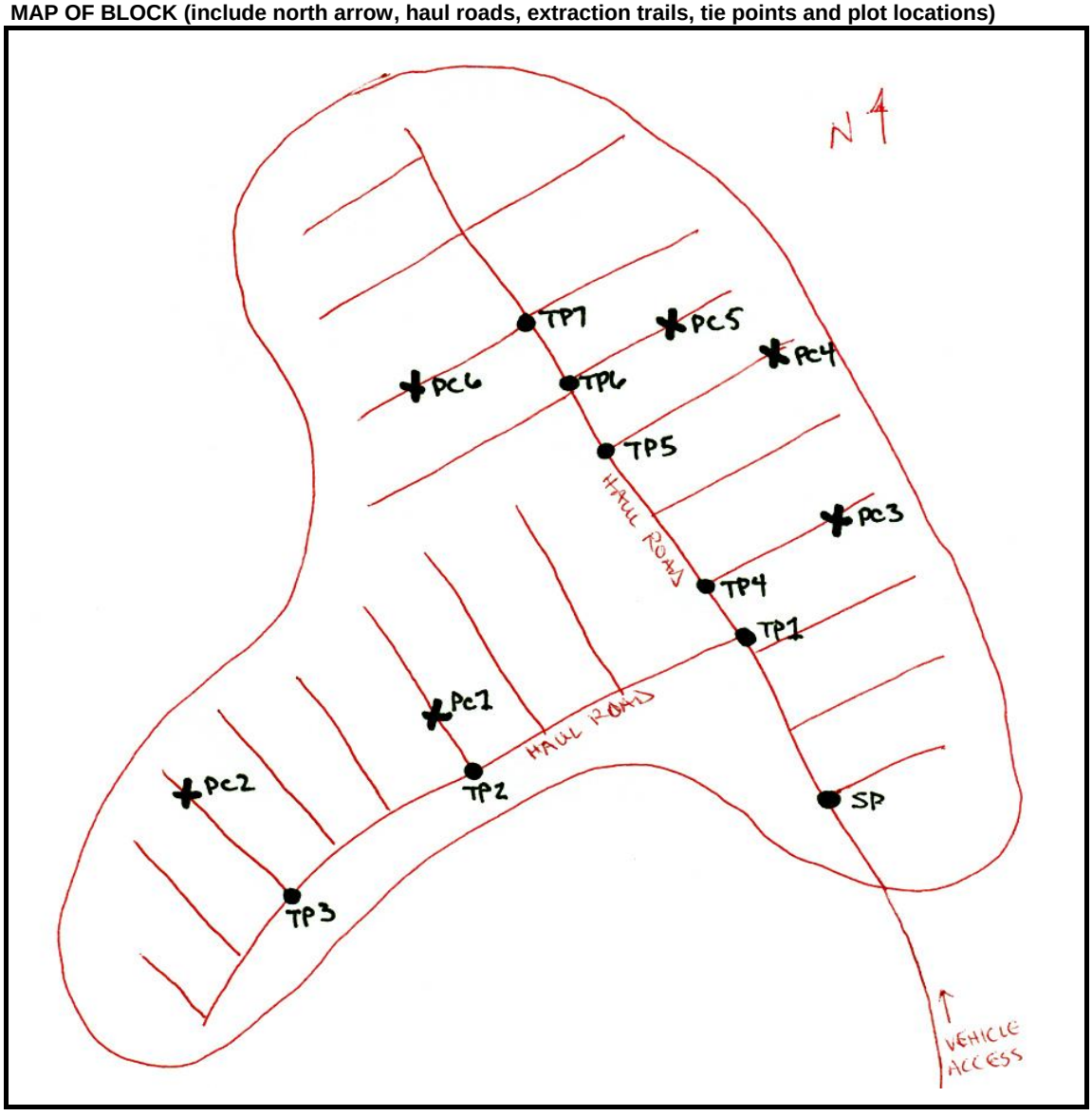
Additional tie points will be used to mark any changes in direction that occur while navigating between the starting point and subsequent tie points. For example, in Figure 5 (next page) or Appendix III, TP1 marks a change in direction when moving from the primary Haul Road to a secondary Haul Road.

- ✓ Establish a **blue post** at each tie point, place 3 **blue ribbons** at eye level on a tree closest to the tie point.
- ✓ Place a tag on each tie post, recording
  - MWMA - Company Code – SCUP - Harvest Block Identifier – TP#
  - Distance and azimuth to next tie point(s) (generally there will be two)

example: **MWMA-ALPA-SCUP-16751-TP1**
216 m @ 239° to TP2 / 64 m @ 325° to TP4

SIDE 2

MAP OF BLOCK (include north arrow, haul roads, extraction trails, tie points and plot locations)



STARTING AND TIE POINT INFORMATION

DIRECTIONS BETWEEN TIE POINTS

FROM			TO			AZIMUTH			DIST (m)			
S	P		T	P	1	3	3	2		1	5	7
T	P	1	T	P	2	2	3	9		2	1	6
T	P	2	T	P	3	2	2	3		1	9	2
T	P	1	T	P	4	3	2	5			6	4
T	P	4	T	P	5	3	2	2		1	3	9
T	P	5	T	P	6	3	4	1			6	0
T	P	6	T	P	7	3	4	0			6	2

PLOT CLUSTER INFORMATION

DIRECTIONS FROM TIE POINTS TO PLOT CENTER

FROM			TO			AZIMUTH			DIST (m)			
T	P	2	P	C	1	3	3	9			6	5
T	P	3	P	C	2	3	2	5		1	3	8
T	P	4	P	C	3		7	2		1	1	6
T	P	5	P	C	4		7	1		1	5	2
T	P	6	P	C	5		6	8			8	7
T	P	7	P	C	6	2	5	8			9	9

Figure 6. Sample navigation notes, Block Form (Side 2). Also located in Appendix III.

Once the starting point and all tie points are established, record the following information on the **Block Form (Side 2)**:

STARTING AND TIE POINT INFORMATION

- ✓ Record the azimuth and distance from the starting point to the first tie point, from the first tie point to the second tie point, and so on, as shown in Figure 5 or Appendix III.

PLOT CLUSTER INFORMATION

- ✓ Record the azimuth and distance from tie points to each of the six Plot Clusters. Only tie points associated with a Plot Cluster are to be included in this section. Directions to and between all other tie points will have already been documented in the previous section.

6. Plot Establishment

6.1 Plot Center

Locations of Plot Cluster centers are determined using one of the two methods described in Section 4. Navigate to the Plot Cluster center using the prescribed distances and directions.

- ✓ Once at the first Plot Cluster center, establish a **blue post** in the center of the Extraction Trail, with an aluminum tag labeled with the following information separated by dashes (SCUP Plot ID):
  - MWMA - Company Code – SCUP - Harvest Block Identifier – PC#

example: MWMA-ALPA-SCUP-16751-PC1

6.2 Plot Cluster Sequence

This section describes the steps for establishing a Plot Cluster, which consists of a Buffer Plot, two Removal Plots (A and B) and an Extraction Plot. Appendix II lists the equipment required to establish one Plot Cluster, and Appendix III provides a sample Field Plot Establishment Form which has been filled out to illustrate the correct recording of data. Appendix IV provides a list of codes used on the form.

The Plot Cluster sequence is randomly selected (either Buffer-Removal-Extraction-Removal or Removal-Extraction-Removal-Buffer) using methods described on the next page. See Figure 6 for a sample layout. Plot "center" is the center of the Extraction Plot.

- ✓ Where the treatment includes a Buffer, there is a Removal Plot (A and B) on either side of the Extraction Plot. Only one side of the Extraction Trail will have a Buffer Plot; the sequence id determined using a coin toss;
- ✓ Where the treatment does not include a Buffer, there is a single Removal Plot, spanning the distance between two adjacent extraction trails; the sequence id, Removal – Extraction or Extraction – Removal, is determined by a coin toss.

6.2.1 Plot Cluster Sequence When Treatment Includes Buffers:

All layout and measurement is completed relative to the side of the Plot Cluster that contains the Buffer Plot.

1. Stand facing along the Extraction Trail (does not matter which direction). Flip a coin to select which side of the Extraction Plot will have the Buffer Plot (either left or right of the crew member and perpendicular to the extraction line).
2. The selected side will have a Buffer Plot and Removal Plot (A), with the Plot Cluster boundary occurring at the far edge of the Buffer Plot.
3. The non-selected side will have only Removal Plot (B), with the Plot Cluster boundary occurring at the far edge of Removal Plot B.
4. Figure 7 shows the Plot Cluster layout.
5. If there is only a Buffer Stratum on one side, then no coin is required; the side with the Buffer Stratum is selected for the Buffer Plot. If there is no buffer stratum on either side, this is an ineligible Extraction Trail and an alternate Plot Cluster location must be selected.

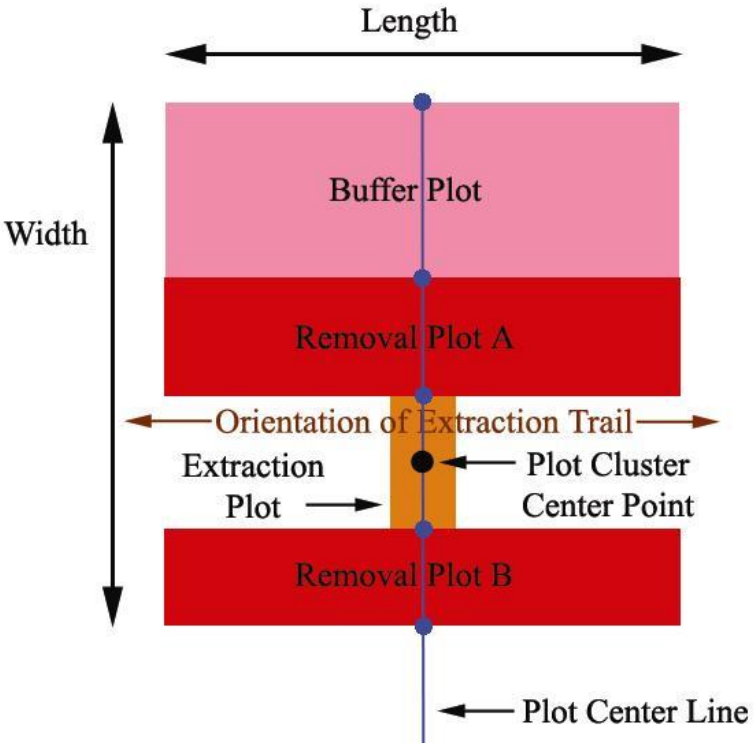


Figure 7. Plot cluster layout when Buffer is present.

6.2.2 Plot Cluster Sequence When Treatment Does Not include Buffers

All measurement and layout is completed relative to the side of the Plot Cluster that contains the Removal Plot.

1. Stand facing along the Extraction Trail (does not matter which direction). Flip a coin to select which side of the Extraction Plot will have the Removal Plot (either left or right of the crew member and perpendicular to the extraction line).
2. The selected side will have the Removal Plot, with the Plot Cluster boundary occurring at the far edge of the Removal Plot.
3. The non-selected side will not have a Removal Plot, with the Plot Cluster boundary occurring at the far edge of Extraction Plot.
4. Figure 8 shows the Plot Cluster layout.

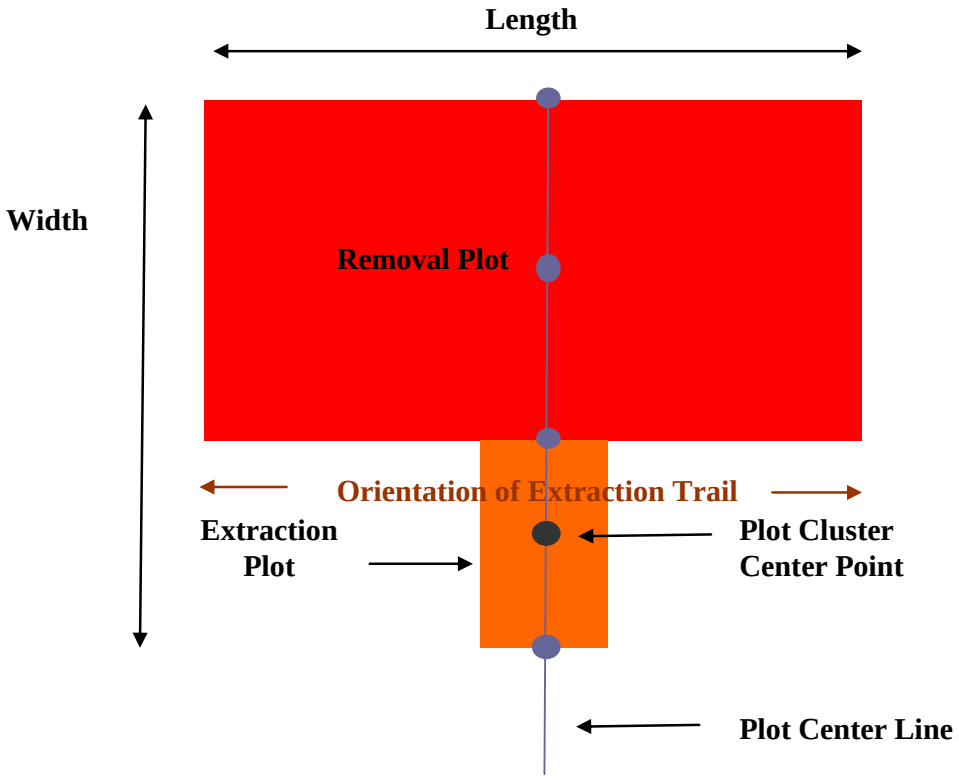


Figure 8. Plot cluster layout when no Buffer is present

6.3 Plot Center Line

The Plot Cluster centerline extends across all plots and intersects the Plot Cluster center point, located in the center of the Extraction Trail. This line should be perpendicular to the general orientation of Extraction Trail (blue line in Figure 6). It is important to have this line laid out as close to perpendicular to the Extraction Trail as possible, otherwise QC tolerances for Plot Cluster layout parameters may be exceeded.

6.3.1 Location

Note: This process describes plot and center line location for treatments that include Buffer. If no Buffer is present, the steps are the same however the measurements start on the outside edge of the Removal Plot as opposed to the outside edge of the Buffer Plot.

Determine the direction of the centerline:

1. Take a compass reading along the Extraction Trail (*i.e.* 275°).
2. Add or subtract 90° depending on which side of the Extraction Trail contains the Buffer Plot or the Removal Plot if no buffer is present (*i.e.* 5°).
3. Run a measuring tape perpendicular to the Extraction Trail (use the azimuth from step 2):
    a. From the next Extraction Trail outside the Buffer Strip (Removal Plot where no Buffer present)
    b. Across the Buffer Strip and Removal Strip A (Removal Plot where no Buffer present)
    c. Through the Plot Cluster center point on the Extraction Trail
    d. Through Removal Strip B (where Buffer present)
    e. And well into the next Buffer Strip (or next Removal Plot if no Buffer is present)
4. Leave the tape on the ground, making sure it is **straight**.

Note: Leave the measuring tape out along the centerline because it is needed for the duration of Plot Cluster establishment and measurement.

Mark the boundaries of the Buffer Strip:

1. Get a general feel of the width of the surrounding Removal Strips, keeping in mind the prescribed width (*i.e.* 8 m). A good way to do this:
    a. Walk around the Removal Strips on either side of the Buffer Strip
    b. Within each Removal Strip, mark stumps on either side of the centerline by laying strips of blue flagging tape on them
    c. You may have to mark stumps quite a distance from the centerline (10 or 15 m) in order to get a good idea of Buffer Strip boundary
2. Establish a **blue pigtail**[2] on the Plot Cluster centerline (with the measuring tape still in place) at the outer boundary of the Buffer Plot, based on general Removal Stratum width.
3. Establish a **blue pigtail** on the Plot Cluster centerline at the boundary between the Buffer Strip and the Removal Strip A, based on general Removal Stratum widths.

Mark the boundaries of the Removal Strips:

1. Move the measuring tape left along the centerline until the zero end of the measuring tape is located at the **blue pigtail** marking the outer edge of the Buffer Strip

[2] Metal pigtail marker with blue flagging tape.

2. Establish a **blue pigtail** on the Plot Cluster centerline at the boundary between Removal Strip A and the Extraction Trail.
3. Establish a **blue pigtail** on the Plot Cluster centerline at the boundary between the Extraction Trail and Removal Strip B.
4. Get a general feel for the width of Removal Strip B (use flagging to mark stumps)
5. Establish a **blue pigtail** on the Plot Cluster centerline at the outer boundary of Removal Strip B.

6.3.2 Measurement

With the tape still extended across the Plot Cluster at the centerline and the zero end at the outer boundary of the Buffer Strip, measure the distance of each boundary or **blue pigtail** (Buffer, Removal A, Extraction and Removal B) from the outer boundary of the Buffer Strip[3]. The Stratum widths will be calculated based on these recorded measurements. This will ensure that the sum of the individual plot widths is equal the width of the Plot Cluster.

Record this information on the **Plot Form Page 1 (Side 1)**:

STRIP WIDTH INFORMATION

Starting at outer boundary of Buffer Strip:

✓ Outer boundary of Buffer Strip at centerline in m (always 0 m)

Moving across Plot Cluster:

✓ Removal Strip A boundary in m (Buffer/Removal A)
✓ Extraction Trail boundary in m (Removal A/Extraction)
✓ Removal Strip B boundary in m (Extraction/Removal B)
✓ Outer edge of Removal Strip B in m

Note: Leave the measuring tape out along the Plot Cluster centerline because it is needed for the duration of Plot Cluster establishment and measurement.

6.4 Individual Plot Boundaries

The required length of the Plot Cluster is based on the measured width of the Buffer Strip at the centerline. Look up the required plot length in Table 5 using the measured Buffer Stratum width.

[3] Because the bearing of strips will vary, for consistency, all measurements across the Plot Cluster will begin at the outer edge of the Buffer Strip.

Table 5. Recommended plot lengths based on Buffer Strip width.

Buffer Strip Width	Buffer Plot Length	Removal Plot Length	Extraction Plot Length
<= 10 m	16 m	16 m	2 m
> 10 m	8 m	8 m	2 m

For treatments that do not have Buffers, the width of the Removal area will be used to determine the length of the Removal Plot as described in Table 6.

Table 6. Recommended plot lengths based on Removal Strip width.

Removal Strip Width	Removal Plot Length	Extraction Plot Length
< 20 m	16 m	2 m
≥ 20 m	8 m	2 m

6.4.1 Location

Note: This process describes plot location for treatments that include Buffer. If no Buffer is present, the steps are the same however the measurements start on the outside edge of the Removal Plot as opposed to the outside edge of the Buffer Plot.

Buffer Plot boundary markers are established 4 m on either side of the centerline for 8 m long plots. For 16 m long plots, boundary markers are established at both 4 m and 8 m on either side of the centerline.

Figure 7 illustrates the placement of Plot Cluster boundary markers based on Stratum boundary markers along the centerline (blue posts).

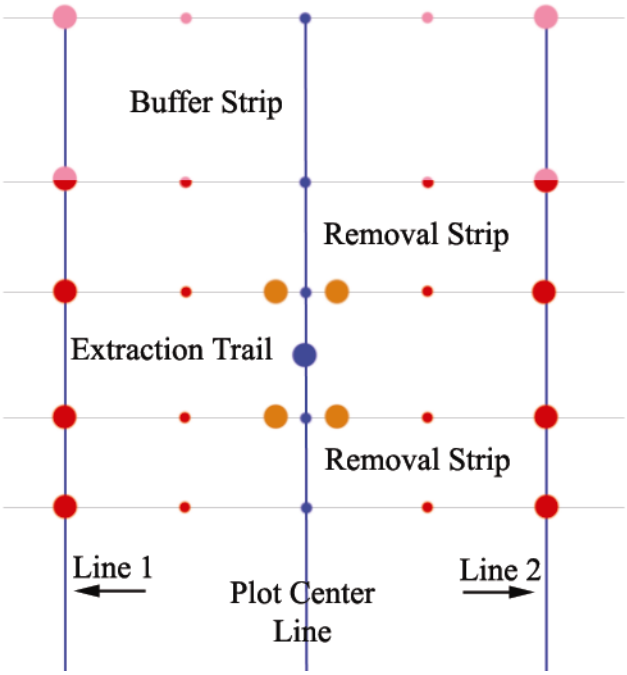


Figure 9. Plot boundary markings[4].

Mark the Buffer Plot and Removal Plot boundaries:

1. Outer Buffer Strip:
    a. For 8 m long plots, establish **pink posts**[5] perpendicular to the centerline at 4 m on either side of the **blue pigtail** markers.
    b. For 16 m long plots, place **pink pigtails** at 4 m and **pink posts** at 8 m perpendicular to the centerline on either side of the **blue pigtail** markers.
2. Buffer Strip/Removal Strip A boundary:

[4] Large dots represent posts, small dots represent pigtail markers.
[5] All posts and/or pigtails should be buried at least halfway into the ground.

a. For 8 m long plots, establish **pink/red posts** perpendicular to the centerline at 4 m on either side of the **blue pigtail** markers.
b. For 16 m long plots, place **pink/red**[6] **pigtails** at 4 m and **pink/red posts** at 8 m perpendicular to the centerline on either side of the **blue pigtail** markers.

3. Removal Strip A/Extraction Trail boundary:
    a. For 8 m long plots, establish **red posts** perpendicular to the centerline at 4 m on either side of the **blue pigtail** markers.
    b. For 16 m long plots, place **red pigtails** at 4 m and **red posts** at 8 m perpendicular to the centerline on either side of the **blue pigtail** markers.
4. Removal Strip B/Extraction Trail boundary:
    a. For 8 m long plots, establish **red posts** perpendicular to the centerline at 4 m on either side of the **blue pigtail** markers.
    b. For 16 m long plots, place **red pigtails** at 4 m and **red posts** at 8 m perpendicular to the centerline on either side of the **blue pigtail** markers.
5. Outer Removal Strip B:
    a. For 8 m long plots, establish **red posts** perpendicular to the centerline at 4 m on either side of the **blue pigtail** markers.
    b. For 16 m long plots, place **red pigtails** at 4 m and **red posts** at 8 m perpendicular to the centerline on either side of the **blue pigtail** markers.

Mark the Extraction Plot boundaries:

1. At the boundary between the Extraction Trail and Removal Strip A, establish **orange posts** perpendicular to the centerline at 1 m on either side of the **blue pigtail** markers.
2. At the boundary between the Extraction Trail and Removal Strip B, establish **orange posts** perpendicular to the centerline at 1 m on either side of the **blue pigtail** markers.

6.4.2 Measurement

Two additional lines will be used to measure the widths of each Stratum associated with the Plot Cluster sequence (Buffer, Removal A, Extraction, Removal B), and to ensure that the Plot Cluster layout is within quality control standards.

Place the zero end of a measurement tape at the far edge of the Buffer Plot (**pink post**) and extend the tape across the Plot Cluster sequence (Buffer Plot, Removal Plot A, Extraction Trial and Removal Plot B) to the far edge of the Removal Plot B. The tape should cross each post, and create Line 1 (Figure 7).

Record the distance from the outer edge of the Buffer Strip for each Stratum (Buffer, Removal A, Extraction and Removal B) starting at the Buffer Strip. The plot widths will be calculated based on these recorded measurements. This will ensure that the sum of the individual plot widths is equal the width of the Plot Cluster.

[6] For metal posts, spray with both colours; for pigtail markers, use both colours of flagging tape.

Record on the **Plot Form Page 1 (Side 1)**:

STRIP WIDTH INFORMATION

Starting at outer boundary of Buffer Strip:

- ✓ Outer boundary of Buffer Strip at centerline in m (always 0 m)

Moving across Plot Cluster:

- ✓ Removal Strip A boundary in m
- ✓ Extraction Trail boundary in m
- ✓ Removal Strip B boundary in m
- ✓ Outer boundary of Removal Strip B in m

Repeat the measurement procedure for the other side of the Plot Cluster, creating and measuring Line 2 (Figure 7).

Measure and record the two boundary widths of the Establishment Plot (between the two **orange posts**).

For quality control purposes, the total length of the Plot Cluster sequence must be within 30 cm of the total length of the centerline for both Line 1 and Line 2. If not, the Plot Cluster layout must be rechecked and adjusted.

6.5 Plot Cluster Boundary Delineation

The Plot Cluster will be revisited for future re-measurements. Therefore, trees close to, but outside the Plot Cluster must be identified. Mark the Plot Cluster boundary by spraying a **blue line** at breast height on all trees just outside the perimeter of Removal Plot A, Removal Plot B and the Buffer Plot. Spray the trees on the side facing away from the Plot Cluster.

6.6 Age Plot Establishment

Age information for both aspen and spruce is required for each Plot Cluster within each Block. Age at breast height will be collected in 300 m2 plots adjacent to the Plot Cluster from three aspen and three white spruce by coring the stems at breast height and counting the tree rings.

Age plots will be established as it follows.

6.6.1 Age Plots where Treatment Includes Buffers

Three age plots will be established in Blocks where the treatment includes Buffers. One 300 m^2 plot will be established in the Buffer, one 150 m^2 plot will be established in the Removal Strip A and 150 m^2 will be established in the Removal Strip B.

6.6.1.1 Buffer Age Plot

A 300 m^2 plot will be established in the Buffer strip adjacent to the Buffer Plot and it will be used to collect breast height age for aspen. The plot will be located left or right of the Buffer Plot so that it fits within the length of the Buffer strip. The Buffer Age Plot will have the following characteristics:

- ✓ The width of the Buffer Age Plot will be the same as the width of the Buffer Plot;
- ✓ The length of the plot will be calculated as 300/Buffer Plot width.

In each Buffer Age Plot three largest aspen by DBH will be selected and measured as described in Section 7.1

6.6.1.2 Removal Age Plots

In each Removal Strip (A and B) a 150 m^2 plot will be established adjacent to the Removal Plot A or B. These plots will be located left or right of the Removal Plot and they will be used to collect age information for the white spruce. The Removal Age Plots will have the following characteristics:

- ✓ The width of the Removal Age Plots (A and B) will be the same as the width of the Removal Strip (A and B); and
- ✓ The length of the plot will be calculated as 150/Removal Age Plot width.

The white spruce tree selection for age measurement will follow the steps:

- ✓ In each 150 m^2 Removal Age Plot the three largest white spruce by DBH will be selected;
- ✓ The 6 white spruce selected (3 in each Removal Age Plot) will be ranked in the descending order of their DBH; and
- ✓ The top 3 largest white spruce by DBH will be selected for age measurement as described in Section 7.1.

6.6.2 Age Plots where Treatment Does Not Include Buffers

For treatments that do not include a Buffer there is only one Age Plot to be established. In this case age is measured only for the white spruce.

6.6.2.1 Removal Age Plot

A single 300 m^2 will be established in the Removal Strip adjacent to the Removal Plot. The age plot will be located left or right of the Removal Plot and it will be used to collect age information only for white spruce.

The Removal Plot Age will have the following characteristics:

- ✓ The width of the Removal Age Plot will be the same as the width of the Removal Strip; and
- ✓ The length of the plot will be calculated as 300/Removal Age Plot width.

The white spruce tree selection for age measurement will follow the steps:

- ✓ In the 300 m^2 Removal Age Plot the three largest white spruce by DBH will be selected;
- ✓ The selected white spruce will be measured as described in Section 7.1.

7. Plot Cluster Measurement Protocols

7.1 Plot Cluster Description

Once the Plot Cluster has been established, measurement of plot attributes can commence. Record the following information on the **Plot Form Page 1 (Side 1)**:

PLOT HEADER INFORMATION

- ✓ Township
- ✓ Range
- ✓ Meridian
- ✓ SCUP Plot ID (MWMA-Company Code-SCUP-Harvest Block Number-PC#)
- ✓ Measurement date (yyyy/mm/dd)
- ✓ Crew Initials (up to three crew members)
- ✓ Measurement number (measurement number at establishment = 001)

PLOT DESCRIPTION INFORMATION

- ✓ Slope percent (taken from the outer boundary of the Buffer Plot across the Plot Cluster)
  Measure the slope gradient using a clinometer and record to the nearest percent.
- ✓ Slope position
  See Appendix IV for a description of slope position codes.
- ✓ Aspect (taken from the outer boundary of the Buffer Plot across the Plot Cluster)
  Determine the average aspect (direction the slope faces) of Plot Cluster in degrees. For Plot Clusters with no slope, the aspect is assigned a value '0'; a north aspect is recorded as 360 degrees.

- ✓ Elevation in m

  Determine the average elevation of the Plot Cluster using an altimeter or a GPS unit.
- ✓ UTM coordinates (also submit in digital format with SCUP Plot ID)
- ✓ Orientation of Extraction Trail to the nearest degree (*i.e.* 275°)
- ✓ Direction of Buffer Strip in relation to Plot Cluster center within Extraction Trail (*i.e.* 5°)
- ✓ Plot length (either 8 m or 16 m)

ECOLOGICAL INFORMATION

- ✓ Ecosite to ecosite phase

  Using the appropriate Field Guide to Ecosites, determine the ecosite based on vegetation within the Buffer Plot, and enough soils assessment to obtain soil moisture and nutrient regime. Ecosite should be assessed for <u>each</u> Plot Cluster.
- ✓ Soil moisture regime

  Use soil codes from the Ecosite field guide.
- ✓ Soil nutrient regime

  Use soil codes from the Ecosite field guide.

ASPEN AGE INFORMATION

In the Buffer Age Plot once the three largest DBH aspen were selected, record the following for each individual tree:

- ✓ Diameter at breast height (cm)
- ✓ Height (m)
- ✓ Age at breast height (y)

Mark the selected aspen with a band of blue paint, completely encircling the bole, at breast height. Note the approximate location of the tree in the comments section, including a rough azimuth from the Buffer Plot, to help QC crews relocate the tree.

SPRUCE AGE INFORMATION

In the Removal Age Plots (or Removal Age Plot where no Buffer is present) after the largest DBH white spruce were selected, as described in Sections 6.6.1.2 and 6.6.2.1, record the following for each individual tree:

- ✓ Diameter at breast height (cm)
- ✓ Height (m)
- ✓ Age at breast height (y)

Mark the selected white with a band of blue paint, completely encircling the bole, at breast height. Note the approximate location of the tree in the comments section, including a rough azimuth from the Removal Plot(s), to help QC crews relocate the tree.

7.2 Buffer and Removal Plots

The tagging and measuring of live trees within the Buffer and Removal Plots is conducted by dividing the Plot Cluster into *Sections*. Sections are 4 m wide strips which run parallel to the Plot Cluster centerline and perpendicular to the Extraction Trail (within the Removal and Buffer Plots).

7.2.1 Section Layout

For Plot Clusters that are 8 m in length there are two Sections (each 4 m wide) separated by the center line. Use the measuring tape along the centerline as the dividing line between Section 1 and Section 2.

For Plot Clusters that are 16 m in length, there are four Sections (4 m each) divided evenly across the Plot Cluster. Using the measuring tape along the centerline as the dividing line between Section 2 and Section 3. Run another measuring tape along the Plot Cluster at 4 m on either side of the centerline (line should cross all red and pink pigtail markers) to separate Sections 1 and 2, and Sections 3 and 4. All measuring tapes should be at 0 m at the outer edge of the Buffer Plot and pulled tight.

7.2.2 Tree Numbering

Tree numbering begins in Section 1 at the outer boundary of the Buffer Plot. The tree numbers will correspond to the plot type and Section number as shown in Table 5. All numbers start at the thousand level and increment by 1. For example, trees in Removal Plot A and Section 1 will be numbered RA1000, RA1001, RA1002, ….*etc.* Figure 8 illustrates the Section layout and tree numbering.

Table 7. Tree numbering.

Plot Type	Section Number			
	1	2	3	4
Buffer	B1000	B2000	B3000	B4000
Removal A	RA1000	RA2000	RA3000	RA4000
Removal B	RB1000	RB2000	RB3000	RB4000

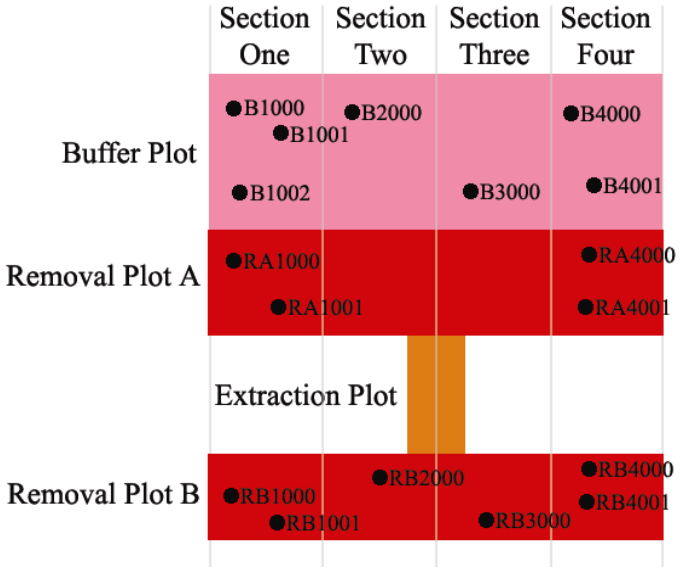


Figure 10. Section layout and tree numbering.

7.2.3 Measurement

Starting with the Buffer Plot, within each Section, measure and record the following Tree Information on the **Plot Forms**:

1. Divide the work so that one cruiser acts as the tally person (standing on the centerline) and one person tags and measures the trees.
2. Number trees from the outer boundary of the Buffer Plot towards Removal Plot A working your way through each Section.
3. Tag all acceptable[7] conifer species > 1.3 m in height.
4. Tag all acceptable deciduous species > 1.3 m in height.
    a. Place nails at breast height (1.3 m from root collar) so that diameter tape is consistently placed right above nail level.
    b. If a tree is too small to nail, loosely attach a tag to the lateral branch closest to breast height.
5. For each tagged tree, measure/assess and record on the **Plot Forms**[8]:
    - ✓ Section number
    - ✓ Tree Number
    - ✓ Species code
    - ✓ Diameter at breast height (0.1 cm)
    - ✓ Total height (0.1 m)
    - ✓ Height to live crown (0.1 m)
    - ✓ Distance along centerline (0.1 m) from outer boundary of Buffer Plot

[7] Acceptable species are defined in Appendix IV.
[8] Plot Form Page 1 (Side 2) = Buffer Plot; Plot Form Page 2 (Side 2) = Removal Strips A and B.

- ✓ Crown class code
- ✓ Up to 3 condition codes, in order of priority

6. Appendix IV provides the species codes, crown class codes and condition codes.
7. Appendix V provides instruction on correct diameter measurement.
8. Appendix VI provides instruction on correct height measurement.

Repeat this procedure for Removal Plot A and Removal Plot B. The measured distances along the centerline must be the cumulative distance from the outside of the Buffer Plot.

In order to estimate the basal area removed (level of release), assess recent stumps in the Removal Plots (*e.g.*, those resulting from Strip Cut Understory Protection harvesting only). On the tally sheet, record tree number as 999; measure and record on the **Plot Forms**:

- ✓ Section number
- ✓ Diameter at 10 cm (0.1 cm)
- ✓ Distance along centerline (0.1 m) from outer boundary of Buffer Plot

Paint all sampled stumps with an 'X' in blue paint on the top of the stump to help relocate them during quality control assessment.

7.3 Extraction Plot

Trees within the Extraction Plot are tallied by species and height class until they exceed breast height for conifers, or until they reach or exceed a DBH of 7.0 cm for deciduous species. Record the following information on **Plot Form Page 2 (Side 1)**:

1. Tally all acceptable conifer regeneration > 30 cm and ≤ 130 cm tall by species
2. Tally all acceptable deciduous regeneration> 30 cm and ≤ 130 cm tall by species

If and when the trees within Extraction Plot are large enough, record:

1. Tag all acceptable conifer species > 1.3 m in height.
2. Tag all acceptable conifer species > 1.3 m in height.
    a. Place nails at breast height (1.3 m from root collar) so that diameter tape is consistently placed snugly above nail level.
    b. If a tree is too small to nail, loosely attach a tag to the lateral branch closest to breast height.
3. Number trees from E5000, E5001, etc…
4. For each tagged tree measure/assess and record:
    - ✓ Tree Number
    - ✓ Species code
    - ✓ Diameter at breast height (0.1 cm)
    - ✓ Total height (0.01 m)

- ✓ Height to live crown (0.01 m)
- ✓ Crown class code
- ✓ Up to 3 condition codes, in order of priority

5. Appendix IV provides the species codes, crown class codes and condition codes.
6. Appendix V provides instruction on correct diameter measurement.
7. Appendix VI provides instruction on correct height measurement.

7.4 Plot Re measurement

Removal and Extraction Plots are re measured at five-year intervals, up to and including 20 years, after which a 10-year re measurement schedule is followed. Buffer Plots are measured every 10 years. Re measurement should always occur prior to the commencement of the growing season.

1. ***Navigate to and between plots.*** Replace or repair the starting and/or tie points as required. This includes touch-up painting of nearby trees and replacement of faded flagging tape. If access has changed since the last measurement, complete a new Block Form, including new maps with directions to and within the Block (see Section 5).

2. ***Plot Maintenance.*** Replace or repair any posts or pigtails which show signs of damage or fading. This includes touch-up painting of metal posts and replacement of faded flagging tape. Walk the Plot Cluster boundary and touch up paint on blue-marked trees. Ensure that all tree tags remain securely fastened and legible, and that DBH markings are intact.

3. ***Re-establish centerline and Section markings.*** Re-establish the three 50 m tapes, one at the centerline and one each along the outer Plot Cluster posts, with 0 m located at the outer Buffer boundary. If the Plot Cluster length is 16 m, re-run string or a tape at 4 m on either side of the centerline, to re-establish the division between sections. Ensure that previously numbered trees are located within the correct Section (*e.g.*, 1000+ trees should be within Section 1, 2000+ trees should be within Section 2, *etc.*). Adjust tapes and string accordingly.

4. ***Identify new trees.*** Locate and tag any new trees within the tagging limits, and measure their distance along the centerline (distance is relative to the outer Buffer boundary). Tree numbers should follow the instructions in Section 7.2.2, with the first new tree number incrementing from the last tree number at last measurement. **DO NOT reuse tree numbers from dead or missing trees.**

5. ***Re measure Plot Cluster.*** Repeat all measurements outlined in Sections 6 and 7. All previously measured trees must be relocated and measured, in addition to measuring new trees. Note: DBH should not decrease on subsequent measurements. Height should not decrease unless a damage condition code is recorded. Trees that have died between measurement periods should be noted using the condition codes in Appendix IV.

8. Field Measurement Quality Control Standards

Blocks will be field checked to ensure that all establishment and measurement have been met. A minimum of one out of every five sampled Blocks, by company, will be subjected to QC protocols (default of one Block by company where less than five Blocks are sampled). Within each selected Block, all navigation information will be QC'd. In addition, two Plot Clusters will be randomly selected for QC'ing plot measurements.

Standards for quality control for Plot Clusters are provided in Table 6. Standard quality control checks involve checking approximately 50% of the measurements within the selected Plot Cluster (except for total number of trees and species, which will have a 100% check). At the discretion of the check cruiser, more than 50% of the measurements may be checked. A total Plot Cluster error of $\geq$ 2.0 is considered unacceptable and the Plot Cluster may have to be re sampled, at the discretion of the check cruiser. If the error $\geq$ 2.0, then all other Plot Clusters within the Block will be checked.

All costs associated with correcting errors are the responsibility of the field crew. Plot Clusters will be returned to the pool for quality control selection.

Table 8. Quality control standards for Plot Cluster establishment and measurement.

Attribute	Allowable Error	Points
Plot Cluster Length	- length of each side of the Plot Cluster must be within 0.3 m of center line length	0.5
Plot Cluster Center	- must be correctly flagged and identified - plot header information must be complete	0.5
Slope %	- must be within $\pm$10% of the slope gradient value	0.1 per > 10%
Slope Position	- must be within $\pm$ 1 position class	0.25 per class
Aspect	- must be within $\pm$ 10 degrees	0.1 per > 10%
Ecosite	- no error	0.25
Number of Live Trees Tagged	- no error allowed; all acceptable stems within the Buffer and Removal Plots must be included	0.5 per tree

Table 6 continued. Quality control standards for plot establishment and measurement.

Attribute	Allowable Error	Points
Corner Posts	must be properly placed by color code standard - must reasonably mark boundary of plots within Plot Cluster	0.5
Species	- no error allowed; all species must be identified correctly	0.25 per tree
Breast Height Tags	- must be within $\pm$ 3 cm from 1.3 m	0.25 per tree
Diameter - Breast Height	- must be within $\pm$ 0.2 cm of the DBH	0.25 per tree
Height	- must be within $\pm$ 0.5 meters of the height,	0.25 per tree
Crown Class Codes	- a maximum of 10 % of the stems can be misclassified by one crown class	0.25 > 10%
Condition Codes	- a maximum of 10% of the affected stems may be misclassified	0.25 > 10%
Number of Dead Trees	- no error allowed; all acceptable trees within the plot boundaries must be included	0.5 per tree
Tally by Height Class	- no species missed - check tally must be within 10% of cruise tally	0.1 per piece > 10%

APPENDIX I: GLOSSARY OF TERMS

Block: Harvest Block to which a Single Pass Strip Cut Understory Protection harvest treatment has been applied; unit area defined by a given harvest prescription.

Buffer Strip: an area where no overstory removal has occurred; generally used for protection of removal areas from effects of wind.

Buffer Plot: that component of the Plot Cluster which is located within the Buffer Stratum.

Buffer Stratum: a population of interest within the sampling frame; consists of areas within the sampling frame where no overstory removal has occurred.

Extraction Plot: that component of the Plot Cluster which is located within the Extraction Stratum.

Extraction Stratum: a population of interest within the sampling frame; consists of areas within the sampling frame where all overstory has been removed and no protection or release of understory has occurred.

Extraction Trail: an area where all overstory has been removed and no protection or release of understory has occurred; used for access to removal areas.

Haul Road: machine traffic area used for transporting wood removed from Extraction Trails.

Plot Cluster: a single sampling unit consisting of a series of interconnecting plots: Buffer Plot, Removal Plot A, Extraction Plot and Removal Plot B.

Plot Width: the dimension of the plot that is perpendicular to the orientation of the Extraction Trail.

Plot Length: the plot dimension parallel to the orientation of the Extraction Trail.

Removal Strip: the area where deciduous overstory has been removed in order to release conifer understory; understory protection is an important aspect of harvesting within this area.

Removal Plot: that component of the Plot Cluster which is located within the Removal Stratum.

Removal Stratum: a population of interest within the sampling frame; consists of areas within the sampling frame where deciduous overstory has been removed, releasing conifer understory.

Sampling Matrix: eligible Blocks are placed into categories based on class variables believed to be important/related to the response variables of interest; used to focus sampling efforts across a range of predetermined conditions of interest.

Section: a 4 m wide strip running perpendicular to the Extraction Trail; plots are subdivided into Sections in order to obtain semi-spatial information on the distribution of stems.

Single Pass: a type of Strip Cut Understory Protection where harvesting treatment for conifer release is only conducted once prior to full harvest of a Block.

Strip Cut Understory Protection: a silvicultural system used primarily to release understory conifers from beneath deciduous overstory, while retaining some overstory in order to provide protection from windthrow; the Strip Cut process involves:

1. Removing all trees in generally parallel strips, to allow harvesting equipment to access the rest of the Block (Extraction Trails);
2. Removal of deciduous overstory by "reaching" of equipment into areas on either side of the Extraction Trail (Removal Strip); and
3. Retention of deciduous overstory beyond the "reach" zone in order to protect the conifers from effects of wind (Buffer Strip).

APPENDIX II: EQUIPMENT LIST

The following supplies are needed for the establishment of a single Plot Cluster:

Reusable supplies

- ✓ 3 x 50 m tapes
- ✓ mallet
- ✓ increment borer
- ✓ soil auger
- ✓ height measurement equipment – *e.g.*, range finder, Suunto or Criterion
- ✓ DBH tape
- ✓ compass
- ✓ field manual
- ✓ pencils

Non-reusable supplies

- ✓ 16-19 rebar posts or EMT electrical conduits (minimum 90 cm long)
- ✓ 5-15 pigtail markers for Plot Cluster marking
- ✓ blue spray paint
- ✓ red spray paint
- ✓ orange spray paint
- ✓ pink spray paint
- ✓ blue flagging tape
- ✓ red flagging tape
- ✓ orange flagging tape
- ✓ pink flagging tape
- ✓ tree tags
- ✓ Plot Cluster center tag
- ✓ aluminum nails (for attaching tags)
- ✓ wire (for attaching tags)
- ✓ tally sheets

APPENDIX III: Field Tally Sheets

Block Form Side 1

SIDE 1

BLOCK DATA FORM

HEADER INFORMATION

LOCATION INFORMATION								BLOCK IDENTIFICATION CODE																NAT SUB	
FMU			TWP			RGE		M	GROUP					COMPANY					TREATMENT					HARVEST BLOCK NO.							
	L	2	0	7	3	2	2	4	M	W	M	A	-	A	L	P	A	-	S	C	U	P	-	1	6	7	5	1			B	M

MEASUREMENT DATE (yyyy/mm/dd)										CREW INITIALS								MEAS. NUMBER		
2	0	0	6	/	0	4	/	1	8	K	F	/	R	K	/			0	0	1

BLOCK INFORMATION

PRE HARVEST BLOCK INFORMATION																																					
PRESCRIBED STRATUM WIDTHS											BLOCK INFORMATION																											
BUFFER (m)				REMOVAL (m)				EXTRACT. (m)				HARVEST COMPLETION (yyyy/mm/dd)										ECOSITE (FROM PHA, IF AVAIL)																
		.				.				.							/			/					-			.			/							

* blanks indicate that this information was not looked up prior to field sampling

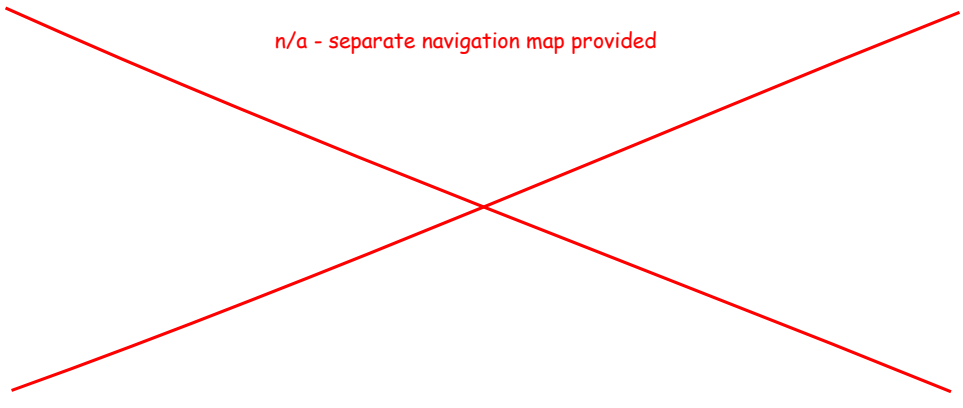
AERIAL PHOTOGRAPHY INFORMATION																						CREW INITIALS											
PROJECT NO									DATE (yyyy/mm/dd)										LINE NO.			PHOTO												
													/				/										/				/			

* line indicates that aerial photograph information was not available

DIRECTIONS TO STARTING POINT

- take Highway 813 north from Athabasca
- proceed past Colling Lake to the intersection of Highway 813 with Tower Road (25 km north of Colling Lake, on the left)
- from Tower Road, drive 25.9 km along Highway 813 north; turn right onto gravel road
- drive 1.3 km along the gravel road to the first intersection; continue straight through the intersection
- drive another 2.2 km along the gravel road to the second intersection; turn left
- drive 1.9 km; you will reach the edge of the block to be sampled
- drive another 55 m along the same road (haul road) to reach the first extraction trail
- a starting point (SP) post was placed on the west side of the haul road at the intersection with the first extraction trail

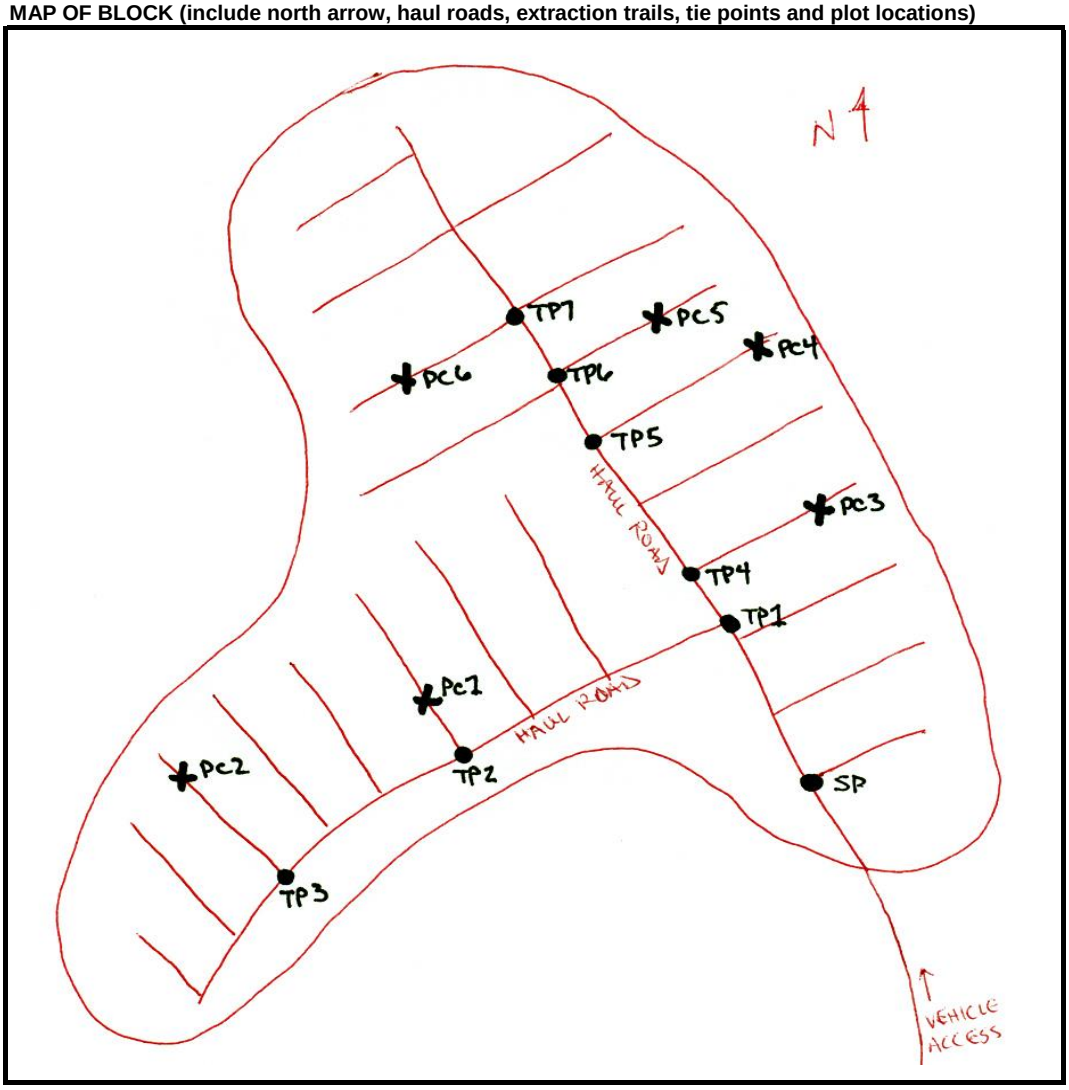
MAP TO STARTING POINT (include north arrow and any major navigational features)



Block Form Side 2

SIDE 2

MAP OF BLOCK (include north arrow, haul roads, extraction trails, tie points and plot locations)



STARTING AND TIE POINT INFORMATION

DIRECTIONS BETWEEN TIE POINTS												
FROM			TO			AZIMUTH			DIST (m)			
S	P		T	P	1	3	3	2		1	5	7
T	P	1	T	P	2	2	3	9		2	1	6
T	P	2	T	P	3	2	2	3		1	9	2
T	P	1	T	P	4	3	2	5			6	4
T	P	4	T	P	5	3	2	2		1	3	9
T	P	5	T	P	6	3	4	1			6	0
T	P	6	T	P	7	3	4	0			6	2

PLOT CLUSTER INFORMATION

DIRECTIONS FROM TIE POINTS TO PLOT CENTERS												
FROM			TO			AZIMUTH			DIST (m)			
T	P	2	P	C	1	3	3	9			6	5
T	P	3	P	C	2	3	2	5		1	3	8
T	P	4	P	C	3		7	2		1	1	6
T	P	5	P	C	4		7	1		1	5	2
T	P	6	P	C	5		6	8			8	7
T	P	7	P	C	6	2	5	8			9	9

Plot Form Page 1 Side 1

SIDE 1

PLOT FORM PAGE 1

HEADER INFORMATION

LOCATION INFO						PLOT IDENTIFICATION CODE																							
TWP			RGE		M	GROUP					COMPANY					TREATMENT					HARVEST BLOCK NO.								CLUSTER		
0	7	3	2	2	4	M	W	M	A	-	A	L	P	A	-	S	C	U	P	-	1	6	7	5	1			-	P	C	2

MEASUREMENT DATE (yyyy/mm/dd)										CREW INITIALS								MEAS. NUMBER		
2	0	0	6	/	0	4	/	1	8	K	F	/	R	K	/			0	0	1

PLOT DESCRIPTION INFORMATION

SLOPE				ASPECT			ELEVATION (m)				UTM COORDINATES												BEARING EXTRACT. TRAIL			BEARING TO BUFFER			PLOT LEN (m)		
%		POS									EASTING						NORTHING															
1	1	0	4	2	2	7	1	2	5	0	1	1	1	1	1	1	1	1	1	1	1	1	1	8	3	2	7	3	0	8	

ECOLOGICAL INFORMATION

ECOSITE										SOIL MOIST.			SOIL NUTR.		
B	M	-	D	2	.	2	/	S	M	4			5			C

ASPEN AGE INFORMATION

DBH (cm)				HEIGHT (m)				BH AGE (y)		
2	2	.	3	2	4	.	8	0	8	8

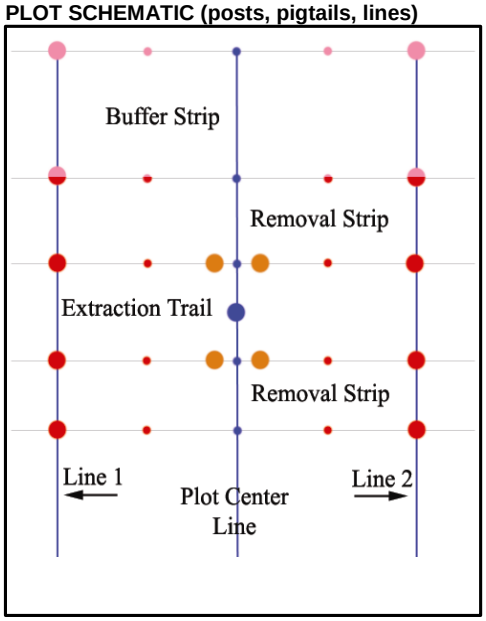
STRIP WIDTH INFORMATION

LINE	OUTSIDE EDGE BUFFER (m)					BUFFER/ REMOVAL A (m)					REMOVAL A/ EXTRACTION (m)					EXTRACTION/ REMOVAL B (m)					OUTSIDE EDGE REMOVAL B (m)				
CL			0	.	0		1	1	.	2		2	0	.	4		2	4	.	4		2	9	.	2
L1			0	.	0		1	1	.	1		2	0	.	4		2	4	.	5		2	9	.	3
L2			0	.	0		1	1	.	2		2	0	.	3		2	4	.	4		2	9	.	2

COMMENTS (incl. notes on reasons if plot offset)

Aspen SI tree located 26 m NE of Buffer plot

PLOT SCHEMATIC (posts, pigtails, lines)



Plot Form Page 1 Side 2

SIDE 2

BUFFER INFORMATION

REC TYPE	SECT NO.	TREE NO.	SPEC CODE	DBH (cm)	HT (m)	HT TO LIVE CROWN (m)	DISTANCE ALONG CENTERLINE (m) from outside Buffer	CR CLSS	1 COND CODE	2 COND CODE	3 COND CODE
B	1	000	SW	12.5	12.8	5.6	0.2	I	00		
B	1	001	AW	19.9	20.0	15.5	1.5	D	00	23	
B	1	002	SW	14.5	14.8	5.6	1.6	I	00		
B	1	003	SW	14.6	15.4	4.8	2.4	I	00		
B	1	004	SW	13.6	13.4	6.5	2.6	I	00		
B	1	005	AW	22.1	21.8	16.2	2.7	D	00		
B	1	006	SW	14.6	14.5	4.1	3.5	I	00		
B	1	007	AW	20.1	19.9	16.5	3.8	D	00		
B	1	008	AW	21.8	21.1	15.4	5.9	D	00		
B	1	009	SW	16.5	15.6	5.5	6.6	I	00		
B	1	010	SW	14.2	15.4	4.9	8.3	I	00		
B	1	011	SW	11.4	12.3	3.6	9.2	I	25		
B	1	012	AW	22.0	21.2	16.3	10.1	D	00		
B	2	000	SW	13.2	13.8	4.2	0.5	I	00	23	
B	2	001	AW	24.6	22.3	15.4	0.8	D	00		
B	2	002	SW	14.5	14.5	5.7	1.5	I	00		
B	2	003	AW	24.6	23.8	18.8	2.9	D	00		
B	2	004	SW	15.6	15.8	5.3	3.6	I	00		
B	2	005	SW	16.5	15.6	6.6	5.5	I	00		
B	2	006	AW	25.5	24.6	18.3	5.4	D	00		
B	2	007	SW	15.5	15.6	2.2	5.6	I	25		
B	2	008	AW	22.2	21.3	15.5	6.9	D	00		
B	2	009	SW	14.2	15.4	3.5	7.6	I	00		
B	2	010	AW	22.2	21.5	15.8	8.4	D	00		
B	2	011	SW	17.6	18.3	5.4	8.8	I	25		
B	2	012	AW	22.8	21.8	15.5	9.6	D	00		
B	2	013	SW	12.4	12.9	3.4	10.1	I	00		
B	2	014	AW	22.3	21.2	15.4	10.4	D	00		
B	2	015	SW	13.6	13.4	6.5	2.6	I	00		
B	2	016	AW	22.1	21.8	16.2	2.7	D	00		
B	2	017	SW	14.6	14.5	4.1	3.5	I	00		
B	2	018	AW	20.1	19.9	16.5	3.8	D	00		
B	2	019	SW	16.5	15.6	5.5	6.6	I	00		
B	2	020	SW	14.2	15.4	4.9	8.3	I	00		
B	2	021	SW	11.4	12.3	3.6	9.2	I	25		
B	2	022	AW	22.0	21.2	16.3	10.1	D	00		
B	2	023	SW	13.2	13.8	4.2	0.5	I	00	23	
B	2	024	AW	24.6	22.3	15.4	0.8	D	00		
B	2	025	SW	14.5	14.5	5.7	1.5	I	00		
B	2	026	AW	24.6	23.8	18.8	2.9	D	00		
B	2	027	SW	15.6	15.8	5.3	3.6	I	00		
B	2	028	SW	16.5	15.6	6.6	5.5	I	00		
B	2	029	AW	25.5	24.6	18.3	5.4	D	00		
B	2	030	SW	15.5	15.6	2.2	5.6	I	25		
B	2	031	AW	22.2	21.3	15.5	6.9	D	00		
B	2	032	SW	14.2	15.4	3.5	7.6	I	00		
B	2	033	AW	22.2	21.5	15.8	8.4	D	00		
B	2	034	SW	17.6	18.3	5.4	8.8	I	25		
B	2	035	AW	22.8	21.8	15.5	9.6	D	00		
B	2	036	SW	12.4	12.9	3.4	10.1	I	00		
B											
B											
B											
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Plot Form Page 2 Side 1

PLOT FORM PAGE 2

SIDE 1

HEADER INFORMATION

LOCATION INFO			PLOT IDENTIFICATION CODE				
TWP	RGE	M	GROUP	COMPANY	TREATMENT	HARVEST BLOCK NO.	CLUSTER
			M W M A -	-	S C U P -	-	P C

MEASUREMENT DATE (yyyy/mm/dd)	CREW INITIALS	MEAS. NUMBER
/ /	/ /	

EXTRACTION PLOT TALLY INFORMATION

REC TYPE	SECT NO.	SPEC CODE	TALLY BY HT CLASS: > 30 cm <= 130 cm	TALLY BY HT CLASS: > 130 cm <= 300 cm	TALLY BY HT CLASS: > 300 cm < 7cm dbh
E	5				
E	5				
E	5				
E	5				
E	5				
E	5				
E	5				
E	5				
E	5				

REC TYPE	SECT NO.	TREE NO.	SPEC CODE	HT OF 3 TALLEST DECID BY HT CLASS: > 30 cm and <= 130 cm	HT OF 3 TALLEST DECID BY HT CLASS: > 130 cm and <= 300 cm	HT OF 3 TALLEST DECID BY HT CLASS: > 300 cm and < 7cm dbh
E	5			.	.	.
E	5			.	.	.
E	5			.	.	.
E	5			.	.	.
E	5			.	.	.
E	5			.	.	.
E	5			.	.	.
E	5			.	.	.
E	5			.	.	.

EXTRACTION PLOT TREE INFORMATION

REC TYPE	SECT NO.	TREE NO.	SPEC CODE	DBH (cm)	HT (m)	HT TO LIVE CROWN (m)	CR CLSS	1 COND CODE	2 COND CODE	3 COND CODE
E	5			.	.	.				
E	5			.	.	.				
E	5			.	.	.				
E	5			.	.	.				
E	5			.	.	.				
E	5			.	.	.				
E	5			.	.	.				
E	5			.	.	.				
E	5			.	.	.				
E	5			.	.	.				
E	5			.	.	.				
E	5			.	.	.				
E	5			.	.	.				
E	5			.	.	.				
E	5			.	.	.				
E	5			.	.	.				
E	5			.	.	.				
E	5			.	.	.				
E	5			.	.	.				

Plot Form Page 2 Side 2

SIDE 2

REMOVAL PLOT A INFORMATION

REC TYPE		SECT NO.	TREE NO.			SPEC CODE		DBH/STUMP DIAM. (cm)				HT (m)				HT TO LIVE CROWN (m)				DISTANCE ALONG CENTERLINE (m)				CR CLSS	1 COND CODE		2 COND CODE		3 COND CODE	
R	A	1	0	0	0	S	W	1	0	.	1	1	1	.	2	0	5	.	5		1	1	.	6	D	0	0				
R	A	1	0	0	0	S	W	1	2	.	2	1	6	.	5	0	3	.	6		1	1	.	7	D	0	0				
R	A	1	0	0	1	S	W	1	6	.	5	1	8	.	6	0	2	.	8		1	2	.	5	D	0	0				
R	A	1	0	0	2	S	W	1	1	.	4	1	2	.	4	0	3	.	4		1	3	.	5	D	0	0				
R	A	1	0	0	3	S	W	1	3	.	6	1	3	.	8	0	4	.	5		1	6	.	6	D	0	0				
R	A	2	0	0	0	S	W	1	4	.	8	1	4	.	5	0	3	.	5		1	1	.	3	D	0	0				
R	A	2	0	0	1	S	W	1	8	.	5	1	8	.	2	0	5	.	1		1	5	.	6	D	0	0				
R	A	2	0	0	2	S	W	1	2	.	3	1	2	.	3	0	3	.	2		1	6	.	7	D	0	0				
R	A	2	0	0	3	S	W	1	4	.	2	1	5	.	5	0	2	.	4		1	8	.	8	D	0	0	5	7		
R	A	2	0	0	4	S	W	1	8	.	4	1	7	.	4	0	2	.	8		2	0	.	0	D	0	0				
R	A	2	0	0	5	A	W	1	2	.	8	1	3	.	2	0	8	.	8		2	0	.	3	D	0	0				
R	A	2	9	9	9			1	8	.	4			.				.			1	8	.	6							
R	A	2	9	9	9			2	0	.	7			.				.			1	4	.	2							
R	A									.				.				.					.								
R	A									.				.				.					.								
R	A									.				.				.					.								
R	A									.				.				.					.								
R	A									.				.				.					.								
R	A									.				.				.					.								

REMOVAL PLOT B INFORMATION

REC TYPE		SECT NO.	TREE NO.			SPEC CODE		DBH/STUMP DIAM. (cm)				HT (m)				HT TO LIVE CROWN (m)				DISTANCE ALONG CENTERLINE (m)				CR CLSS	1 COND CODE		2 COND CODE		3 COND CODE	
R	B	1	0	0	0	S	W	1	0	.	1	1	1	.	2	0	5	.	5		2	4	.	6	D	0	0				
R	B	1	0	0	0	S	W	1	2	.	2	1	6	.	5	0	6	.	6		2	4	.	7	D	0	0				
R	B	1	0	0	1	S	W	1	6	.	5	1	8	.	6	0	2	.	8		2	5	.	5	D	0	0				
R	B	1	0	0	2	S	W	1	1	.	4	1	2	.	4	0	6	.	4		2	6	.	5	D	0	0				
R	B	1	0	0	3	S	W	1	3	.	6	1	3	.	8	0	4	.	5		2	8	.	6	D	0	0				
R	B	1	9	9	9			1	5	.	1			.				.			2	4	.	1							
R	B	1	9	9	9			1	8	.	5			.				.			2	7	.	7							
R	B	2	0	0	0	A	W	1	4	.	8	1	4	.	5	0	8	.	5		2	4	.	8	D	0	0				
R	B	2	0	0	1	S	W	1	8	.	5	1	8	.	2	0	5	.	1		2	5	.	6	D	0	0	5	7		
R	B	2	0	0	2	S	W	1	2	.	3	1	2	.	3	0	3	.	2		2	6	.	7	D	0	0				
R	B	2	0	0	3	S	W	1	4	.	2	1	5	.	5	0	2	.	4		2	8	.	8	D	0	0				
R	B	2	0	0	4	S	W	1	8	.	4	1	7	.	4	0	2	.	8		2	8	.	1	D	0	0				
R	B	2	0	0	5	S	W	1	2	.	8	1	3	.	2	0	8	.	8		2	9	.	0	D	0	0				
R	B									.				.				.					.								
R	B									.				.				.					.								
R	B									.				.				.					.								
R	B									.				.				.					.								
R	B									.				.				.					.								
R	B									.				.				.					.								

APPENDIX IV: Tally Sheet Codes

Member Company Codes

Table 9. Member company codes.

Company Code	Company Name
AINS	Ainsworth Lumber Co. Ltd.
ALPL	Alberta Plywood Ltd.
ALPA	Alberta Pacific Forest Industries Ltd.
DMI	Daishowa Marubeni International Ltd.
FOOT	Footner Forest Products Ltd.
MWFP	Millar Western Forest Products Ltd.
SLP	Slave Lake Pulp Corp.
TOLK	Tolko Industries Ltd.
WEYC	Weyerhaeuser of Canada
VAND	Vanderwell Contractors Ltd.

Slope Position Codes

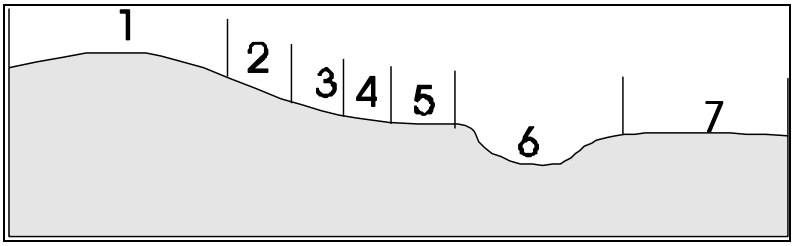

Figure 11. Slope codes.

Table 10. Slope position descriptions.

Code	Topographic Position	Description
1	Crest	The uppermost portion of a slope, shape usually convex in all directions with no distinct aspect.
2	Upper Slope	The upper portion of the slope immediately below the crest, slope shape usually convex with a specific aspect.
3	Mid Slope	The area of the slope between the upper and lower slopes where the slope shape is usually straight and with a specific aspect.
4	Lower Slope	The lower portion of the slope immediately above the toe where the slope shape is usually concave and with a specific aspect.
5	Toe	The lowermost portion of the slope immediately below and adjacent to the lower slope where the slope shape is concave grading rapidly to level with no distinct aspect.
6	Depression	Any area that is concave in all directions, usually at the toe of a slope or within level topography with no distinct aspect.
7	Level	Any level area excluding toe slopes, generally horizontal, with no distinct aspect.

Acceptable Species Codes

Table 11. Acceptable species codes.

Species Code	Species
SW	white spruce
SB	black spruce
PL	lodgepole pine
PJ	jack pine
FB	balsam fir
LT	larch (tamarack)
AW	trembling aspen
PB	balsam poplar
BW	white birch
DD	dead deciduous
DC	dead coniferous
DU	dead unknown

Crown Class Codes

Table 12. Crown class codes.

Crown Class Code	Description
D	Dominant - crown extends above the general level of the canopy.
C	Codominant - crown forms the general level of the canopy.
I	Intermediate - crown is below but extending into the bottom of the general level of the canopy.
S	Suppressed - crown is entirely below the general level of the canopy.

Condition Codes

Table 13. Condition codes (based on LFS PSP standards).

Condition Code	Description	Condition Code	Description
0	**Healthy**	45	Other mammalian/avian evidence
1	**Insects**	51	Conks/Blind Conks
2	**Disease**	52	Open Scars
3	**Rabbit Browsing**	53	Burls and Galls (DBH ≥ 7.0 cm)
4	Shepherds Crook	54	Fork (DIB>7.0cm-2.5m past fork)
5	Browsing (other)	55	Pronounced Crook (DIB>7.0cm -2.5m past crook)
6	Fire	**56**	**Broken Top (<=10cm DIB at break, DBH ≥ 7.0 cm; no CC)**
7	Mechanical	57	Limby (DBH ≥ 7.0 cm)
8	Windthrow	**58**	**Leaning (**DBH ≥ 7.0 cm**, & if severe, No CC)**
9	Climate	**59**	**Broken Stem (>=10cm DIB at break; No CC)**
10	Flooding	60	Generic woodpecker feeding
11	Poor Planting	**61**	**Dead and Down (No CC;** DBH ≥ 7.0 cm**)**
12	Suppression	62	Stem Insects (Bark & Sawyer Beetle; DBH ≥ 7.0 cm)
13	Frost Heaving	63	Stem Disease (Cankers; DBH ≥ 7.0 cm)
14	Erosion	64	Foliar Insects (DBH ≥ 7.0 cm)
15	**Missing**	65	Foliar Disease (Needle blights & rust; DBH ≥ 7.0 cm)
16	**Dead Top/Dieback**	66	Stem Form Defect (=>7.0cm DIB where defect begins)
17	Poor Seedbed	67	Closed Scars
18	Herbicide	68	Atropellis Canker
19	Western Gall Rust	69	Comandra Blister Rust
20	Armillaria Root Rot	70	Elytroderma needle cast of pine
21	Moldy Planting Stock	71	Hypoxylon Canker
22	Multiple Leader	72	Spruce Cone Rust
23	Poor Form	73	Stalactiform Blister Rust
24	**Broken Top (new or old)**	74	Tomentosus Root Rot
25	**Dead & Standing (No CC)**	75	Spruce Spanworm
26	Snow Press	76	Cone Maggot
27	Dead Top with new leader	77	Coneworm
28	Sucker from old stump	78	Eastern Spruce Budworm
29	Cut down	79	Mountain Pine Beetle
30	Terminal Weevil	80	Spruce Beetle
31	SW Gall Aphid	81	Spruce Needle Rust
32	Tent Caterpiller	82	Yellow-headed Spruce Sawfly
33	Root Collar Weevil	83	Large Aspen Tortrix
34	J-Root	84	Excavations by woodpeckers
35	**Leaning**	85	Yellow-bellied Sapsucker feeding
36	Same Stump	86	Small Mammal feeding on tree bole
37	Unknown	87	Small Cavity
38	Pitch Moth	88	Large Cavity
39	DBH taken on new leader	89	Hollow tree/bole section
40	Nutrient Deficiency	90	Beaver (feeding/harvest)
41	Mouse Feeding	91 - 96	Hawksworth Mistletoe Rating System
42	Ungulate feeding/rubbing	98	Data changed by office
43	Domestic livestock (rubbing)		
44	Nest		

APPENDIX V: DIAMETER MEASUREMENTS

Measure diameter at 1.3 m above the root collar, paying attention to the following anomalies (Figure 10).

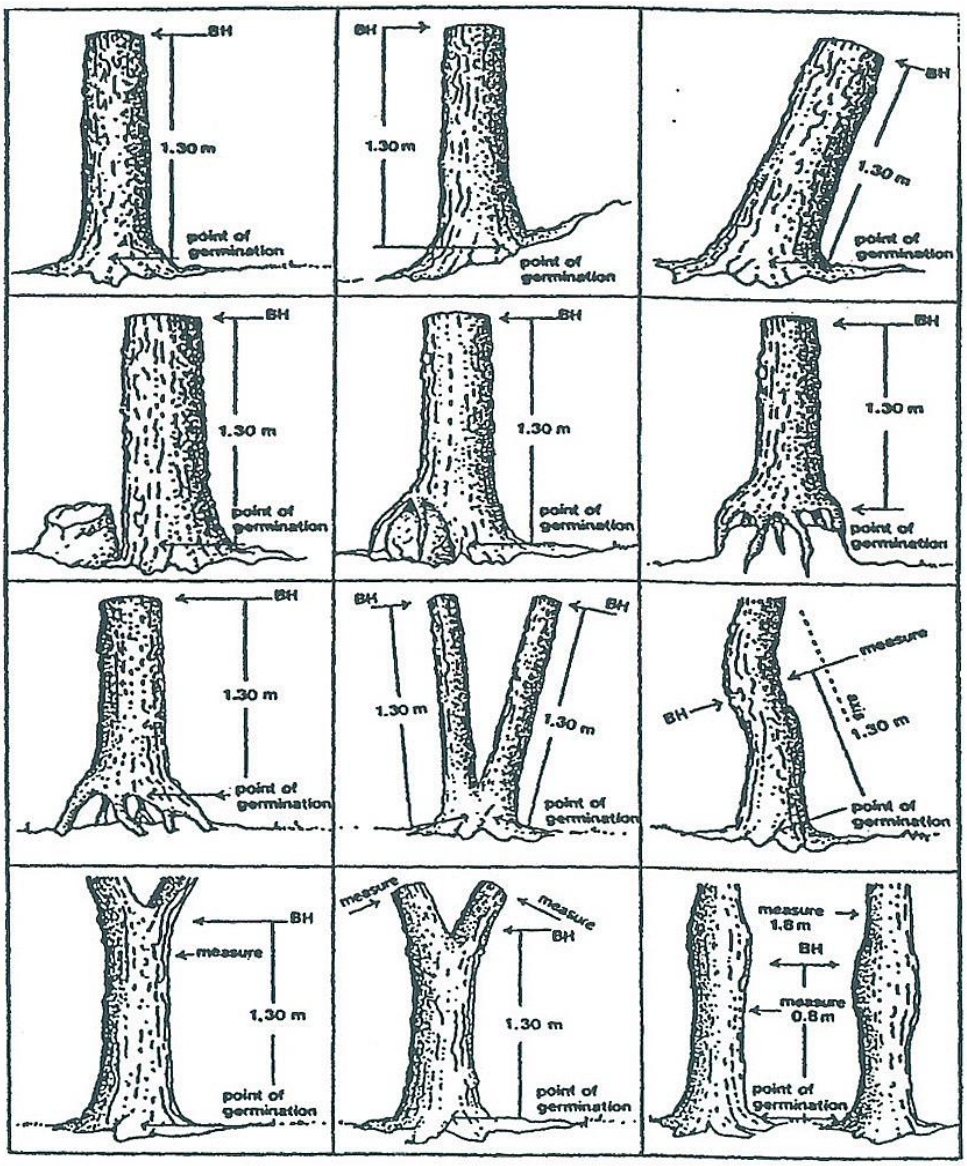

Figure 12. Diameter measurement techniques.

1. If tree is on a slope, measure at 1.3 m at midpoint.
2. If tree is leaning, measure at 1.3 m perpendicular to the lean.
3. If tree is forked below 1.3 m, measure as two separate trees at 1.3 m.
4. If tree is forked above 1.3 m, measure as one tree at 1.3 m.
5. If tree is deformed at 1.3 m or is a bottleneck tree, measure diameter above deformation or bottleneck. Record in comments field the height at which diameter was taken.

APPENDIX VI: HEIGHT MEASUREMENT

If total tree height is determined using a clinometer (Figure 11):

1. Measure distance from the tree. A rule of thumb is to be at least as far away as the tree is tall
2. Take a clinometer reading to the top of the tree (%).
3. Take a clinometer reading to the bottom of the tree (%).
4. Determine height using equation provided below.

Total Tree Height (m) = Horizontal Dist (m) x $\frac{\text{Top Reading \% - Bottom Reading \%}}{100\%}$

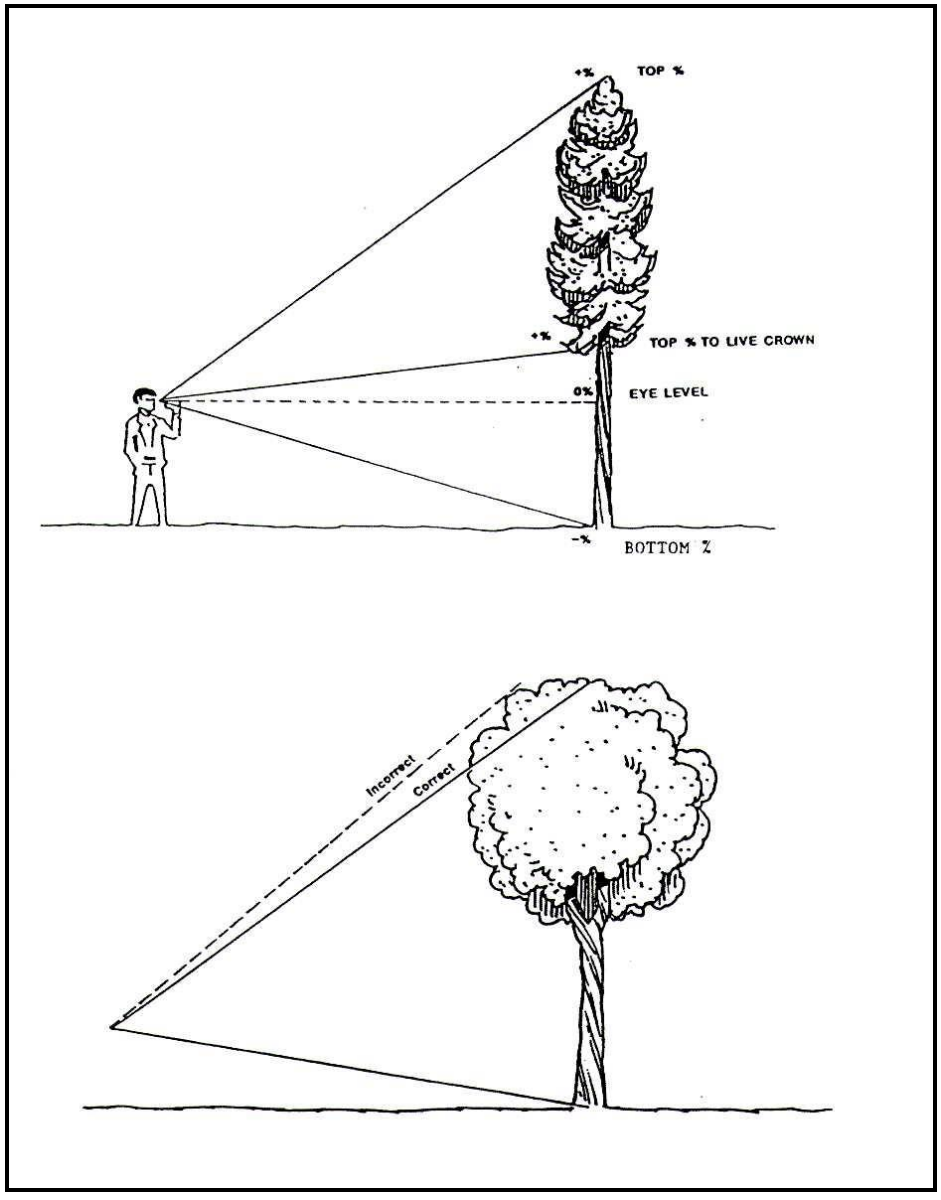

Figure 13. Coniferous and deciduous height measurement.

For leaning trees, height readings are taken while standing perpendicular to the direction of the lean (Figure 12).

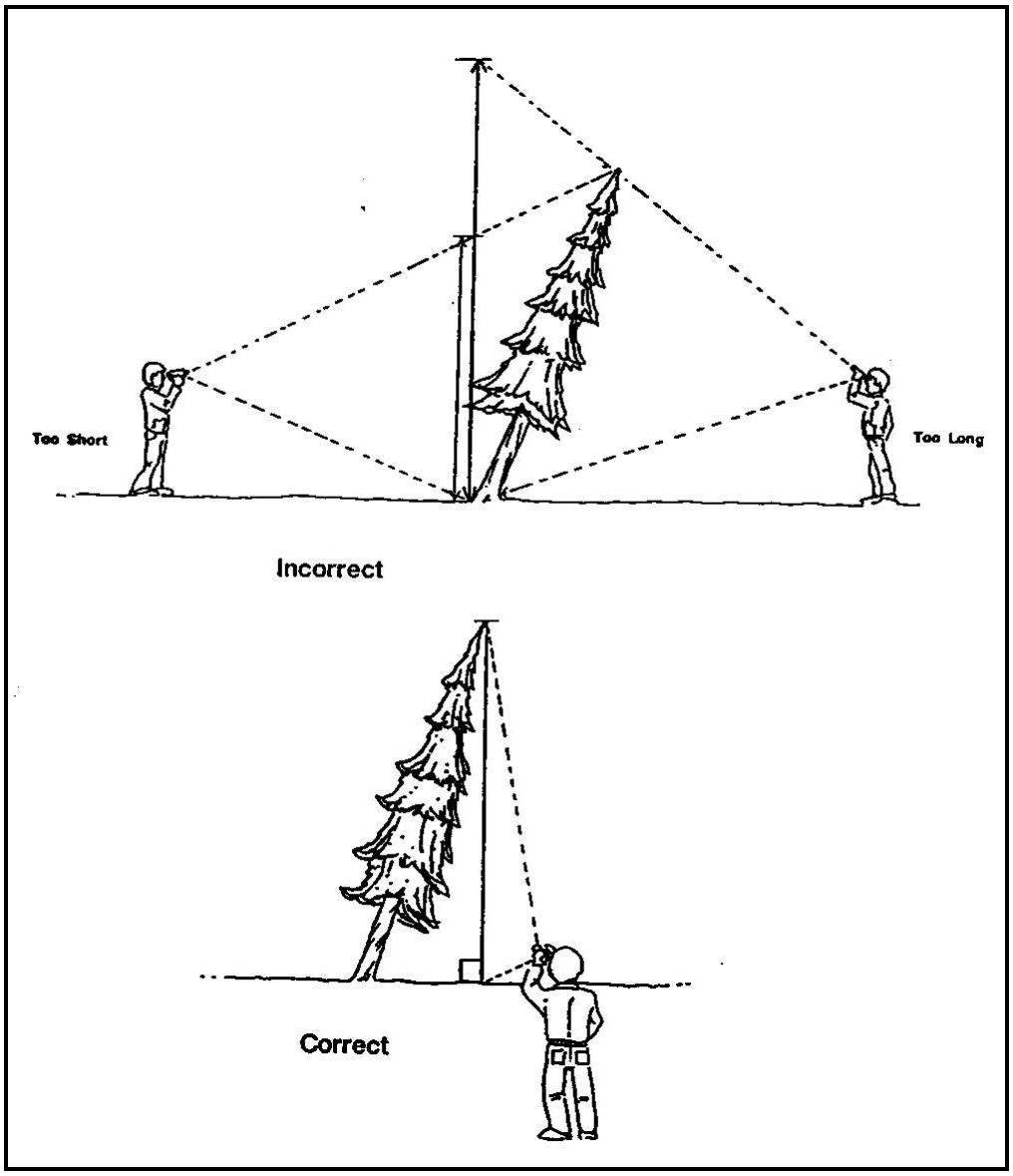

Figure 14. Measuring height on a leaning tree.

Diagrams taken from Alberta Lands and Forest Permanent Sample Plot Field Procedures Manual, 1994.