Hinton Wood Products

A division of West Fraser Mills Ltd.

Growth & Yield Program

for the 2014 DFMP

May 19, 2017

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Introduction

This Growth and Yield Program has been developed in support of the Hinton Wood Products' Detailed Forest Management Plan. It is intended to provide information for the establishment of appropriate Annual Allowable Cuts and for demonstration that site productivity is being maintained. To optimize the time and effort required to maintain the program, it needs to be cost-effective, scientifically valid and consistent with assumptions used for timber supply analysis.

Hinton Wood Products (HWP) has been a long time participant in provincial initiatives by companies and government to improve systems and procedures to measure the growth and yield of forests in Alberta. As a founding member of the Foothills Growth and Yield Association and part of the original group to restructure reforestation surveys, much of the company's recent work has been focused on regenerating stands. This focus will continue with membership in the *Forest Growth Organization of Western Canada* (FGrOW) which was established in April 2015 and is an amalgamation of four growth and yield organizations:

1. Alberta Forest Growth Organization (AFGO)
2. Foothills Growth and Yield Association (FGYA)
3. Mixedwood Management Association (MWMA)
4. Western Boreal Growth and Yield Association (WESBOGY)

FGrOW will play a lead role in growth and yield research and related policy development in Western Canada. It will promote communications between members, within the forest industry, and with other industries interested in growth and yield. By working closely with the University of Alberta, it establishes the scientific credibility that allows it to act as the "one window" for growth and yield information in western Canada.

As member of the organization, HWP is also a member of several project teams. Specifically;

1. Foothills Pine Project Team (FPPT)
2. Policy & Practice Project Team (PPPT)
3. Empirical Post-Harvest Stand Growth Assessment (EPH)
4. Tree Improvement Alberta (TIA)

HWP's involvement in FGrOW has led to a reassessment of the Growth and Yield Program and the continued development of the PSP and TSP programs.

The goals adopted for this growth and yield program provide the basis for long term data collection and analysis in support of timber supply modeling. The goals are:

1. Estimate historical growth rates on the HWP FMA area at the forest and yield stratum level.
2. Validate yield curves for the HWP FMA area and develop new curves, if necessary.
3. Compare projected versus delivered volumes.
4. Monitor growth in regenerating harvested areas.
5. Work with FGrOW to implement a *Vision for Growth and Yield in Alberta*.
6. Support growth model development.

1. Background

1.1 Data Sources

Growth and yield programs require large amounts of data to adequately estimate conditions within the complex natural systems that they represent. Emerging technologies, including LiDAR and other remote sensing, has the potential to provide long-term cost savings by decreasing the amount of field data collection required. HWP will continue to investigate opportunities to utilize emerging technologies to reduce cost and improve estimates.

1.1.1 Alberta Vegetation Inventory (AVI)

A complete forest inventory, to Alberta Vegetation Inventory (AVI) standards has been prepared using aerial photography from 2001. Deletions to the available landbase have been updated to April 30, 2012 for use in the Timber Supply Analysis. The available (active) landbase has been divided into 9 yield strata, using the AVI information. Details on the stratification and other landbase attributes may be found in Appendix 19 of the DFMP (Hinton Wood Products, 2014a). A map of the cover type distributions is shown in Figure 1.

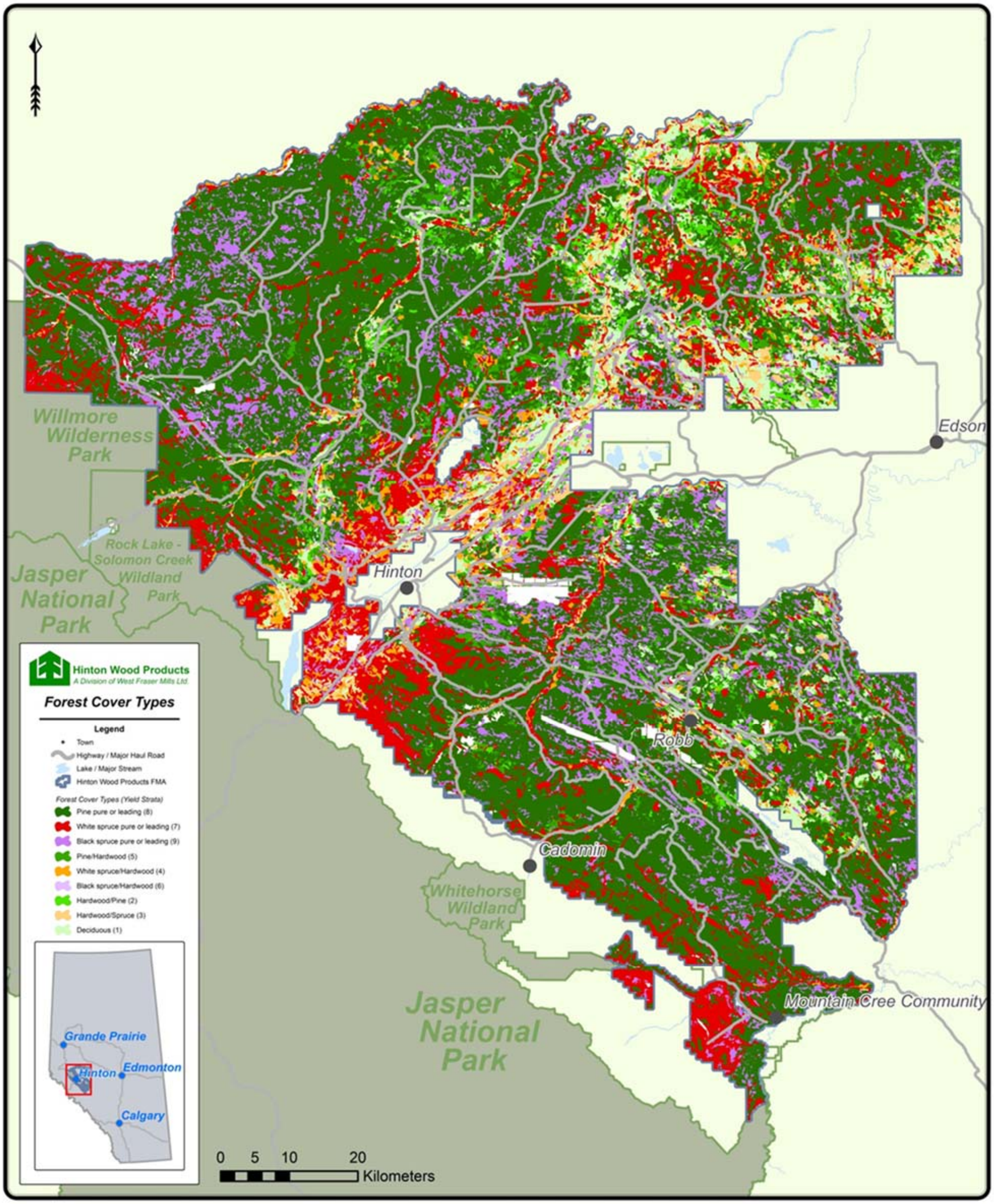
The forest inventory shows that approximately 37% of the active landbase has stands that are 111 years old and older, with the 111 to 120 age class being the dominant one. Age class distribution, by stratum is shown in Table 1.

A new AVI will be developed prior to the 2026 Forest Management Plan. This process will begin with aerial photography acquisition in 2020. The new AVI delineation and attritribute capture is expected to take up to three years and will be completed between 2021 and 2023. This new AVI will be used to create a new landbase and to stratify the active landbase for for the purpose of developing yield curves for the next FMP.

Table 1 Distribution of Yield Classes on the Active Landbase

Age Class	Total Area (ha)	Active Area (ha)	Passive Area (ha)	Yield Class (Active Landbase) in hectares									
				HW	HW/PL	HW/SW	SW/HW	PL/HW	SB/HW	SW	PL	SB	Total
0	118,468	-	118,468	-	-	-	-	-	-	-	-	-	-
10	80,180	79,032	1,148	2,390	968	1,153	2,155	2,415	-	10,909	58,828	215	79,032
20	44,386	43,482	904	245	258	385	948	1,378	11	7,285	32,880	92	43,482
30	28,926	26,449	2,476	1,170	765	413	513	2,719	55	3,276	17,514	24	26,449
40	39,141	34,542	4,599	2,685	2,682	1,778	2,091	5,866	24	4,083	15,210	123	34,542
50	44,837	36,666	8,171	2,364	2,255	1,618	3,474	3,967	36	6,659	16,183	110	36,666
60	36,611	24,214	12,397	806	546	1,020	1,118	1,237	9	2,890	16,449	138	24,214
70	23,011	13,117	9,893	971	1,062	764	738	988	4	1,322	7,230	36	13,117
80	67,126	40,665	26,461	2,333	1,205	1,294	1,274	1,723	8	4,421	28,216	191	40,665
90	51,279	27,638	23,641	3,662	1,008	1,083	965	1,329	27	3,099	16,214	252	27,638
100	42,076	30,544	11,532	4,031	2,290	1,958	950	1,004	2	3,921	16,283	104	30,544
110	84,089	63,099	20,990	9,640	3,606	3,674	1,194	3,767	44	4,406	36,495	273	63,099
120	198,382	148,877	49,505	15,147	7,106	7,279	3,268	12,009	56	11,934	91,361	717	148,877
130	48,575	34,925	13,650	4,071	1,270	2,261	1,805	2,958	90	6,512	15,385	573	34,925
140	26,102	13,712	12,390	453	72	341	1,733	791	55	6,051	3,922	294	13,712
150	19,923	10,485	9,438	205	57	78	921	458	57	5,512	2,881	315	10,485
160	14,727	6,930	7,796	124	21	18	417	235	4	3,923	2,089	100	6,930
170	17,516	10,918	6,598	5	16	67	224	27	14	3,771	6,337	457	10,918
180	4,096	2,539	1,556	32	-	5	88	78	-	1,656	635	46	2,539
190	3,913	2,488	1,425	-	-	22	56	12	-	1,423	956	18	2,488
200	2,638	1,648	990	25	15	4	148	11	-	724	720	1	1,648
210	1,813	590	1,223	-	-	-	-	-	-	442	148	-	590
220	15,679	6,512	9,167	-	-	0	36	-	-	3,552	2,895	30	6,512
230	163	62	101	-	-	-	-	-	-	48	14	-	62
240	1,579	487	1,092	-	-	-	5	-	-	202	280	-	487
250	7,231	2,812	4,419	-	-	-	-	-	-	1,204	1,595	13	2,812
Total	**1,022,465**	**662,434**	**360,031**	**50,357**	**25,202**	**25,215**	**24,121**	**42,973**	**498**	**99,227**	**390,720**	**4,121**	**662,434**

Figure 1 Forest Cover Types on the HWP Landbase



1.1.2 Hinton Wood Products Permanent Growth Sample Program

Between 1956 and 1961, North Western Pulp & Power Ltd. (now Hinton Wood Products) established approximately 3,000 inventory plots throughout the Hinton Pulpwood Lease. These square-shaped, one-fifth acre plots were arranged in clusters of four with the cluster centres established every two miles at the intersection of the Alberta Legal Survey grid section lines (in the case of baselines and correction lines, the clusters of four plots were divided to align with the baseline/correction line offset). This systematic inventory sampling program was known as the Continuous Forest Inventory (CFI).

The original intent of the CFI was simply to inventory the forest resource of the recently allocated Hinton Pulpwood Lease, for which no inventory or mapping had been completed for yet. Soon after the CFI was completed, and the first Forest Management Plan was prepared, it became evident that the real value of the CFI plots was not in creating forest inventories, but rather developing growth and yield tables. In 1970, the CFI program was converted into the Permanent Growth Sample (PGS) Program, at which time the second measurement of the originally established plots began (re-measurement intervals were originally scheduled for five years, but this was revised to ten years after the first re-measurement).

In 1988, the Hinton Wood Products Forest Management Agreement (FMA) area was expanded to include additional areas in what is today known as the Athabasca, Berland and Embarras working circles. In 1991, an additional 114 PGS plots were established on a two-mile by two-mile grid. In addition to the systematically located PGS plots (original CFI and PGS grid plots), a number of other PGS plots have been established in an effort to fill specific shortcomings of the existing data or to assess specific operational opportunities. Table 2 identifies the current plot installations in the PGS Program.

Table 2 PGS Program Installation Groups

Plots Set	Original Intent	Plot size Ha (Acre)	First Measurement
Original CFI/PGS grid	Inventory – G & Y	0.08 (1/5)	1957/1958
1988 Expansion grid	G & Y	0.04 (1/10)	1990/1991
Robb (Embarras)	Young Pine	0.04 (1/10)	1969/1970
McCardell Creek	Young Pine	0.04 (1/10)	1970
Lynx Creek (Marlboro)	Young Pine	0.04 (1/10)	1980
Canyon Creek (Athabasca)	Mixedwood	0.04 (1/10)	1988
Lambert Creek (McLeod)	Young Aspen	0.04 (1/10)	1996
Caribou Lichen Thinning (Berland)	Caribou & Lichen	0.04 (1/10)	1999

HWP's PGS program is Alberta's oldest and most extensive industry established network of permanent sample plots. It forms the backbone of HWP's growth and yield program by providing data for:

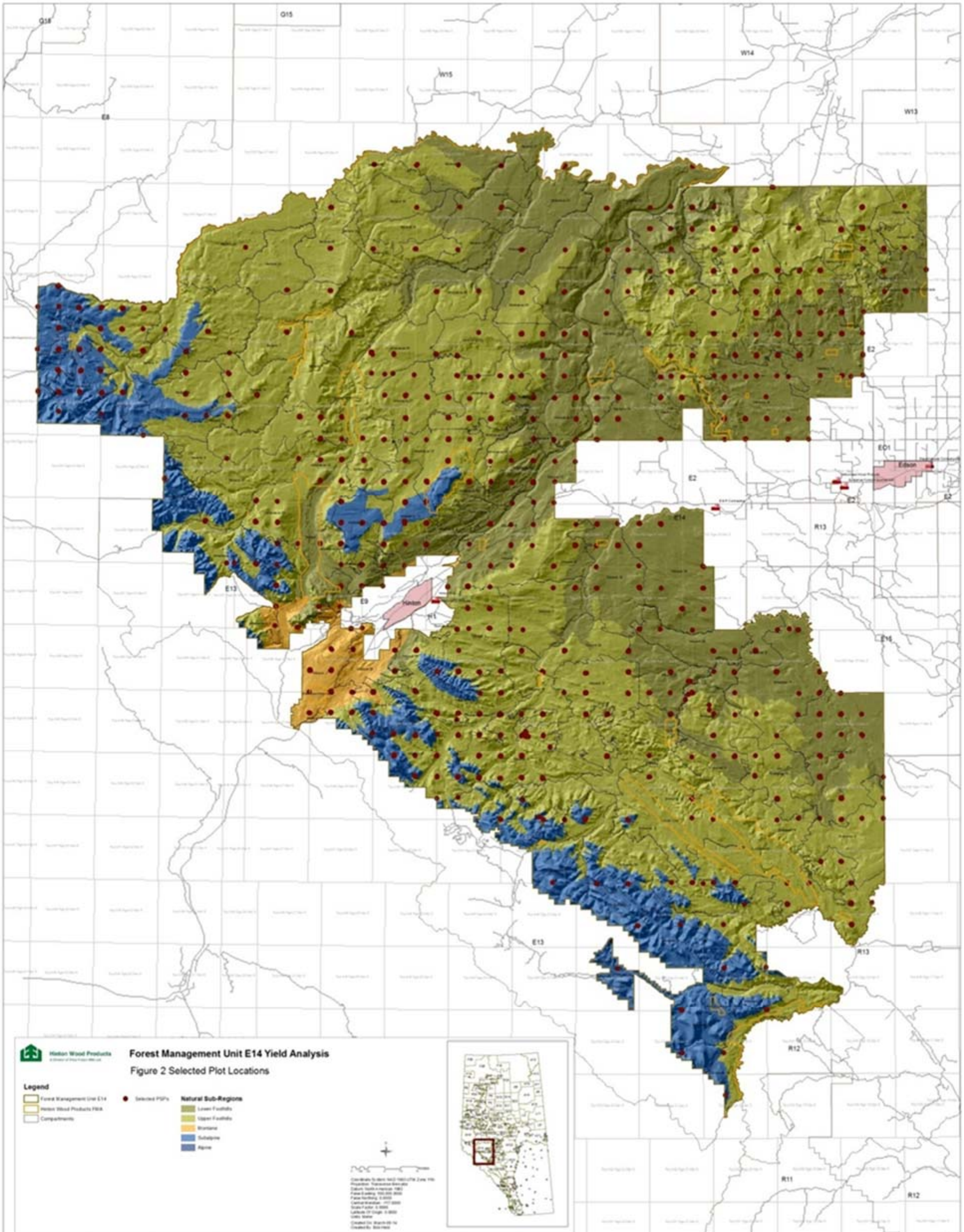
1. Fire origin yield estimates
2. Managed stand yield estimates
3. Growth model (GYPSY) development
4. Independent research studies

Table 3 shows the plots that were used to develop yield curves for the HWP Timber Supply Analysis. The locations of these plots are shown on the map in Figure 2.

Table 3 Distribution of PGS plots by Stratum and Measurement Year

Measurement Year	Number of Plots									
	Aw	**Hw/Pl**	**Hw/Sw**	**Sw/Hw**	**Pl/Hw**	**Sb/Hw**	**Sw**	**Pl**	**Sb**	**Total**
1991	10	7	-	5	8	-	16	56	-	102
1992	1	1	-	-	-	-	-	9	-	11
1993	-	-	-	-	1	-	-	7	-	8
1994	4	4	1	3	2	-	-	1	-	15
1995	6	2	8	3	7	-	4	13	-	43
1996	8	5	3	2	5	-	3	8	-	34
1997	3	2	1	1	-	-	2	6	-	15
1998	3	1	2	2	-	-	6	30	-	44
1999	2	-	-	1	3	-	10	19	-	35
2000	3	3	3	-	2	-	8	20	3	42
2001	16	4	4	11	13	-	26	74	2	150
2002	3	1	4	5	7	-	18	38	-	76
2003	7	3	3	4	17	3	28	118	3	186
2004	42	14	16	5	5	-	2	14	-	98
2005	-	4	-	-	9	-	6	14	-	33
2006	8	9	3	13	16	-	22	48	-	119
2007	3	4	2	4	6	-	13	56	-	88
2008	-	-	-	-	-	-	2	-	-	2
Total	119	64	50	59	101	3	166	531	8	1,101

Figure 2 Selected Plot Locations



1.1.3 Alberta Agriculture and Forestry Permanent Sample Plots

Alberta Agriculture and Forestry (AAF) has two permanent sample plots on the HWP FMA area and two in the Cache Percotte Forest. The re-measurement schedule is uncertain at this time. The data is not currently being used by HWP.

1.2 Growth & Yield Plan Goals

The Growth and Yield plan guides the process used to achieve the following goals:

1. Estimate historical growth rates on the HWP FMA area at the forest and yield stratum level.
2. Validate yield curves for the HWP FMA area and develop new curves, if necessary.
3. Compare projected versus delivered volumes.
4. Monitor growth in regenerating harvested areas.
5. Work with FGrOW to implement a Vision for Growth and Yield in Alberta.
6. Support growth model development.

The first goal of this Growth and Yield plan is to estimate historical growth rates on the HWP FMA area at the forest and yield stratum level. The information will be used to validate information generated by timber supply models and to improve modeling capabilities for land excluded from the timber harvesting landbase. Data from HWP's permanent sample plots will be used to measure growth and succession.

1.2.1 Growth Rate on the FMA Landbase

To develop an unbiased estimate of the actual growth occurring on the HWP FMA area, a grid of permanent sample plots (PSPs) has been established. Comparison of the average permanent sample plot (PSP) rate of growth over the active landbase results in an overall unbiased estimate of volume per hectare for the forested landbase. It gives an estimate of annual growth and the total growing stock and provides a useful comparison to the annual allowable cut.

At the forest level, it is useful to have a general idea of overall productivity. This estimate helps to define the parameters within which a company operates by providing an overall validation of the yield prediction. Over time PSP data provides estimates of growth for each yield stratum.

1.2.2 Validation of Yield Curves

The second goal of this Growth and Yield plan is to validate yield curves on the HWP FMA area and develop new curves if necessary. Yield curves used in the current timber supply analysis for unmanaged stands were developed using PGS plot data from the active landbase of the FMA area. Table 4 summarizes stratum areas, yields and mean annual increment values for each yield class for coniferous and deciduous groups in unmanaged stands.

Table 4 Productivity of Yield Classes on the Active Landbase using Unmanaged Yield Estimates

Yield Class	Net Area (ha)	Coniferous Tree Length				Deciduous Tree Length			
		Volume (m^3/ha)	Maximum MAI (m^3/ha/yr)	MAI Culmin. Age	Total MAI (m^3/yr)	Volume (m^3/ha)	Maximum MAI (m^3/ha/yr)	MAI Culmin. Age	Total MAI (m^3/yr)
1	50,357	72.1	0.66	110	33,015	193.3	1.76	110	88,483
2	25,202	115.2	1.28	90	32,267	81.6	0.91	90	22,845
3	25,215	225.1	1.50	150	37,836	78.9	0.53	150	13,269
4	24,121	225.1	1.50	150	36,195	78.9	0.53	150	12,694
5	42,973	115.2	1.28	90	55,021	81.6	0.91	90	38,954
6	498	225.1	1.50	150	748	78.9	0.53	150	262
7	99,227	155.2	1.55	100	154,006	7.8	0.08	100	7,736
8	390,720	211.6	1.92	110	751,649	9.3	0.08	110	33,140
9	4,121	124.2	1.24	100	5,117	-	-	100	-
	662,434	**183.1**	**1.67**	**109**	**1,105,854**	**35.7**	**0.33**	**109**	**217,384**

1.2.3 Projected Versus Delivered Volumes

Volumes will be validated regularly to ensure that actual yields are comparable to predicted. Delivered volume will be compared to planned volume on a block-by-block basis annually. Over time, the delivered volume per hectare should be comparable to the predicted volume per hectare for each stratum. If individual strata are not giving accurate predictions, they will be checked and new curves will be developed, as required.

A comparison of predicted and delivered volumes has been included in Appendix 20 of the 2014 DFMP (Hinton Wood Products, 2014b). It showed that coniferous deliveries exceeded planned by 11.4% and deciduous deliveries exceeded planned by 2.9%.

1.2.4 Managed Stand Performance

The adoption of the Reforestation Standard of Alberta (RSA) for the province has provided a mechanism to link reforestation to growth and yield. Ongoing work in the development of regeneration models will allow mean annual increment (MAI) to be forecast for each opening that forms part of a performance survey sampling program. Table 5 summarizes stratum areas, yields and mean annual increment values for each yield class for coniferous and deciduous groups in both unmanaged and managed stands. Performance of yield strata relative to existing yield curves and timber supply assumptions will be assessed in each timber supply quadrant. The data collected will be used to refine reforestation models and predict the growth of managed stands, including stands where improved seed has been deployed.

Hinton Wood Products has produced improved seed in the Controlled Parentage Program (CPP) regions as shown in Table 6 below. Areas where improved stock is deployed will be sampled separately to assess differences in growth and yield due to the use of improved seed.

Table 5 Areas and Coniferous and Deciduous Volumes for Yield Strata on the HWP Landbase

Yield Class	State	Net Area (ha)	Coniferous Tree Length Vol. (m^3/ha)	Coniferous Tree Length Max MAI (m^3/ha/yr)	Coniferous Tree Length Culm. Age	Coniferous Tree Length Total MAI (m^3/yr)	Deciduous Tree Length Vol. (m^3/ha)	Deciduous Tree Length Max MAI (m^3/ha/yr)	Deciduous Tree Length Culm. Age	Deciduous Tree Length Total MAI (m^3)
1	Regen	2,476	72.1	0.66	110	1,623	193.0	1.75	110	4,345
1	Natural	47,881	72.1	0.66	110	31,391	193.3	1.76	110	84,132
2	Regen	1,120	245.6	2.73	90	3,055	79.9	0.89	90	994
2	Natural	24,082	115.2	1.28	90	30,834	81.6	0.91	90	21,830
3	Regen	1,467	256.9	2.57	100	3,770	99.9	1.00	100	1,466
3	Natural	23,748	225.1	1.50	150	35,634	78.9	0.53	150	12,497
4	Regen	3,030	256.9	2.57	100	7,783	99.9	1.00	100	3,026
4	Natural	21,092	225.1	1.50	150	31,649	78.9	0.53	150	11,099
5	Regen	2,848	245.6	2.73	90	7,770	79.9	0.89	90	2,529
5	Natural	40,125	115.2	1.28	90	51,374	81.6	0.91	90	36,373
6	Regen	11	256.9	2.57	100	28	99.9	1.00	100	11
6	Natural	487	225.1	1.50	150	731	78.9	0.53	150	257
7	Regen	18,012	291.7	2.92	100	52,539	54.9	0.55	100	9,886
7	Natural	81,215	155.2	1.55	100	126,051	7.8	0.08	100	6,332
8	Regen	84,683	301.6	3.35	90	283,810	31.9	0.35	90	30,026
8	Natural	306,038	211.6	1.92	110	588,740	9.3	0.08	110	25,958
9	Regen	306	233.4	2.33	100	713	-	-	100	-
9	Natural	3,816	124.2	1.24	100	4,738	-	-	100	-
	Total	**662,434**	**199.4**	**1.91**	**106**	**1,262,234**	**40.0**	**0.38**	**106**	**250,759**

Table 6 Controlled Parentage Program Seed Sources

Species	CPP Region	Orchard codes	Approved operational elevations (metres) as of May 1, 2013
Lodgepole Pine	Region A	WWG801 (Presslee)	1050 -1350
Lodgepole Pine	Region B2	HASOCIG303	1200-1600
Lodgepole Pine	Region B1	G147 orchard	800-1200 (north of the Athabasca River Only
White Spruce	Region I	HASOCIG333	800-1200
Black Spruce	Region L1	WWG802 (Lanaria)or WWG806 (Presslee)	800-1200

1.2.5 Implement a Vision for Growth and Yield in Alberta

Some changes in forest management practices are limited by policy. The Alberta government traditionally has a low tolerance for risk, with conservative policies that are slow to change. This limits advancement in forest management practices, such as data sharing across FMA boundaries, realizing benefits of genetic gain, and other innovations. The *Vision for Growth and Yield in Alberta* is a strategy aimed at coordinating the collection and analysis of growth and yield data in a manner that provides the foundation for cost-effective and efficient programs for both industry and government.

1.2.6 Growth Models

On the ground data collection is becoming increasingly costly as availability of qualified field personnel decreases. Industry is placed in competition with each other to access field services. The Provincial Growth and Yield Initiative (PGYI) will support development of the Growth and Yield Projection System (GYPSY) and Mixedwood Growth Model (MGM) models by providing a dataset that covers the range of Natural Sub-regions and stand types in the Province in a consistent format. PGYI marks a new era of data sharing and collaboration, as all FMA-holders in the province are participating. Hinton Wood Products has participated with other West Fraser divisions in the development of PGYI. HWP will continue this cooperation by participating in FGrOW projects.

Forest management in Alberta is relying on increasing use of growth models. The GYPSY model is already an integral part the Reforestation Standard of Alberta. As the proportion of the landbase occupied by post-harvest stands increases, there is an increasing need to use GYPSY and MGM for yield curve development. However, there are known limitations to both models. One of the most pressing of these limitations is the lack of confidence in their ability to represent managed stand growth because of the small amount of data from post-harvest stands that have been used in model development. Their capability to model multi-species and multi-aged stands, and intensive plantations needs to be improved. HWP will participate, through FGrOW, in the collection and analysis of data to improve the function of GYPSY and MGM.

2. Permanent Sample Plot Program

Permanent sample plots (PSPs) are an effective means of collecting growth information for a forest. In addition to the initial measurements and scheduled monitoring, they must be protected from disturbance by other activities that may affect the rates of growth of the plot trees until such time as they are harvested. The HWP PGS Manual will be used to guide PSP measurements and is found in Appendix B.

The Provincial Growth and Yield Initiative (PGYI), to which all FMA holders in Alberta are signatories, is now up and running. The objective of the PGYI is to collectively obtain data on tree growth through repeated measurements of PSPs to develop, calibrate & validate growth models for FMP yield curve development. FGrOW has published a guideline for minimum standards for PGYI PSP plot establishment and measurement. The protocol described in the HWP PGS manual meets the minimum requirements contained in the PGYI protocol. HWP's PGYI plot commitments are shown in Table 7.

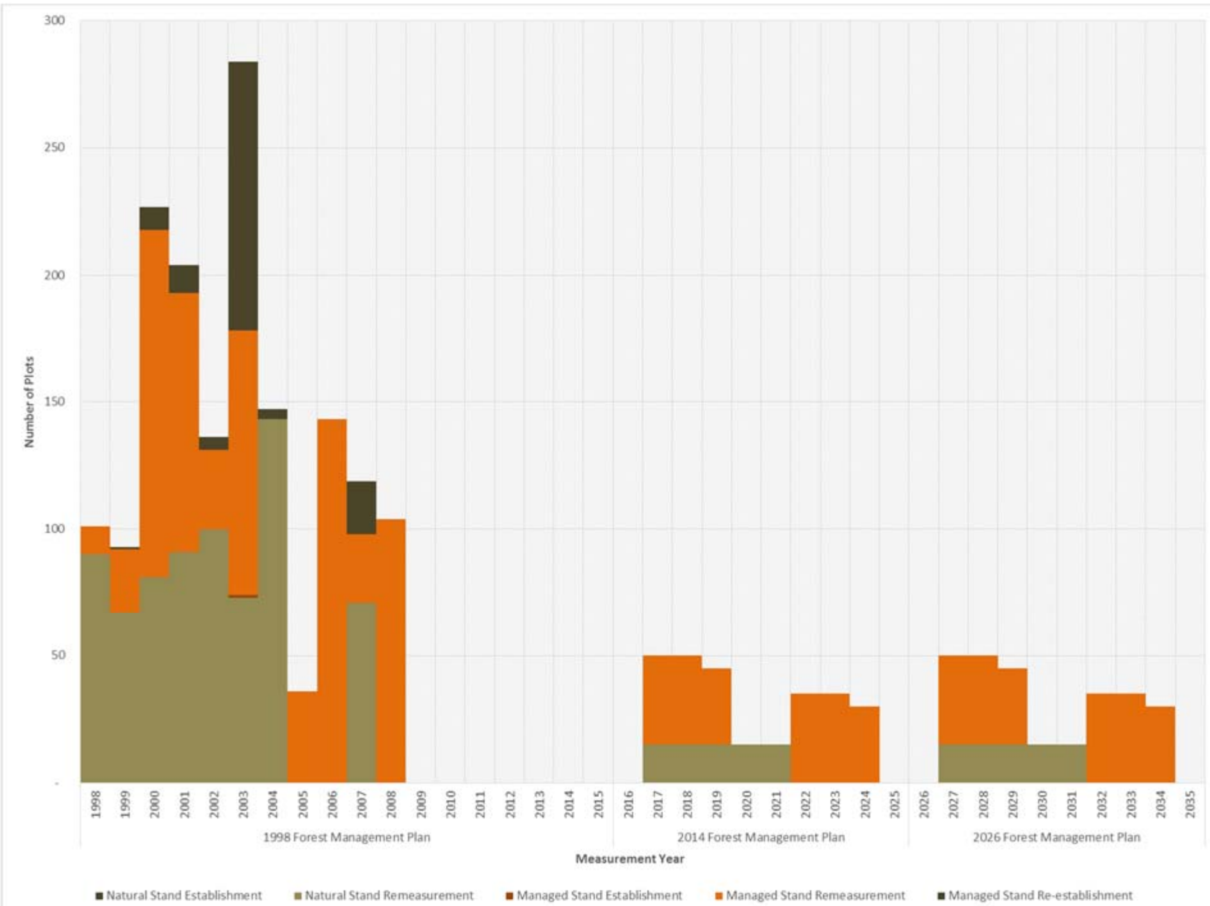
HWP will continue to maintain PSPs that have not been disturbed and are not part of the PGYI plot list, however there is currently no plan to re-measure these plots.

Table 7 PGYI Commitments

	Natural		Managed	
Strata	**Target**	**Allocated**	**Target**	**Allocated**
Pl	26	26	31	31
Sw	14	14	23	23
PlMx	21	21	-	-
HwPl	-	-	9	9
PlHw	-	-	17	17
SwMx	6	6	-	-
HwSw	-	-	8	8
SwHw	-	-	7	7
Sb	6	6	2	2
Hardwood	2	2	3	3
Total	**75**	**75**	**100**	**100**

HWP has reviewed the 175 candidate plots selected by FGrOW for inclusion in the PGYI program. FGrOW selected 75 fire origin (natural) and 100 regenerating (managed) plots on the Hinton Wood Products FMA. Plots that were not suitable for re-measurement due to damage by industrial development or other factors were substituted with the next available plot within the same yield strata and age class (if possible). These plots have been placed on a re-measurement schedule, with the next measurements to occur in 2017. The regenerating plots will be re-measured on a five year interval while the fire origin plots will be re-measured on a ten year interval. A summary of the re-measurement schedule including the historical measurements completed under the 1998 FMP is shown in Figure 3 with a complete list in Appendix A.

Figure 3 HWP PSP Measurement Schedule Summary



3. Yield Monitoring Program

3.1 Monitoring and Reporting

Monitoring of a growth and yield program is a broad-level check that takes place over an extended period of time. Long term monitoring at the forest level will involve confirmation that the assumptions used in timber supply modeling are appropriate. Data collected from managed stands through permanent and temporary sample plots will provide volume information to confirm the validity of minimum harvest ages, clear cut eligibility and regenerated stand density assumptions. Should the data collected show that the assumptions used are not appropriate, they will be changed in the next Forest Management Plan.

3.1.1 Implementation and Maintenance

Although forest inventories, yield curve development and timber supply analyses are completed only periodically, maintenance of an effective growth and yield program requires ongoing work. Effective implementation and maintenance of this program by HWP will be required over time to ensure that data are collected and that models are updated. Implementation will be guided by developments in the work being completed under the *Vision for Growth and Yield in Alberta*.

Establishment and performance survey data will be collected for HWP cutblocks as current policy requires. The data will be used to the fullest extent possible to monitor and quantify growth and yield of the regenerating forest.

3.1.2 Reporting

A reporting framework is currently in place for HWP to provide information on the company's activities to Alberta Agriculture and Forestry (AAF). Every five years, a Stewardship Report is prepared that assesses the company's performance relative to DFMP targets. It is intended that progress in implementation of the Growth and Yield Program will be included in the existing reports in order to keep relevant information consolidated. When a detailed study or review is completed, results will be submitted separately with an overview included in the Stewardship Report.

As the HWP FMA area is one landbase, it is essential that silvicultural operations conducted by other parties be consistent with the approved HWP Detailed Forest Management Plan, the HWP Timber Harvest Planning and Operating Ground Rules and the Reforestation Standard of Alberta (RSA). Ongoing cooperation of all parties and regular review by HWP and AAF staff will help to ensure that this growth and yield plan provides timely, useful information for management of the Hinton Wood Products Forest Management Agreement area.

3.2 Temporary Sample Plot & Pseudo-Permanent Sample Plot Programs

HWP will initiate a Temporary Sample Plot (TSP) program and a pseudo-Permanent Sample Plot (pPSP) program at different stages of the Forest Management Plan (FMP) implementation to address different information needs. The following plot sampling programs are planned for the next ten years:

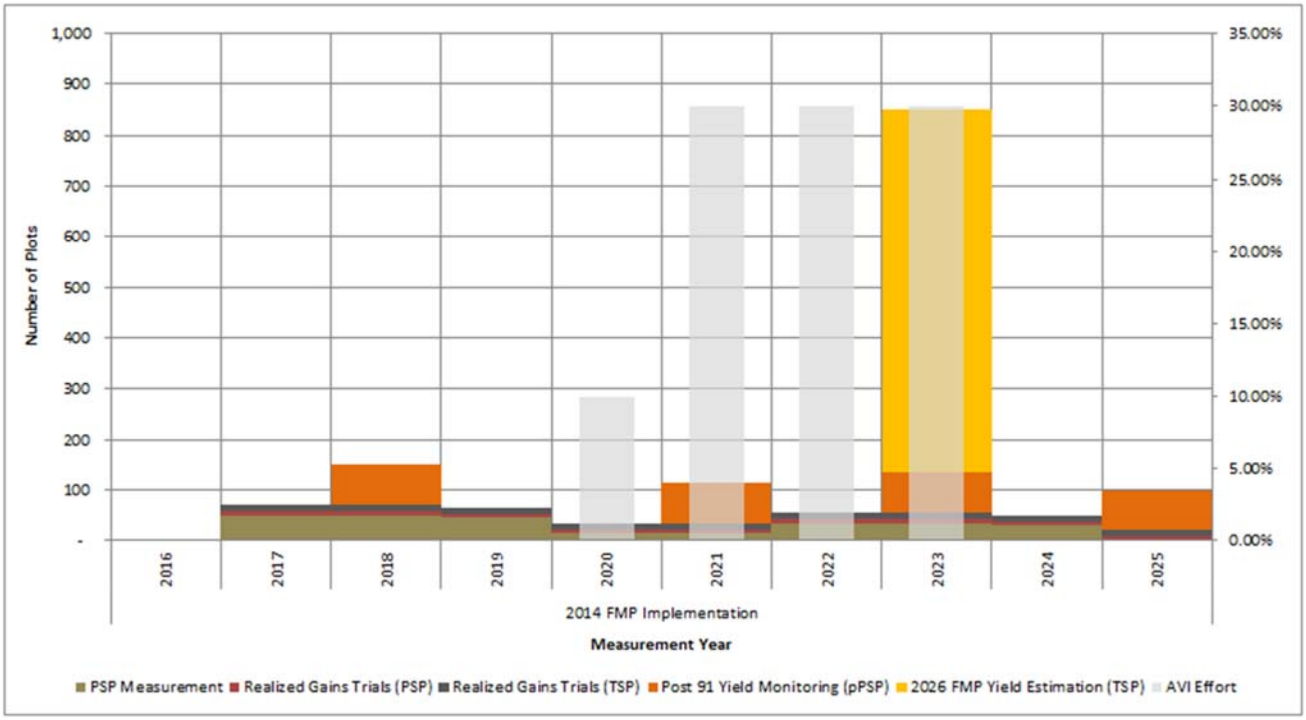
- Realized Gain Trials – improved stock monitoring (mixed TSP/PSP program)
- Monitor regenerating (managed) yields developed from RSA data for the 2014 FMP (pPSP program)
- Collect data for regenerating (managed) yield curve development for the 2026 FMP (mixed TSP/ pPSP/PSP program)
- Collect data for natural (unmanaged) yield curve development for the 2026 FMP (mixed TSP/PSP program)

Table 8 and Figure 4 show the planned plot measurement timing for the various programs associated with the Growth and Yield Plan, as well as the timing of the AVI update for the 2026 FMP.

Table 8 HWP Plot Measurement Schedule 2017-2026

		Managed Stand Plots			Natural Stand Plots	
Program	**Years**	**TSP**	**pPSP**	**PSP**	**TSP**	**PSP**
PGYI	2017-2019			100		
PGYI	2017-2021					75
RGT (Improved Stock Monitoring)	2017-2025	TBD		TBD		
RSA Managed Stand Monitoring	2018-2025		320			
AVI Capture	2020-2023	N/A	N/A	N/A	N/A	N/A
PGYI	2022-2024			100		
Next FMP Yield Estimation	2023	70			645	

Figure 4 HWP TSP Measurement Schedule Summary



3.2.1 Realized Gain Trials

HWP is a participant in the TIA Realized Gain Trials (RGT) program. Beginning in 2017, we will be installing and measuring paired plots in regenerating stands with planted improved stock, as well as a control planted with wild stock. A portion of the paired plots will be sampled with TSPs. This program is described further in section 3.3 below.

3.2.2 Monitoring regenerating (managed) yields

HWP will need to validate the yield assumptions for regenerating cut blocks that have been surveyed under the Reforestation Standard of Alberta (RSA). The yields for these stands in this FMP were estimated using data from RSA surveys completed at performance age, in areas surveyed between 2009 and 2012.

HWP plans to sample the regenerating (managed) stands to gather data in addition to the available RSA survey data for developing yield curves for the next FMP.

Developing yield relationships for managed stands will involve the following steps:

- Collection of psuedo-PSP data from the active landbase within FMU E14
- Compilation of the data for use in GYPSY
- Compilation of the data to be used in calculation of age adjustment factors
- Yield projection

Data Collection

HWP plans to establish psuedo-PSPs (pPSPs) beginning in 2018 to collect information for use in validation of the managed stand yield curves. The managed stand yield curves used in the 2014 HWP Forest Management Plan were based on RSA performance surveys completed between 2009 and 2012 (4 years of surveys). These stands will be between 20 and 23 years old at the time of the first measurement in 2018. They will be re-measured on a five year frequency until they reach an age where they no longer need to be monitored (assumed to be approximately 35 years in this plan). Older plots will need to be retired to allow for younger managed stands to be added periodically to the measurement schedule. The next set of manged stands with completed RSA performance surveys between 2013 and 2017 (5 years of surveys) will have psuedo-PSPs established in 2021 and will also be re-measured on a five year frequency. The full measurement plan for this FMP is summarized in Table 12 below and described in detail in Appendix C – Pseudo-Permanent Sample Plot Measurement Schedule.

The population to be sampled will consist of the blocks that had RSA performance surveys completed over a range of years (i.e. 2009-2012) for each strata sampled, and are in the active landbase for the 2014 HWP Forest Management Plan. These areas will be stratified by RSA Base 10 Yield Strata, Natural Sub-region group (UF/SA, LF) and RSA performance survey density Class (LM, H, D). Plot locations will be randomly chosen from a 500m spatial point grid overlaid across the surveyed block area that makes up the sampling population within the active landbase. Trees will be cabled and/or tagged to ensure that they can be located at the next measurement. As the mixed wood stands do no contribute significant area in the 2009-2012 RSA performance survey population that the managed stand yield curves were based on (shown in Table 9 below), the majority of plots will be deployed in the white spruce (Sw) and lodgepole pine (Pl) stratas to strengthen the data available for use in monitoring these managed yield curves. RSA performance survey data available between 2013 and 2016 shows a similar proportion of area within the yield strata groups (shown in Table 10 below). The combined strata areas for the 2009-2016 RSA performance survey population are shown in Table 11 below. The area summary by yield strata for each timber year within the post 1991 block population up to the 2011 timber year is also shown in Table 13 below for reference.

Some of the strata do not have significant area within the active landbase and therefore have smaller sample sizes. The following strata will be grouped as a result:

- Hw/Pl & Pl/Hw
- HwSw, SwHw & SbHw

Black spruce will not be sampled because a natural yield curve (based on a reduction of the Sw natural yield) was used for black spruce in the 2014 FMP Timber Supply Analysis.

These psuedo-PSPs will use a circular 200m^2 main tree plot, 50m^2 sapling plot and 10m^2 regeneration plot design. Tree measurements will follow the Provincial Growth and Yield Initiative (PGYI) guidelines for PSPs. Tagging limits for these plots will be as follows:

- Regeneration plot: trees must be ≥ 0.3m height and < 1.3m height
- Sapling plot: trees must be ≥ 1.3m height and ≥ 5.0cm DBH
- Tree plot: trees must be ≥ 5.1cm DBH

A manual for this sampling program will be developed and submitted to Alberta Agriculture and Forestry for approval prior to commencing these plot measurements (expected to begin in early 2018).

Table 9 RSA Performance Survey Area Population (2009-2012 Surveys) and Plot Allocation Summary

RSA Survey Area Population (2009-2012 Performance Surveys)

	Active Land Base			Plot Measurements 2016-2025		
Yield Class Grouping	**Area (Hectares)**	**% of Area**	**Annual Average (4 Years)**	**# of Plots Per Measurement**	**Total # of Plots**	**% of Total**
HwSw/SwHw/SbHw	1,004.78	3.5%	251.20	5	20	6.3%
HwPl/PlHw	575.04	2.0%	143.76	5	20	6.3%
Sw	5,444.10	19.2%	1,361.03	25	100	31.3%
Pl	21,330.43	75.2%	5,332.61	45	180	56.3%
Total	28,354.35	100.0%	7,088.59	80	320	100.0%

Table 10 RSA Performance Survey Area Population (2013-2016 Surveys)

RSA Survey Area Population (2013-2016 Performance Surveys)

	Active Land Base		
Yield Class Grouping	**Area (Hectares)**	**% of Area**	**Annual Average (4 Years)**
HwSw/SwHw/SbHw	825.33	2.9%	206.33
HwPl/PlHw	621.11	2.2%	155.28
Sw	4,791.46	16.7%	1,197.87
Pl	22,433.85	78.2%	5,608.46
Total	28,671.75	100.0%	7,167.94

Table 11 RSA Performance Survey Area Population (2009-2016 Surveys)

RSA Survey Area Population (2009-2016 Performance Surveys)

	Active Land Base		
Yield Class Grouping	**Area (Hectares)**	**% of Area**	**Annual Average (8 Years)**
HwSw/SwHw/SbHw	1,830.11	3.2%	228.76
HwPl/PlHw	1,196.15	2.1%	149.52
Sw	10,235.56	17.9%	1,279.45
Pl	43,764.28	76.7%	5,470.54
Total	57,026.10	100.0%	7,128.26

Table 12 Managed Stand Yield Monitoring Plot Measurement Summary

	# of Plots by Measurement Year				
Yield Class Grouping	**2018**	**2021**	**2023**	**2025**	**Strata Totals**
HwSw/SwHw/SbHw	5	5	5	5	20
HwPl/PlHw	5	5	5	5	20
Sw	25	25	25	25	100
Pl	45	45	45	45	180
Totals	80	80	80	80	320

Data Compilation

The plot data will be compiled to provide input to GYPSY as "seed" values for each species group (Pl/Lt, Sw/Se/Fa/Fb, and Aw/Pb/Bw). The compiled values for GYPSY input include:

- Top height (measured)
- DBH age of Top height trees
- Total age (predicted)
- Site index (predicted)
- Total stems (measured)
- Basal area (measured)
- Stand age (predicted)

Age Adjustment Factors

A stand age value is required for the GYPSY projections. Up to four ages are collected in the sampling process. The maximum of the pine, white spruce, black spruce and deciduous calculated total age is used to set the stand age.

The measured age used in the GYPSY projection can differ from the inventory (AVI) age. To account for this, an adjustment value for each strata grouping will be calculated. The difference between the stand age and the calculated AVI age will be determined for each plot. These will be averaged by yield class group to provide a yield curve adjustment to ensure the stratum yield projections are applicable to the inventory.

Yield Projections

A GYPSY yield projection will be completed for each plot. The sample plots will be allocated to ensure an even distribution across natural sub-regions, which may result in a bias. To account for this, an area weighted average yield will be calculated for each stratum. The weighting for each yield class/natural sub-region combination will be based on its contribution to the active landbase.

Table 13 Areas by Yield Strata for HWP Post 1991 blocks

Yield Strata	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Sum
1 - AW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 - HW/PL	62.77	-	24.53	30.51	13.25	20.78	-	20.07	74.33	66.96	55.78	72.75	123.92	129.89	52.68	55.58	12.68	23.68	95.78	89.83	93.75	1,119.54
3 - HW/SW	-	3.31	69.15	51.59	171.32	2.67	29.41	41.98	93.23	42.47	241.11	131.45	168.98	151.05	148.79	15.45	14.39	60.85	2.82	8.39	18.99	1,467.39
4 - SW/HW	37.44	90.32	21.04	197.54	322.27	170.75	79.33	44.22	38.78	146.84	711.92	198.17	485.65	145.90	146.06	29.74	94.28	-	21.91	22.00	25.44	3,029.62
5 - PL/HW	23.78	71.11	17.52	63.06	139.65	98.55	82.73	42.22	187.20	334.46	226.40	253.35	265.52	284.69	126.40	68.41	14.87	49.22	65.74	132.28	300.66	2,847.83
6 - SB/HW	-	-	-	-	5.61	5.18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10.79
7 - SW	619.97	780.50	1,497.99	1,756.21	816.70	1,132.34	823.39	1,508.91	1,204.00	1,403.30	876.30	1,068.39	1,072.09	989.41	949.56	552.10	595.77	104.41	81.53	133.98	45.01	18,011.88
8 - PL	3,271.55	3,943.34	3,570.83	4,820.20	3,078.67	4,956.30	3,757.65	4,142.19	5,605.85	4,160.02	5,479.77	5,302.88	5,744.42	4,912.30	5,533.86	3,190.83	2,329.46	2,079.54	2,303.00	2,769.91	3,730.35	84,682.91
9 - SB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sum	4,015.51	4,888.57	5,201.07	6,919.11	4,547.47	6,386.57	4,772.52	5,799.59	7,203.41	6,154.05	7,591.28	7,026.98	7,860.58	6,613.25	6,957.36	3,912.11	3,061.44	2,317.69	2,570.80	3,156.40	4,214.21	111,169.97

3.2.3 Natural and regenerating yield relationships for yield curve development for the 2026 FMP

HWP will also need to collect information for the purpose of developing yield curves for the next FMP.

A new AVI will be developed beginning with aerial photography acquisition in 2020. The new AVI delineation and attritribute capture is expected to take up to three years and will be completed between 2021 and 2023. HWP will complete a new landbase dataset in 2023 following the completion of the AVI.

TSPs will be established in 2023 to gather the information needed for yield estimation for the 2026 FMP. TSPs will be allocated to strata based on the new landbase to achieve the desired number of plots are in each strata as defined in the new AVI. Other data already available by 2023 will also be used for yield estimation, including PGYI PSP measurements for managed and natural stands, RSA performance survey data, and the psuedo-PSP measurements collected for monitoring managed stands.

All TSPs will be designed and measured following the protocol described in the Hinton Wood Products Temporary Sample Plot Program manual which is included in Appendix D – Hinton Wood Products Temporary Sample Plot Program Manual. The data collection and yield projections will be handled using the same process as described in Section 3.2.2 above with the exception of plot allocation and yield strata grouping. HWP proposes the following plot allocations (shown in Table 14 and Table 15 below) for this sampling program.

HWP plans to use PGYI managed PSPs to substitute for 100 of the planned 410 TSPs for the regenerating (managed) stand yield estimation (shown in Table 14 below). HWP plans to have completed measurements on 240 pseudo-PSPs by 2023 for the purpose of monitoring yield estimates for managed stands and these plots will also be used as substitute plots. The full measurement plan for the pseudo-PSPs is summarized in Table 12 above and described in detail in Appendix C – Pseudo-Permanent Sample Plot Measurement Schedule.

Table 14 2026 FMP Yield Curve Development Projected TSP Plot Allocation (Managed Stands)

Active Land Base			Plots	
Yield Class		**Yield Class Grouping**	**Plots**	**% total**
1	Aw	Use Natural Deciduous	-	0.0%
2	HwPl	2,5	45	11.0%
3	HwSw	3,4,6	40	9.8%
4	SwHw	3,4,6	40	9.8%
5	PlHw	2,5	45	11.0%
6	SbHw	3,4,6	10	2.4%
7	Sw	7	90	22.0%
8	Pl	8	140	34.1%
9	Sb	Use Natural Sw with reduction	-	0.0%
	Total		410	100.0%

HWP also plans to use PGYI unmanaged PSPs to substitute for 75 of the planned 720 TSPs (shown in Table 15 below) for the natural (unmanaged) yield estimation.

Table 15 2026 FMP Yield Curve Development Projected TSP Plot Allocation (Unmanaged Stands)

Active Land Base			Plots	
Yield Class		**Yield Class Grouping**	**Plots**	**% total**
1	Aw	1	90	12.5%
2	HwPl	2	90	12.5%
3	HwSw	3	90	12.5%
4	SwHw	4,6	45	6.3%
5	PlHw	5	90	12.5%
6	SbHw	4,6	45	6.3%
7	Sw	7	90	12.5%
8	Pl	8	180	25.0%
9	Sb	-	-	0.0%
	Total		720	100.0%

Final yield strata grouping and plot allocation within each strata will be determined after the new AVI is available and the new landbase is completed.

3.3 Monitoring Growth of Improved Stock

Hinton Wood Products intends to incorporate improved stock gain assumptions in the next Forest Management Plan. To support these gain assumptions, a robust sampling program will be required.

Hinton Wood Products is a project supporter and participant in the FRIAA project "Establishment of Realized Gain Trials - Conifer". This project is part of FGrOW's Tree Improvement Alberta (TIA) program.

To that effect we are proposing to select 10 sites in 2016 for establishment in 2017. There will be a minimum of 6 paired TSPs and 4 paired PSPs established as per the project protocol. Operational deployment of improved material started in 2009 on the Hinton FMA. We anticipate that the RSA "Tree Improvement Specific Strata" openings will be eligible for performance survey beginning in 2020-2022.

We will be monitoring performance of the regenerated stands by strata and comparing their projections against assumptions made to Tree Improvement regenerated yield curves as RSA surveys become available. These surveys will be based on the Reforestation Standard of Alberta Section 8.4.3.3.1 Enhanced Forest Management RSA strata assignment definition curve assignment of:

- Minimum 2 ha polygon size
- At least 50% was bare ground planted
- At least 70% of planted seedlings were planted with improved stock.

HWP recognizes that the data provided by the current scope of the TIA Realized Gain Trials (RGT) program will not be sufficient to validate the gains projected for improved stock. HWP commits to working with Alberta Agriculture and Forestry to develop reasonable targets for monitoring the growth of Improved Stock on the Hinton FMA.

4. References

Alberta Environmental Protection. 1991. *Alberta Vegetation Inventory Standards Manual - Version 2.1.* Alberta Environmental Protection, Resource Data Division, Data Acquisition Branch. Edmonton, Alberta.

Alberta Agriculture and Forestry. 2016. *Reforestation Standard of Alberta.* Alberta Agriculture and Forestry, Forestry Division, Forest Management Branch. Edmonton, Alberta.

Provincial Growth and Yield Initiative. 2015. Minimum Standards and Suggested Protocol and Priorities for Establishing and Measuring Permanent Sample Plots in Alberta. Technical Report Pub No. T/605. Forest Management Branch, Alberta Agriculture and Forestry, Edmonton, AB.

Hinton Wood Products. 2014a. *Development of the Landbase for the 2014 DFMP*. Prepared September 30, 2014 in support of the Detailed Forest Management Plan for Hinton Wood Products, a division of West Fraser Mills Ltd. Hinton, Alberta.

Hinton Wood Products. 2014b. *Yield Curves for the 2014 DFMP*. Prepared April 9, 2014 in support of the Detailed Forest Management Plan for Hinton Wood Products, a division of West Fraser Mills Ltd. Hinton, Alberta.

Appendix A – Permanent Sample Plot Re-measurement Schedule

Plotid	Measurement Year	Measurement Type	Plot Type	Last Measurement Date
1010313	2017	Re-measurement	Regenerating	27/01/2003
1010341	2017	Re-measurement	Regenerating	11/03/2003
1010342	2017	Re-measurement	Regenerating	11/03/2003
1010435	2017	Re-measurement	Regenerating	30/01/2003
1010672	2017	Re-measurement	Regenerating	11/03/2003
1010738	2017	Re-measurement	Regenerating	13/03/2003
1010797	2017	Re-measurement	Regenerating	27/03/2008
1010799	2017	Re-measurement	Regenerating	11/02/2002
1021002	2017	Re-measurement	Fire Origin	01/02/1991
1021005	2017	Re-measurement	Fire Origin	01/02/1991
1021013	2017	Re-measurement	Fire Origin	01/04/1991
1067008	2017	Re-measurement	Regenerating	01/01/1993
1067009	2017	Re-measurement	Regenerating	01/01/1993
2010131	2017	Re-measurement	Fire Origin	21/09/2004
2010134	2017	Re-measurement	Fire Origin	01/01/1989
2010209	2017	Re-measurement	Regenerating	08/03/2001
2010219	2017	Re-measurement	Regenerating	15/03/2003
2010220	2017	Re-measurement	Regenerating	15/03/2003
2010242	2017	Re-measurement	Fire Origin	01/03/1989
2010252	2017	Re-measurement	Fire Origin	01/02/1989
2010347	2017	Re-measurement	Regenerating	04/02/2006
2010350	2017	Re-measurement	Regenerating	06/03/2003
2010390	2017	Re-measurement	Regenerating	26/03/2003
2010426	2017	Re-measurement	Fire Origin	01/01/1989
2010458	2017	Re-measurement	Regenerating	10/03/2003
2010471	2017	Re-measurement	Regenerating	04/04/2003
2010472	2017	Re-measurement	Regenerating	05/04/2003
2010473	2017	Re-measurement	Regenerating	04/04/2003
2010475	2017	Re-measurement	Regenerating	04/02/2006
2010478	2017	Re-measurement	Regenerating	19/04/2007
2010654	2017	Re-measurement	Regenerating	20/04/2003
2050008	2017	Re-measurement	Fire Origin	01/08/1990
3010053	2017	Re-measurement	Fire Origin	01/09/1988
3010147	2017	Re-measurement	Regenerating	20/02/2002
3010554	2017	Re-measurement	Regenerating	05/02/2002
3021031	2017	Re-measurement	Fire Origin	01/08/1991
3030029	2017	Re-measurement	Fire Origin	01/01/1991
3030030	2017	Re-measurement	Fire Origin	01/01/1989
4010173	2017	Re-measurement	Regenerating	16/03/2003
4010189	2017	Re-measurement	Regenerating	01/04/2003
4010288	2017	Re-measurement	Regenerating	23/03/2003
4010310	2017	Re-measurement	Regenerating	02/12/2003
4010311	2017	Re-measurement	Regenerating	03/12/2003
4010339	2017	Re-measurement	Regenerating	11/02/2002
4010451	2017	Re-measurement	Regenerating	12/03/2001
4010454	2017	Re-measurement	Regenerating	11/04/2008
4010460	2017	Re-measurement	Regenerating	16/03/2003
4010924	2017	Re-measurement	Regenerating	25/02/2003
5021021	2017	Re-measurement	Fire Origin	01/01/1991
5021028	2017	Re-measurement	Fire Origin	01/04/1991
1010437	2018	Re-measurement	Regenerating	28/02/2006
1010443	2018	Re-measurement	Fire Origin	01/12/1994
1010444	2018	Re-measurement	Fire Origin	01/01/1995
1010532	2018	Re-measurement	Regenerating	12/12/2005
1010536	2018	Re-measurement	Regenerating	24/11/2005
1010614	2018	Re-measurement	Regenerating	24/02/2006
1010633	2018	Re-measurement	Fire Origin	01/02/1995
1010689	2018	Re-measurement	Regenerating	13/03/2006
1010740	2018	Re-measurement	Regenerating	08/02/2006
1010741	2018	Re-measurement	Regenerating	14/02/2006
1010809	2018	Re-measurement	Regenerating	09/01/2006
1010955	2018	Re-measurement	Regenerating	17/01/2006
1010985	2018	Re-measurement	Fire Origin	01/01/1995
2010068	2018	Re-measurement	Regenerating	29/11/2005
2010093	2018	Re-measurement	Regenerating	06/01/2006

Plotid	Measurement Year	Measurement Type	Plot Type	Last Measurement Date
2010267	2018	Re-measurement	Regenerating	29/03/2007
2010273	2018	Re-measurement	Regenerating	07/02/2006
2010276	2018	Re-measurement	Regenerating	06/02/2006
2010277	2018	Re-measurement	Regenerating	06/02/2006
2010346	2018	Re-measurement	Regenerating	01/02/2006
2010362	2018	Re-measurement	Regenerating	04/02/2006
2010566	2018	Re-measurement	Fire Origin	01/03/1996
3010374	2018	Re-measurement	Regenerating	09/12/2005
3010485	2018	Re-measurement	Regenerating	07/12/2005
4010126	2018	Re-measurement	Regenerating	11/01/2006
4010130	2018	Re-measurement	Regenerating	01/12/2005
4010168	2018	Re-measurement	Regenerating	18/01/2006
4010225	2018	Re-measurement	Regenerating	21/01/2006
4010273	2018	Re-measurement	Fire Origin	01/01/1991
4010325	2018	Re-measurement	Regenerating	12/01/2006
4010377	2018	Re-measurement	Regenerating	20/01/2006
4010383	2018	Re-measurement	Regenerating	17/01/2006
4010384	2018	Re-measurement	Regenerating	17/01/2006
4010437	2018	Re-measurement	Regenerating	23/01/2006
4010521	2018	Re-measurement	Fire Origin	01/12/1993
4010560	2018	Re-measurement	Fire Origin	04/04/2007
4010562	2018	Re-measurement	Fire Origin	30/11/1993
4010570	2018	Re-measurement	Fire Origin	24/01/2007
4010757	2018	Re-measurement	Fire Origin	01/02/1995
4010796	2018	Re-measurement	Fire Origin	24/11/1993
4010802	2018	Re-measurement	Fire Origin	01/03/1995
4010953	2018	Re-measurement	Regenerating	24/01/2007
4040040	2018	Re-measurement	Fire Origin	01/09/1992
4040055	2018	Re-measurement	Fire Origin	01/09/1992
5010249	2018	Re-measurement	Regenerating	25/01/2006
5010269	2018	Re-measurement	Regenerating	17/01/2003
5010358	2018	Re-measurement	Regenerating	24/01/2006
5010486	2018	Re-measurement	Regenerating	09/02/2006
5010497	2018	Re-measurement	Regenerating	16/02/2006
5010498	2018	Re-measurement	Regenerating	14/02/2006
1010322	2019	Re-measurement	Regenerating	25/01/2007
1010697	2019	Re-measurement	Fire Origin	01/03/1995
1010761	2019	Re-measurement	Fire Origin	01/03/1995
1010857	2019	Re-measurement	Regenerating	14/04/2008
1010859	2019	Re-measurement	Regenerating	10/04/2008
1010861	2019	Re-measurement	Regenerating	21/02/2006
1010862	2019	Re-measurement	Regenerating	20/02/2006
1010921	2019	Re-measurement	Regenerating	22/02/2006
2010136	2019	Re-measurement	Fire Origin	01/02/1999
2010177	2019	Re-measurement	Fire Origin	15/10/2000
2010205	2019	Re-measurement	Fire Origin	15/09/2000
2010206	2019	Re-measurement	Fire Origin	03/10/2000
2010208	2019	Re-measurement	Fire Origin	15/09/2000
2010290	2019	Re-measurement	Fire Origin	01/10/1999
2010354	2019	Re-measurement	Regenerating	04/03/2008
2010366	2019	Re-measurement	Fire Origin	01/01/1998
2010391	2019	Re-measurement	Regenerating	10/04/2008
2010397	2019	Re-measurement	Regenerating	31/01/2006
2010399	2019	Re-measurement	Regenerating	04/04/2008
2010403	2019	Re-measurement	Regenerating	02/02/2006
2010405	2019	Re-measurement	Regenerating	03/02/2006
2010455	2019	Re-measurement	Fire Origin	21/02/2001
2010467	2019	Re-measurement	Regenerating	23/04/2008
3010016	2019	Re-measurement	Fire Origin	01/02/1996
3010111	2019	Re-measurement	Fire Origin	01/12/1998
3010139	2019	Re-measurement	Fire Origin	01/09/1999
3010397	2019	Re-measurement	Regenerating	12/03/2008
3010409	2019	Re-measurement	Regenerating	22/01/2008
3010411	2019	Re-measurement	Regenerating	21/01/2008
3010510	2019	Re-measurement	Regenerating	27/02/2007

Plotid	Measurement Year	Measurement Type	Plot Type	Last Measurement Date
3010531	2019	Re-measurement	Fire Origin	01/02/1996
4010201	2019	Re-measurement	Regenerating	25/01/2008
4010244	2019	Re-measurement	Fire Origin	01/01/1996
4010259	2019	Re-measurement	Regenerating	31/01/2008
4010284	2019	Re-measurement	Regenerating	20/03/2008
4010500	2019	Re-measurement	Regenerating	24/03/2008
4010501	2019	Re-measurement	Regenerating	25/03/2008
4010503	2019	Re-measurement	Regenerating	24/03/2008
4010507	2019	Re-measurement	Regenerating	06/03/2008
4010511	2019	Re-measurement	Regenerating	19/01/2007
4010678	2019	Re-measurement	Regenerating	12/03/2008
5010366	2019	Re-measurement	Regenerating	14/02/2008
5010473	2019	Re-measurement	Regenerating	26/03/2008
5010480	2019	Re-measurement	Regenerating	06/02/2008
5010482	2019	Re-measurement	Regenerating	11/02/2008
4010338	2020	Re-measurement	Fire Origin	01/02/1999
4010472	2020	Re-measurement	Fire Origin	29/03/2001
4010474	2020	Re-measurement	Fire Origin	26/03/2001
4010476	2020	Re-measurement	Fire Origin	23/02/2000
4010519	2020	Re-measurement	Fire Origin	13/04/2001
4010526	2020	Re-measurement	Fire Origin	21/02/2001
4010685	2020	Re-measurement	Fire Origin	30/03/2001
5010052	2020	Re-measurement	Fire Origin	01/01/1999
5010063	2020	Re-measurement	Fire Origin	13/11/2001
5010162	2020	Re-measurement	Fire Origin	04/02/2000
5010163	2020	Re-measurement	Fire Origin	01/11/1998
5010345	2020	Re-measurement	Fire Origin	01/02/1999
5010380	2020	Re-measurement	Fire Origin	06/03/2001
5010381	2020	Re-measurement	Fire Origin	14/03/2001
5010589	2020	Re-measurement	Fire Origin	15/04/2001
1010011	2021	Re-measurement	Fire Origin	26/02/2004
1010130	2021	Re-measurement	Fire Origin	11/03/2007
1010734	2021	Re-measurement	Fire Origin	16/03/2004
1010735	2021	Re-measurement	Fire Origin	07/03/2007
2010245	2021	Re-measurement	Fire Origin	06/04/2004
2010611	2021	Re-measurement	Fire Origin	06/10/2004
3010003	2021	Re-measurement	Fire Origin	02/04/2004
3010493	2021	Re-measurement	Fire Origin	12/03/2003
4010112	2021	Re-measurement	Fire Origin	16/04/2007
4010396	2021	Re-measurement	Fire Origin	13/02/2007
5010023	2021	Re-measurement	Fire Origin	30/01/2002
5010024	2021	Re-measurement	Fire Origin	31/01/2002
5010096	2021	Re-measurement	Fire Origin	26/11/2002
5010245	2021	Re-measurement	Fire Origin	09/02/2007
5010459	2021	Re-measurement	Fire Origin	01/11/2002
1010313	2022	Re-measurement	Regenerating	2017
1010341	2022	Re-measurement	Regenerating	2017
1010342	2022	Re-measurement	Regenerating	2017
1010435	2022	Re-measurement	Regenerating	2017
1010672	2022	Re-measurement	Regenerating	2017
1010738	2022	Re-measurement	Regenerating	2017
1010797	2022	Re-measurement	Regenerating	2017
1010799	2022	Re-measurement	Regenerating	2017
1067008	2022	Re-measurement	Regenerating	2017
1067009	2022	Re-measurement	Regenerating	2017
2010209	2022	Re-measurement	Regenerating	2017
2010219	2022	Re-measurement	Regenerating	2017
2010220	2022	Re-measurement	Regenerating	2017
2010347	2022	Re-measurement	Regenerating	2017
2010350	2022	Re-measurement	Regenerating	2017
2010390	2022	Re-measurement	Regenerating	2017
2010458	2022	Re-measurement	Regenerating	2017
2010471	2022	Re-measurement	Regenerating	2017
2010472	2022	Re-measurement	Regenerating	2017
2010473	2022	Re-measurement	Regenerating	2017

Plotid	Measurement Year	Measurement Type	Plot Type	Last Measurement Date
2010475	2022	Re-measurement	Regenerating	2017
2010478	2022	Re-measurement	Regenerating	2017
2010654	2022	Re-measurement	Regenerating	2017
3010147	2022	Re-measurement	Regenerating	2017
3010554	2022	Re-measurement	Regenerating	2017
4010173	2022	Re-measurement	Regenerating	2017
4010189	2022	Re-measurement	Regenerating	2017
4010288	2022	Re-measurement	Regenerating	2017
4010310	2022	Re-measurement	Regenerating	2017
4010311	2022	Re-measurement	Regenerating	2017
4010339	2022	Re-measurement	Regenerating	2017
4010451	2022	Re-measurement	Regenerating	2017
4010454	2022	Re-measurement	Regenerating	2017
4010460	2022	Re-measurement	Regenerating	2017
4010924	2022	Re-measurement	Regenerating	2017
1010437	2023	Re-measurement	Regenerating	2018
1010532	2023	Re-measurement	Regenerating	2018
1010536	2023	Re-measurement	Regenerating	2018
1010614	2023	Re-measurement	Regenerating	2018
1010689	2023	Re-measurement	Regenerating	2018
1010740	2023	Re-measurement	Regenerating	2018
1010741	2023	Re-measurement	Regenerating	2018
1010809	2023	Re-measurement	Regenerating	2018
1010955	2023	Re-measurement	Regenerating	2018
2010068	2023	Re-measurement	Regenerating	2018
2010093	2023	Re-measurement	Regenerating	2018
2010267	2023	Re-measurement	Regenerating	2018
2010273	2023	Re-measurement	Regenerating	2018
2010276	2023	Re-measurement	Regenerating	2018
2010277	2023	Re-measurement	Regenerating	2018
2010346	2023	Re-measurement	Regenerating	2018
2010362	2023	Re-measurement	Regenerating	2018
3010374	2023	Re-measurement	Regenerating	2018
3010485	2023	Re-measurement	Regenerating	2018
4010126	2023	Re-measurement	Regenerating	2018
4010130	2023	Re-measurement	Regenerating	2018
4010168	2023	Re-measurement	Regenerating	2018
4010225	2023	Re-measurement	Regenerating	2018
4010325	2023	Re-measurement	Regenerating	2018
4010377	2023	Re-measurement	Regenerating	2018
4010383	2023	Re-measurement	Regenerating	2018
4010384	2023	Re-measurement	Regenerating	2018
4010437	2023	Re-measurement	Regenerating	2018
4010953	2023	Re-measurement	Regenerating	2018
5010249	2023	Re-measurement	Regenerating	2018
5010269	2023	Re-measurement	Regenerating	2018
5010358	2023	Re-measurement	Regenerating	2018
5010486	2023	Re-measurement	Regenerating	2018
5010497	2023	Re-measurement	Regenerating	2018
5010498	2023	Re-measurement	Regenerating	2018
1010322	2024	Re-measurement	Regenerating	2019
1010857	2024	Re-measurement	Regenerating	2019
1010859	2024	Re-measurement	Regenerating	2019
1010861	2024	Re-measurement	Regenerating	2019
1010862	2024	Re-measurement	Regenerating	2019
1010921	2024	Re-measurement	Regenerating	2019
2010354	2024	Re-measurement	Regenerating	2019
2010391	2024	Re-measurement	Regenerating	2019
2010397	2024	Re-measurement	Regenerating	2019
2010399	2024	Re-measurement	Regenerating	2019
2010403	2024	Re-measurement	Regenerating	2019
2010405	2024	Re-measurement	Regenerating	2019
2010467	2024	Re-measurement	Regenerating	2019
3010397	2024	Re-measurement	Regenerating	2019
3010409	2024	Re-measurement	Regenerating	2019

Plotid	Measurement Year	Measurement Type	Plot Type	Last Measurement Date
3010411	2024	Re-measurement	Regenerating	2019
3010510	2024	Re-measurement	Regenerating	2019
4010201	2024	Re-measurement	Regenerating	2019
4010259	2024	Re-measurement	Regenerating	2019
4010284	2024	Re-measurement	Regenerating	2019
4010500	2024	Re-measurement	Regenerating	2019
4010501	2024	Re-measurement	Regenerating	2019
4010503	2024	Re-measurement	Regenerating	2019
4010507	2024	Re-measurement	Regenerating	2019
4010511	2024	Re-measurement	Regenerating	2019
4010678	2024	Re-measurement	Regenerating	2019
5010366	2024	Re-measurement	Regenerating	2019
5010473	2024	Re-measurement	Regenerating	2019
5010480	2024	Re-measurement	Regenerating	2019
5010482	2024	Re-measurement	Regenerating	2019
1010313	2027	Re-measurement	Regenerating	2022
1010341	2027	Re-measurement	Regenerating	2022
1010342	2027	Re-measurement	Regenerating	2022
1010435	2027	Re-measurement	Regenerating	2022
1010672	2027	Re-measurement	Regenerating	2022
1010738	2027	Re-measurement	Regenerating	2022
1010797	2027	Re-measurement	Regenerating	2022
1010799	2027	Re-measurement	Regenerating	2022
1021002	2027	Re-measurement	Fire Origin	2017
1021005	2027	Re-measurement	Fire Origin	2017
1021013	2027	Re-measurement	Fire Origin	2017
1067008	2027	Re-measurement	Regenerating	2022
1067009	2027	Re-measurement	Regenerating	2022
2010131	2027	Re-measurement	Fire Origin	2017
2010134	2027	Re-measurement	Fire Origin	2017
2010209	2027	Re-measurement	Regenerating	2022
2010219	2027	Re-measurement	Regenerating	2022
2010220	2027	Re-measurement	Regenerating	2022
2010242	2027	Re-measurement	Fire Origin	2017
2010252	2027	Re-measurement	Fire Origin	2017
2010347	2027	Re-measurement	Regenerating	2022
2010350	2027	Re-measurement	Regenerating	2022
2010390	2027	Re-measurement	Regenerating	2022
2010426	2027	Re-measurement	Fire Origin	2017
2010458	2027	Re-measurement	Regenerating	2022
2010471	2027	Re-measurement	Regenerating	2022
2010472	2027	Re-measurement	Regenerating	2022
2010473	2027	Re-measurement	Regenerating	2022
2010475	2027	Re-measurement	Regenerating	2022
2010478	2027	Re-measurement	Regenerating	2022
2010654	2027	Re-measurement	Regenerating	2022
2050008	2027	Re-measurement	Fire Origin	2017
3010053	2027	Re-measurement	Fire Origin	2017
3010147	2027	Re-measurement	Regenerating	2022
3010554	2027	Re-measurement	Regenerating	2022
3021031	2027	Re-measurement	Fire Origin	2017
3030029	2027	Re-measurement	Fire Origin	2017
3030030	2027	Re-measurement	Fire Origin	2017
4010173	2027	Re-measurement	Regenerating	2022
4010189	2027	Re-measurement	Regenerating	2022
4010288	2027	Re-measurement	Regenerating	2022
4010310	2027	Re-measurement	Regenerating	2022
4010311	2027	Re-measurement	Regenerating	2022
4010339	2027	Re-measurement	Regenerating	2022
4010451	2027	Re-measurement	Regenerating	2022
4010454	2027	Re-measurement	Regenerating	2022
4010460	2027	Re-measurement	Regenerating	2022
4010924	2027	Re-measurement	Regenerating	2022
5021021	2027	Re-measurement	Fire Origin	2017
5021028	2027	Re-measurement	Fire Origin	2017

Plotid	Measurement Year	Measurement Type	Plot Type	Last Measurement Date
1010437	2028	Re-measurement	Regenerating	2023
1010443	2028	Re-measurement	Fire Origin	2018
1010444	2028	Re-measurement	Fire Origin	2018
1010532	2028	Re-measurement	Regenerating	2023
1010536	2028	Re-measurement	Regenerating	2023
1010614	2028	Re-measurement	Regenerating	2023
1010633	2028	Re-measurement	Fire Origin	2018
1010689	2028	Re-measurement	Regenerating	2023
1010740	2028	Re-measurement	Regenerating	2023
1010741	2028	Re-measurement	Regenerating	2023
1010809	2028	Re-measurement	Regenerating	2023
1010955	2028	Re-measurement	Regenerating	2023
1010985	2028	Re-measurement	Fire Origin	2018
2010068	2028	Re-measurement	Regenerating	2023
2010093	2028	Re-measurement	Regenerating	2023
2010267	2028	Re-measurement	Regenerating	2023
2010273	2028	Re-measurement	Regenerating	2023
2010276	2028	Re-measurement	Regenerating	2023
2010277	2028	Re-measurement	Regenerating	2023
2010346	2028	Re-measurement	Regenerating	2023
2010362	2028	Re-measurement	Regenerating	2023
2010566	2028	Re-measurement	Fire Origin	2018
3010374	2028	Re-measurement	Regenerating	2023
3010485	2028	Re-measurement	Regenerating	2023
4010126	2028	Re-measurement	Regenerating	2023
4010130	2028	Re-measurement	Regenerating	2023
4010168	2028	Re-measurement	Regenerating	2023
4010225	2028	Re-measurement	Regenerating	2023
4010273	2028	Re-measurement	Fire Origin	2018
4010325	2028	Re-measurement	Regenerating	2023
4010377	2028	Re-measurement	Regenerating	2023
4010383	2028	Re-measurement	Regenerating	2023
4010384	2028	Re-measurement	Regenerating	2023
4010437	2028	Re-measurement	Regenerating	2023
4010521	2028	Re-measurement	Fire Origin	2018
4010560	2028	Re-measurement	Fire Origin	2018
4010562	2028	Re-measurement	Fire Origin	2018
4010570	2028	Re-measurement	Fire Origin	2018
4010757	2028	Re-measurement	Fire Origin	2018
4010796	2028	Re-measurement	Fire Origin	2018
4010802	2028	Re-measurement	Fire Origin	2018
4010953	2028	Re-measurement	Regenerating	2023
4040040	2028	Re-measurement	Fire Origin	2018
4040055	2028	Re-measurement	Fire Origin	2018
5010249	2028	Re-measurement	Regenerating	2023
5010269	2028	Re-measurement	Regenerating	2023
5010358	2028	Re-measurement	Regenerating	2023
5010486	2028	Re-measurement	Regenerating	2023
5010497	2028	Re-measurement	Regenerating	2023
5010498	2028	Re-measurement	Regenerating	2023
1010322	2029	Re-measurement	Regenerating	2024
1010697	2029	Re-measurement	Fire Origin	2019
1010761	2029	Re-measurement	Fire Origin	2019
1010857	2029	Re-measurement	Regenerating	2024
1010859	2029	Re-measurement	Regenerating	2024
1010861	2029	Re-measurement	Regenerating	2024
1010862	2029	Re-measurement	Regenerating	2024
1010921	2029	Re-measurement	Regenerating	2024
2010136	2029	Re-measurement	Fire Origin	2019
2010177	2029	Re-measurement	Fire Origin	2019
2010205	2029	Re-measurement	Fire Origin	2019
2010206	2029	Re-measurement	Fire Origin	2019
2010208	2029	Re-measurement	Fire Origin	2019
2010290	2029	Re-measurement	Fire Origin	2019
2010354	2029	Re-measurement	Regenerating	2024

Plotid	Measurement Year	Measurement Type	Plot Type	Last Measurement Date
2010366	2029	Re-measurement	Fire Origin	2019
2010391	2029	Re-measurement	Regenerating	2024
2010397	2029	Re-measurement	Regenerating	2024
2010399	2029	Re-measurement	Regenerating	2024
2010403	2029	Re-measurement	Regenerating	2024
2010405	2029	Re-measurement	Regenerating	2024
2010455	2029	Re-measurement	Fire Origin	2019
2010467	2029	Re-measurement	Regenerating	2024
3010016	2029	Re-measurement	Fire Origin	2019
3010111	2029	Re-measurement	Fire Origin	2019
3010139	2029	Re-measurement	Fire Origin	2019
3010397	2029	Re-measurement	Regenerating	2024
3010409	2029	Re-measurement	Regenerating	2024
3010411	2029	Re-measurement	Regenerating	2024
3010510	2029	Re-measurement	Regenerating	2024
3010531	2029	Re-measurement	Fire Origin	2019
4010201	2029	Re-measurement	Regenerating	2024
4010244	2029	Re-measurement	Fire Origin	2019
4010259	2029	Re-measurement	Regenerating	2024
4010284	2029	Re-measurement	Regenerating	2024
4010500	2029	Re-measurement	Regenerating	2024
4010501	2029	Re-measurement	Regenerating	2024
4010503	2029	Re-measurement	Regenerating	2024
4010507	2029	Re-measurement	Regenerating	2024
4010511	2029	Re-measurement	Regenerating	2024
4010678	2029	Re-measurement	Regenerating	2024
5010366	2029	Re-measurement	Regenerating	2024
5010473	2029	Re-measurement	Regenerating	2024
5010480	2029	Re-measurement	Regenerating	2024
5010482	2029	Re-measurement	Regenerating	2024
4010338	2030	Re-measurement	Fire Origin	2020
4010472	2030	Re-measurement	Fire Origin	2020
4010474	2030	Re-measurement	Fire Origin	2020
4010476	2030	Re-measurement	Fire Origin	2020
4010519	2030	Re-measurement	Fire Origin	2020
4010526	2030	Re-measurement	Fire Origin	2020
4010685	2030	Re-measurement	Fire Origin	2020
5010052	2030	Re-measurement	Fire Origin	2020
5010063	2030	Re-measurement	Fire Origin	2020
5010162	2030	Re-measurement	Fire Origin	2020
5010163	2030	Re-measurement	Fire Origin	2020
5010345	2030	Re-measurement	Fire Origin	2020
5010380	2030	Re-measurement	Fire Origin	2020
5010381	2030	Re-measurement	Fire Origin	2020
5010589	2030	Re-measurement	Fire Origin	2020
1010011	2031	Re-measurement	Fire Origin	2021
1010130	2031	Re-measurement	Fire Origin	2021
1010734	2031	Re-measurement	Fire Origin	2021
1010735	2031	Re-measurement	Fire Origin	2021
2010245	2031	Re-measurement	Fire Origin	2021
2010611	2031	Re-measurement	Fire Origin	2021
3010003	2031	Re-measurement	Fire Origin	2021
3010493	2031	Re-measurement	Fire Origin	2021
4010112	2031	Re-measurement	Fire Origin	2021
4010396	2031	Re-measurement	Fire Origin	2021
5010023	2031	Re-measurement	Fire Origin	2021
5010024	2031	Re-measurement	Fire Origin	2021
5010096	2031	Re-measurement	Fire Origin	2021
5010245	2031	Re-measurement	Fire Origin	2021
5010459	2031	Re-measurement	Fire Origin	2021
1010313	2032	Re-measurement	Regenerating	2027
1010341	2032	Re-measurement	Regenerating	2027
1010342	2032	Re-measurement	Regenerating	2027
1010435	2032	Re-measurement	Regenerating	2027
1010672	2032	Re-measurement	Regenerating	2027

Plotid	Measurement Year	Measurement Type	Plot Type	Last Measurement Date
1010738	2032	Re-measurement	Regenerating	2027
1010797	2032	Re-measurement	Regenerating	2027
1010799	2032	Re-measurement	Regenerating	2027
1067008	2032	Re-measurement	Regenerating	2027
1067009	2032	Re-measurement	Regenerating	2027
2010209	2032	Re-measurement	Regenerating	2027
2010219	2032	Re-measurement	Regenerating	2027
2010220	2032	Re-measurement	Regenerating	2027
2010347	2032	Re-measurement	Regenerating	2027
2010350	2032	Re-measurement	Regenerating	2027
2010390	2032	Re-measurement	Regenerating	2027
2010458	2032	Re-measurement	Regenerating	2027
2010471	2032	Re-measurement	Regenerating	2027
2010472	2032	Re-measurement	Regenerating	2027
2010473	2032	Re-measurement	Regenerating	2027
2010475	2032	Re-measurement	Regenerating	2027
2010478	2032	Re-measurement	Regenerating	2027
2010654	2032	Re-measurement	Regenerating	2027
3010147	2032	Re-measurement	Regenerating	2027
3010554	2032	Re-measurement	Regenerating	2027
4010173	2032	Re-measurement	Regenerating	2027
4010189	2032	Re-measurement	Regenerating	2027
4010288	2032	Re-measurement	Regenerating	2027
4010310	2032	Re-measurement	Regenerating	2027
4010311	2032	Re-measurement	Regenerating	2027
4010339	2032	Re-measurement	Regenerating	2027
4010451	2032	Re-measurement	Regenerating	2027
4010454	2032	Re-measurement	Regenerating	2027
4010460	2032	Re-measurement	Regenerating	2027
4010924	2032	Re-measurement	Regenerating	2027
1010437	2033	Re-measurement	Regenerating	2028
1010532	2033	Re-measurement	Regenerating	2028
1010536	2033	Re-measurement	Regenerating	2028
1010614	2033	Re-measurement	Regenerating	2028
1010689	2033	Re-measurement	Regenerating	2028
1010740	2033	Re-measurement	Regenerating	2028
1010741	2033	Re-measurement	Regenerating	2028
1010809	2033	Re-measurement	Regenerating	2028
1010955	2033	Re-measurement	Regenerating	2028
2010068	2033	Re-measurement	Regenerating	2028
2010093	2033	Re-measurement	Regenerating	2028
2010267	2033	Re-measurement	Regenerating	2028
2010273	2033	Re-measurement	Regenerating	2028
2010276	2033	Re-measurement	Regenerating	2028
2010277	2033	Re-measurement	Regenerating	2028
2010346	2033	Re-measurement	Regenerating	2028
2010362	2033	Re-measurement	Regenerating	2028
3010374	2033	Re-measurement	Regenerating	2028
3010485	2033	Re-measurement	Regenerating	2028
4010126	2033	Re-measurement	Regenerating	2028
4010130	2033	Re-measurement	Regenerating	2028
4010168	2033	Re-measurement	Regenerating	2028
4010225	2033	Re-measurement	Regenerating	2028
4010325	2033	Re-measurement	Regenerating	2028
4010377	2033	Re-measurement	Regenerating	2028
4010383	2033	Re-measurement	Regenerating	2028
4010384	2033	Re-measurement	Regenerating	2028
4010437	2033	Re-measurement	Regenerating	2028
4010953	2033	Re-measurement	Regenerating	2028
5010249	2033	Re-measurement	Regenerating	2028
5010269	2033	Re-measurement	Regenerating	2028
5010358	2033	Re-measurement	Regenerating	2028
5010486	2033	Re-measurement	Regenerating	2028
5010497	2033	Re-measurement	Regenerating	2028
5010498	2033	Re-measurement	Regenerating	2028

Plotid	Measurement Year	Measurement Type	Plot Type	Last Measurement Date
1010322	2034	Re-measurement	Regenerating	2029
1010857	2034	Re-measurement	Regenerating	2029
1010859	2034	Re-measurement	Regenerating	2029
1010861	2034	Re-measurement	Regenerating	2029
1010862	2034	Re-measurement	Regenerating	2029
1010921	2034	Re-measurement	Regenerating	2029
2010354	2034	Re-measurement	Regenerating	2029
2010391	2034	Re-measurement	Regenerating	2029
2010397	2034	Re-measurement	Regenerating	2029
2010399	2034	Re-measurement	Regenerating	2029
2010403	2034	Re-measurement	Regenerating	2029
2010405	2034	Re-measurement	Regenerating	2029
2010467	2034	Re-measurement	Regenerating	2029
3010397	2034	Re-measurement	Regenerating	2029
3010409	2034	Re-measurement	Regenerating	2029
3010411	2034	Re-measurement	Regenerating	2029
3010510	2034	Re-measurement	Regenerating	2029
4010201	2034	Re-measurement	Regenerating	2029
4010259	2034	Re-measurement	Regenerating	2029
4010284	2034	Re-measurement	Regenerating	2029
4010500	2034	Re-measurement	Regenerating	2029
4010501	2034	Re-measurement	Regenerating	2029
4010503	2034	Re-measurement	Regenerating	2029
4010507	2034	Re-measurement	Regenerating	2029
4010511	2034	Re-measurement	Regenerating	2029
4010678	2034	Re-measurement	Regenerating	2029
5010366	2034	Re-measurement	Regenerating	2029
5010473	2034	Re-measurement	Regenerating	2029
5010480	2034	Re-measurement	Regenerating	2029
5010482	2034	Re-measurement	Regenerating	2029

Appendix B – Hinton Wood Products PGS Manual

Hinton Wood Products

A division of West Fraser Mills Ltd.

Woodlands Department

Permanent Growth Sample Program Manual

Version 19
April, 2012

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1. Introduction

Hinton Wood Products, A division of West Fraser Mills Ltd. (HWP) manages a Permanent Growth Sample (PGS) program on its Forest Management Agreement Area (FMA) surrounding the town of Hinton, Alberta. There are over 3200 PGS plots, which constitute one of the most comprehensive programs in North America.

1.1 Program Objectives

The overall objective of HWP's PGS program is to forecast the growth and yield of wood fibre on the FMA. This information is used in the determination of the FMA's Annual Allowable Cut (AAC) volume and is the foundation of the scientific approach to forest management used on the FMA.

Other objectives associated with the PGS Program include:

- Determine relationships between individual tree- and stand-level characteristics, site productivity, stand condition and rate of stand decline in fire-origin and post harvest regenerated stands.
- Develop acceptable regeneration performance standards by site and species.
- Enhance the stand inventory program's ability to accurately predict volumes for small wood and individual deciduous species.
- Develop localized volume and product stand estimates.
- Develop pre- and post- harvest relationships between individual tree- and stand-level responses to silviculture and harvest practices.
- Develop site index relationships for individual species by ecological unit.
- Quantify losses and predict the risk of losses associated with insects, diseases, animals and other natural causes in fire-origin and regenerated stands.
- Provide wildlife habitat information and its changes over time, which will support the development of wildlife models and the forecasting of habitat changes through natural stand evolution and management intervention.

1.2 Purpose of Manual

The purpose of this manual is to document the history and field procedures for the establishment, measurement and maintenance of plots in the HWP PGS program.

2. Program Background

Over the history of the PGS program there have been several changes which need to be understood to ensure proper use of the data.

2.1 Continuous Forest Inventory Plots and the Permanent Growth Sampling Program

Between 1956 and 1961, North Western Pulp & Power Ltd. (now Hinton Wood Products) established approximately 3000 inventory plots throughout the Hinton Pulpwood Lease. These square-shaped, one-fifth acre plots were arranged in clusters of four with the cluster centres established every two miles at the intersection of the Alberta Legal Survey grid section lines (in the case of baselines and correction lines, the clusters of four plots were divided to align with the baseline/correction line offset). This systematic inventory sampling program was known as the Continuous Forest Inventory (CFI).

In areas that had been legally surveyed, and therefore marked on the ground, cluster centres were established at the original survey pin. The four plots within the cluster were established at a distance of 100.6 m at azimuths of 45, 135, 225 and 315 degrees from the cluster centre (Figure 1).

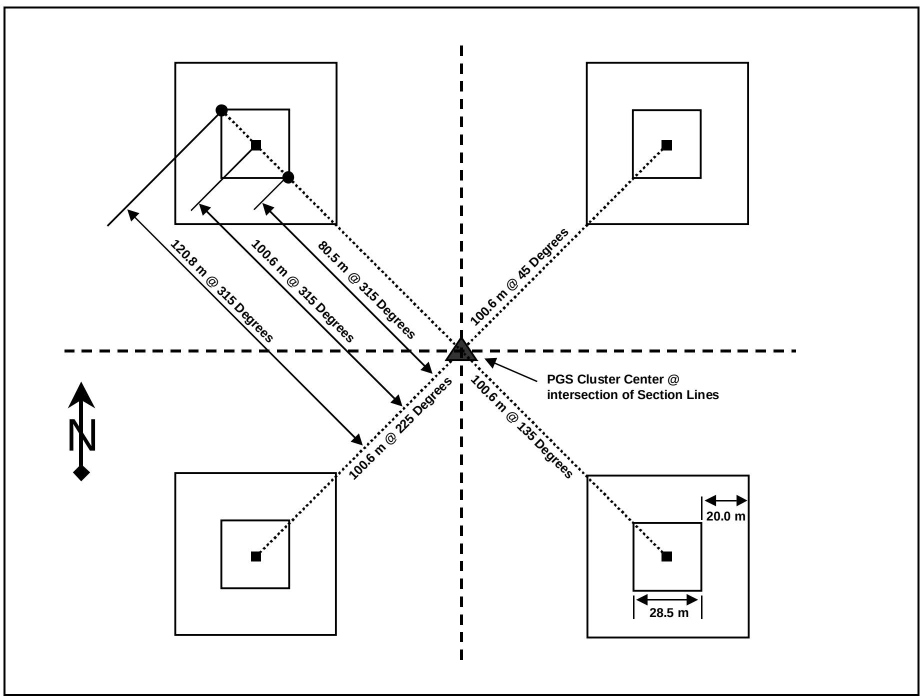


Figure 1. CFI Cluster Layout

In areas that had not been legally surveyed, and therefore not marked on the ground, the plot clusters were pre-positioned using forest cover type maps and aerial photos. Section intersections were first identified on the forest cover maps, and then transferred to aerial photos. Using the aerial photos, permanently identifiable tie-points were identified, which were used as the point of commencement (POC) for locating the cluster centre. Azimuth and distance from the POC to the cluster center were measured from the photograph and used to establish the PGS plots on the ground. At subsequent visits, POC's were relocated when a more convenient tie-point was available (ie. new road, seismic line, etc.).

The original intent of the CFI was simply to inventory the forest resource of the recently allocated Hinton Pulpwood Lease, for which no inventory or mapping had been completed for yet. Soon after the CFI was completed, and the first Forest Management Plan was prepared, it became evident that the real value of the CFI plots was not in creating forest inventories, but rather developing growth and yield tables. In 1970, the CFI program was converted into the Permanent Growth Sample Program, at which time the second measurement of the originally established plots began (re-measurement intervals were originally scheduled for five years, but this was revised to ten years after the first re-measurement).

2.2 Expansion and Focus Plots

In 1988, the FMA was expanded to include additional areas in what is today known as the Athabasca, Berland and Embarras working circles. In 1991, an additional 114 PGS plots were established on a two-mile by two-mile grid.

In addition to the systematically located PGS plots (original CFI and PGS grid), a number of other PGS plots have been established in an effort to fill specific shortcomings of the existing data or to assess specific operational opportunities. Table 1 identifies the current plot installations in the PGS Program.

Table 1. PGS Program Installation Groups.

Plots Set	Original Intent	Plot size Ha (acre)	First Measurement
Original CFI/PGS grid	Inventory – G & Y	0.08 (1/5)	1957/1958
1988 Expansion grid	G & Y	0.04 (1/10)	1990/1991
Robb (Embarras)	Young Pine	0.04 (1/10)	1969/1970
McCardell Creek	Young Pine	0.04 (1/10)	1970
Lynx Creek (Marlboro)	Young Pine	0.04 (1/10)	1980
Canyon Creek (Athabasca)	Mixedwood	0.04 (1/10)	1988
Lambert Creek (McLeod)	Young Aspen	0.04 (1/10)	1996
Caribou Lichen Thinning (Berland)	Caribou & Lichen	0.04 (1/10)	1999

2.3 Procedural Changes

Given the duration of the PGS program on the FMA, there have been several procedural changes over the years. Table 2 does not capture all the changes that have occurred over the many years of the program, but highlights some of the most significant changes, and is more comprehensive for the later years of the program.

Table 2. Procedural Highlights and Significant Changes to the PGS Program.

Year	Procedural Change
1961	• Minimum tagging limit reduced from 11.7 cm (4.6") to 7.6 cm (3.0").
1970	• CFI converted to PGS program. • New establishment plot size reduced from 0.08 ha (0.1 acre) to 0.04 ha (0.2 acre). • Minimum tagging limit reduced from 7.6 cm (3.0") to 5.08 cm (2.0"). • Incorporation of variable sized subplots within main plots.
1971	• Plot re-establishment efforts begin.
1993	• Plot ecological classification efforts begin.
1995	• Proportion of tree heights measured increased from 20 % (every tree with number ending in "0" or "5") to 100 %.
1997	• Geo-referencing of plot locations using Geographic Positioning System (GPS) begins.
1999	• Minimum tagging limits reduced from 5.08 cm to 5.0 cm for 0.08 ha plots and from 5.08 cm to 2.0 cm for 0.04 ha plots.

2000	• Minimum tagging limits raised from 5.0 cm to 7.0 cm for 0.08 ha plots and from 2.0 cm to 5.0 cm for 0.04 ha plots
2003	• Minimum tagging limit raised from 7.0 cm in 0.08 ha plots and 5.0 cm in 0.04 ha plots to >7.0 cm for both plot sizes. • Incorporation of 10 m2 circular regeneration plot within main plot. • Subplot size options reduced to three (30, 50 or 100 m2). • New methodology for tree numbering within newly established plots: o Trees >7.1 cm DBH = 1 – 999 o Trees >= 1.3 m height and <=7.0 cm DBH = 8001 – 8999 o Trees >= 0.3 m height and < 1.3 m height = 9001 – 9999 • Revised methodology for site tree assessment (including stem analysis). • Detailed crown assessments (multiple crown radii, crown fullness factor).

2.3.1 Metric Conversion

The PGS program was established and operated using imperial units for many years. All historical data has been converted from imperial to metric, which is now the current standard for all measurements and assessments (Table 3).

Table 3. Imperial to Metric Conversions for PGS Plots.

	Imperial Measure	Metric Conversion	New Metric Standard
1/10 acre Plot Dimensions	66.0 X 66.0 ft	0.04047 ha	20.1 X 20.1 m
1/5 acre Plot Dimensions	93.4 X 93.4 ft	0.08094 ha	28.5 X 28.5 m
Cluster Centre to Plot centres	330 ft. (5 chains)	100.58	101.0 m
Breast Height	4.5 ft	1.37 m	1.30 m

2.3.2 Recent Changes

As of 2006 there are a number of new issues that will impact the PGS program.

Mountain Pine Beetle

The mountain pine beetle (MPB) epidemic will shortly begin to impact the results obtained from the PGS program. After a plot has been infected the measurements may still provide interesting information, however post-infection measurements will be of limited use for projecting future stand growth. Therefore, crews must clearly indicate if there are any signs of infestation within the plot. In section 3.7.2.13 a new "M" category has been added to a plot damage category.

Reducing the number of plots within a cluster

Originally the CFI and PGS plots were located in clusters of 4 plots (Figure 1). This procedure has been reviewed by HWP staff in conjunction with expert forest biometricians and it was deemed excessive to use 4 plots in a cluster. Therefore, when opportunities arise such as an entire cluster of 4 plots being harvested only 2 plots will be re-established. Currently, HWP does not intend to initiate an active plot decommission program, rather this task will be completed through a process of attrition. The distribution of fire origin to regeneration stands must be considered during this process. Due to the increase in regenerated stand area versus fire origin, measurements in regenerated stands are currently of more value than mature fire origin stands. Considering this, if 2 plots are harvested in a cluster and 2 have not been harvested it is important to re-establish 1 (and maybe 2) of the harvested plots. It is essential that HWP staff give clear guidance to the field crews for each plot cluster on a case-by-case basis. Due to the nature of operational forestry, this is not a process that can be fully addressed through a *one-size-fits-all* rule set.

3. PGS Plot Establishment / Re-establishment

This section describes the methodologies and standards for establishing new, and re-establishing old PGS plots. Generally, new establishments will have additional objectives to those defined for the PGS program, and therefore, may have different methodologies than those defined in the following section.

The re-establishment of PGS plots will generally take place following the harvesting of a plot located within a designated harvest area.

3.1 Plot Positioning

When establishing a PGS plot, the field crew will assess the pre-determined position to verify that the plot will be contained within one stand type. If this is not the case, the field crew will re-locate the plot to ensure that it is contained within one stand. No new plots are to be established or re-established in older (80+ years) fire-origin stands..

If possible, when re-establishing a plot after harvest, the plot should be contained within the original plot. Plots that have been established based on the original CFI/PGS grid will be located 100.6 m from the plot centre at an azimuth of 45 degrees offset from the cardinal directions (unless otherwise stated on the cluster centre tag or access notes). If the re-establishment position needs to be moved to fit within one stand type, the plot can first be moved forward along the same azimuth as the original plot tie line, by 30m increments to a maximum of 120m from the original plot location. If a suitable position cannot be found along this azimuth, the plot can be moved by re-starting from the cluster centre and adding 10° to the azimuth and advancing 100.6m along this azimuth. If a valid plot location has not been found then 30m increments can be added to a maximum of 220.6m (from plot cluster centre) until a valid location has been found. If a plot cannot be established within 220.6m total then an additional 10° can be added to the azimuth and the process repeated to a maximum of +60°. If a plot is still not established then -10° can be subtracted from the azimuth and the process repeated to a maximum of -60°. During this process it may be possible for a new plot to be established close to a pre-existing plot. However, only neighbouring plot buffers are allowed to overlap, the main tree plots must not overlap with the buffer of another plot, if this were to occur the new plot must not be established in that location. Rather the process of finding a plot location must continue as outlined above.

Upon completion of the above process if a plot can not be re-established inside the original plot area, the decision to either move the plot or not re-establish it must be discussed with the HWP contract manager on a case by case basis.

3.2 Plot Centre

Once the position of the plot centre has been determined, a formal plot centre will be established. The plot centre will serve as the point from which all plot boundaries will be determined.

The actual plot centre location will be marked with a metal stake driven into the ground and painted blue. A minimum of 50 cm of the stake will remain above the ground. The centre stake will have an aluminium tag affixed to it with the following information:

- "PGS Plot Centre"
- Working Circle
- PGS Plot Number
- PGS Plot Installation Number
- Azimuth and distance from Cluster Centre to Plot Centre
- Azimuth and distance from Plot Center to Plot Center Tree.
- Date

A plot centre tree/marker will also be established as follows:

- Select the nearest healthy (living, and expected to be standing at time of next measurement – 10 years later). If no suitable tree exists, a square wooden stake will be driven into the ground next to the metal stake to serve as a marker.

- The centre witness tree/marker will be painted with a double band of blue paint at a target height of 2.0 m (each band will be a minimum of 3" thick, and will cover the entire circumference of the tree). In addition, a single band of blue paint will be painted between the height of 0.1 and 0.2 m (minimum of 3" thick and covering the entire circumference) to help identify the witness tree stump or marker in the event it was cut down.

- The centre witness tree/marker will have an aluminium tag affixed to it (facing the direction of the centre stake) with the following information inscribed:

    - "PGS Plot Centre Tree" or "PGS Plot Centre Marker"
    - Working Circle
    - PGS Plot Number
    - PGS Plot Installation Number
    - Azimuth and distance from Cluster Centre to Plot Centre
    - Azimuth and distance from Centre Tree/Marker to Plot Centre
    - Date

3.3 Plot Geo-referencing

Each time a PGS plot is visited it will be geo-referenced by digitally locating the plot center using a Global Positioning System (GPS) receiver. The following guidelines and standards apply when using GPS to geo-reference PGS plots:

- The GPS unit will be positioned directly above the centre post where possible, or within 30 cm where not possible.

- Data points for each plot centre will be stored in HWP's Silvpoint Data Dictionary. The GPS point standards are as follows:
    - A minimum of 120 points is required.
    - PDOP values must be less than 8.0 for all points.
    - Three-dimensional points may be retained
    - Either static or dynamic point collection modes are acceptable

- When submitting GPS data to HWP, the data will be in file format and will be submitted digitally on CD.

3.4 Plot Types and Sizes.

In each PGS plot, there are either two or three plots to assess. Each plot differs in purpose and size, as described in the following section. Refer to Table 4 for plot dimensions, and Figure 2 for plot layout illustration. The dimensions stated in Table 4 are based on horizontal distance as opposed to slope distance; refer to Appendix 1 for slope correction tables and calculation examples.

Table 4. Description of PGS Plot Dimensions and Placements.

Plot Type	Area (m2)	Shape	Dimensions (m)	Diagonal / Diameter (m)	Positioning
Main Tree	405	Square	20.1 x 20.1	28.3	Plot Centre
	810	Square	28.5 x 28.5	40.3	
Subplot	30	Square	5.5 x 5.5	7.78	Plot Centre
	50	Square	7.1 x 7.1	10.04	
	100	Square	10 x 10	14.14	
Regeneration	10	Circular	1.78m radius	1.78	Plot Centre

3.4.1 Main Tree Plot

A main tree plot of 0.04ha (20.1m x 20.1m) will be established or re-established around the plot center for each PGS plot. Within the main tree plot all trees that have a DBH measurement of 7.1cm or greater will be sampled. A number of fire-origin main tree plots are 0.08ha (28.5m x 28.5m) in size. These will be considered valid plot until a need for re-establishment occurs.

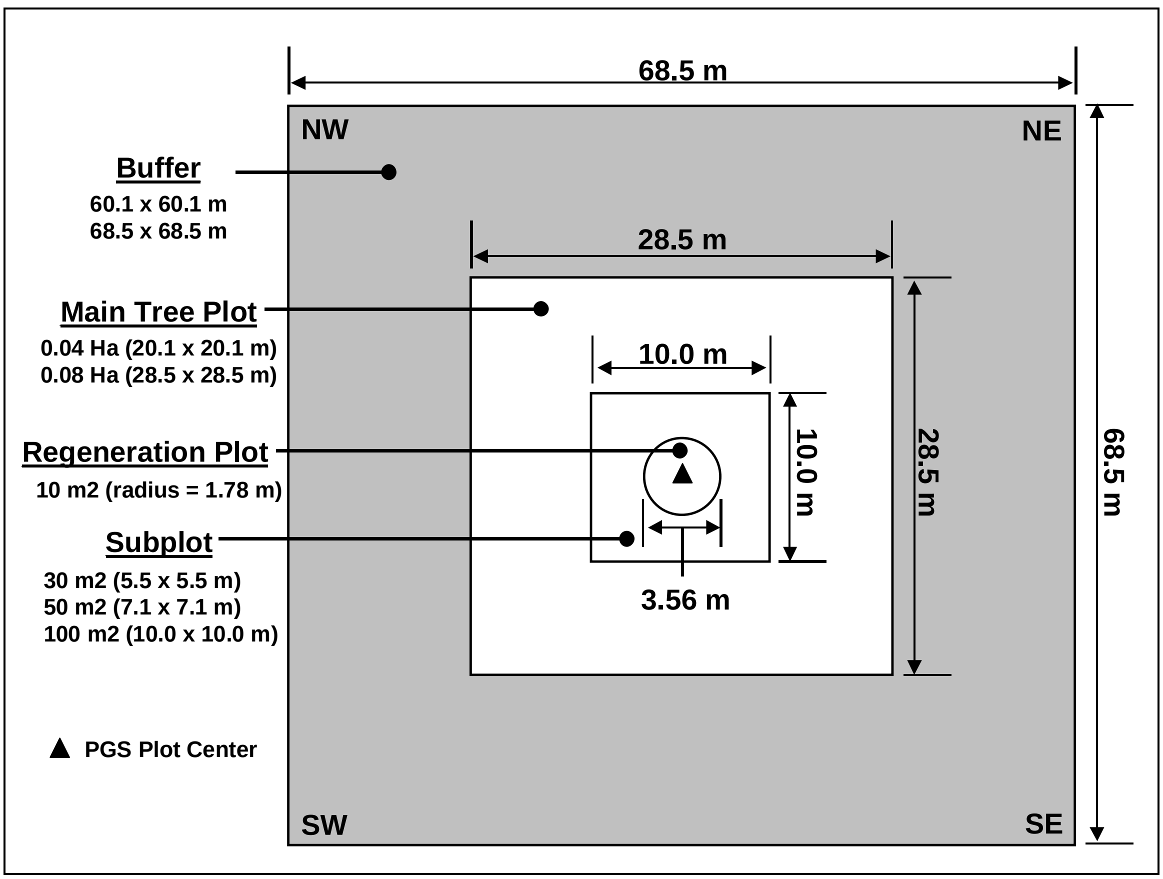


Figure 2. Example of PGS Plot Layout.

3.4.2 Subplot

A subplot will be established or re-established within each main tree plot. The subplot, like the main tree plot, will be positioned around the plot centre. All newly established subplots will be square and $30m^2$ in size (5.5 x 5.5m), however all extant fire-origin subplots of $50m^2$ or $100m^2$ will be measured and considered valid until the plot has been either harvested or decommissioned.

3.4.3 Regeneration Plot

A regeneration plot will be established or re-established in each main tree plot. The regeneration plot is a 10 m2 circular plot positioned around the plot centre.

3.5 Plot Layout and Demarcation

The layout and demarcation of newly established or re-established plots is critical to accurately capturing the plot trees. In addition, clear and consistent demarcation will make working in the plot and locating the plot in the future more efficient.

Unless otherwise stated, all paint used for demarcation will be blue tree paint (spray variety).

3.5.1 Main Tree Plot

Layout and demarcation of the main tree plot will be the most time consuming due to its size, potential number of borderline trees, requirement of sectors and a sizeable buffer.

3.5.1.1 Corners

Once the plot centre has been established and the plot size determined, the plot corners will be installed as described in Appendix 2. At each of the plot corners, a metal stake will be pounded into the ground such that a minimum of 50cm is above the ground. These corner posts will be painted blue and yellow and blue flagging will be attached to the metal post and to a nearby tree or shrub.

Once all four posts are installed, string will be attached to clearly mark the plot boundary. At each of the corner posts, three witness corner trees will be selected and marked. The witness trees will be trees outside of the plot and surrounding the corner post. On each of these trees paint an "x" facing the direction of the corner post.

3.5.1.2 Borderline Trees

Once the corners have been established and marked and the string is in place, the plot should be assessed for borderline trees (trees that are partially in the plot).

If the tree germination point is inside the plot, the tree will be measured, and will have the word "IN" painted facing the centre of the plot. Conversely, if the point of germination is outside the plot, the tree will be excluded, and will have the word "OUT" painted facing the centre of the plot. If the field crew cannot determine whether the point of germination is inside or outside of the plot area (this should be a very rare occurrence), the first instance will be classed as inside the plot – the next instance will be classed as outside the plot. In either case, the tree will either have the word "IN" or "OUT" painted on it in the direction of the plot centre.

3.5.1.3 Plot Sectors

Once the plot corners have been established and the plot boundary string is in place, the plot will be divided into four equal North – South oriented sectors (refer to Figure 3). These sectors provide an efficient means to numbering the trees within the plot. String joining the north and south string boundary should be used to establish the sector boundaries. The spacing between the sectors is 5.03m for the 0.04Ha plot or 7.13m for existing 0.08 Ha plots. The resultant sectors are numbered 1 – 4 starting with 1 on the east side of the plot and ending with 4 on the west side of the plot.

3.5.1.4 Buffer

The main plot will have a buffer painted around it at a distance of 20 from the perimeter (refer to Figure 2). In some cases, there may not be sufficient room to establish a buffer of 20 m, in which case, the buffer will be established as near to 20 m as possible. The buffer will be marked by painting a blue dot (approximately 20 cm in diameter) at eye-level (approximately 1.5 – 1.8 m) on the side of the tree opposite that facing the PGS plot.

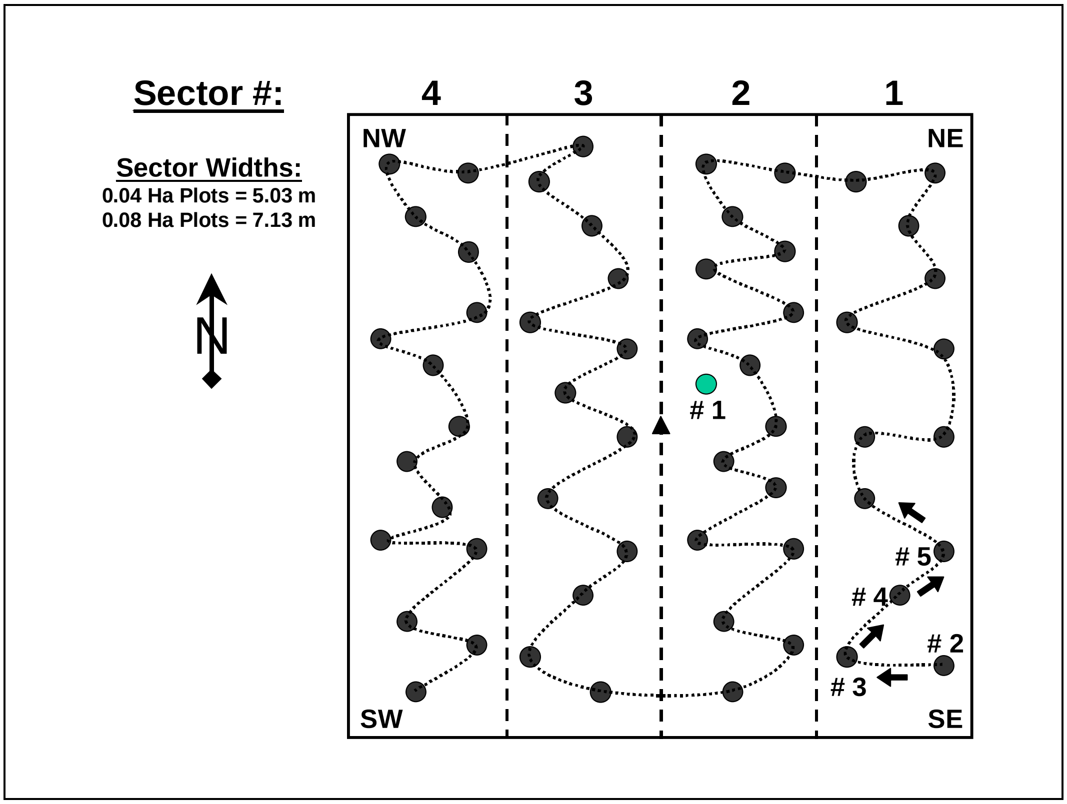


Figure 3. Plot Sector Layout and Numbering Pattern.

3.5.2 Subplot

The Layout and demarcation of the subplot is generally significantly less time consuming than that of the main tree plot, primarily due to its reduced size.

3.5.2.1 Corners

Like the main tree plot, the subplot uses the same set-up procedures as those described in Appendix 2. At each of the four subplot corners, a metal pin will be inserted into the ground. These corner pins will be painted blue, and blue and yellow flagging will be tied to the pin and to a nearby tree or shrub.

3.5.2.2 Borderline Trees

Borderline trees are assessed in the same manner as within the main tree plot. In most cases the trees will be too small to paint the word “IN” or “OUT” on them, therefore, borderline trees do not need to be marked in this manner.

3.5.3 Regeneration Plot

The regeneration plot is established around the plot centre. Given the size of the trees, it is much easier to determine which trees are in/out of the plot. No markings are required for borderline trees in the regeneration plot.

3.6 Tree Tagging and Numbering

Proper and consistent tree tagging and numbering is critical for both locating specific trees in an efficient manner and correctly accounting for trees within the database.

The following general tagging and numbering guidelines will be adhered to:

- **Tags**
  - Un-used, un-damaged, new aluminium tags will be used.

- **Numbers on Tags**
  - Min of 1 cm in height.
  - Underlined when the number contains “6” or “9”.

- **Nail Positioning**
  - Entry point of nail will be at breast height (unless obstructed). Refer to Appendix 4 – Tree Assessments – DBH positioning.
  - Head of nail should be lower than the entry point into the tree.
  - During each re-visit nails must be adjusted to ensure that at least 3 cm of nail is out of tree to allow for growth.

- **Forked Trees**
  - If fork(s) occurs below 1.3 m, each of the resultant stems will be tagged as separate trees.
  - If fork(s) occur above 1.3 m, the stem will be treated as one stem.

3.6.1 Main Tree plot

All living or free standing dead trees with a DBH >= 7.1 cm will be tagged and numbered. Aluminium tags will be attached using 3” aluminium nails at a height of 1.3 m above the point of germination (DBH). If abnormalities such as branch whorls, swelling or major scarring will prevent the accurate measurement of the DBH, the nail and the measurement position will be moved. Refer to DBH Measurements in Appendix 4 for examples of how to determine DBH from point of germination, and where to re-position the measurement point in the event of abnormalities.

Tagging will begin with the centre tree (tree # 1). The centre trees will get a full-length tag, which will be installed so that the tag will face plot centre. Tree # 2 will be located in the southeast corner of the plot in Sector 1. Consecutive numbering will continue in a zig-zag manner as illustrated in Figure 3. These trees will be tagged using a half-length tag, with the exception of the last tagged tree, which will get a full-length tag (indicating the last number used in the plot). With the exception of tree # 1, all tags in Sectors 1 and 3 will be installed on the south side of the tree, while all tags in Sectors 2 and 4 will be installed on the north side of the tree.

Valid numbers in the main tree plot are 1 – 999.

3.6.2 Subplot

Within the subplot, all living or free standing trees with a height >=1.3 m and <= 7.0 cm DBH will be tagged and numbered. Trees with DBH >= 4.0 cm will have their tags affixed by nailing it to the tree, whereas trees with DBH <4.0 cm will have their tags attached to a branch. The DBH position will be marked on the tree with blue paint.

The tagging pattern for the subplot will adhere to that of the main plot – numbering is to begin in the southeast corner of the subplot, the tags are to face the same direction of those in the main plot sectors and the zig-zag pattern is to be followed. All trees tagged in the subplot will get half-length tags, except for the last tree tagged, which will get a full-length tag (indicating the last number used in the plot).

Newly established subplots will use the tree tagging numbers **8001 to 8999**. Some older established subplots may have tagged subplot trees with a main tree plot sequential number. Subplot trees were identified by either a “B” or a “S” in the *subplot* field.

Note subplot trees are <u>not</u> to be renumbered as they grow to become a “main plot” tree or if they were originally numbered with a main tree plot number.

3.6.3 Regeneration Plot

Since 2003, all living or free standing trees with a height >= 0.3 m and < 1.3 m within the regeneration plot, have been tagged and numbered. Since the establishment or re-establishment of plots generally occurs outside of the growing season, there may be snow covering the smaller trees. For this reason, the field crew will need to clear the snow out of the area inside the regeneration plot. Caution should be exercised when removing the snow such that trees are not damaged.

All regeneration plot trees will be tagged either by:

1. Inserting a metal pigtail into the ground directly next to the tree and towards the plot centre. However, this may not be possible if the ground is frozen.
2. Affixing a tag to a branch of the tree (not around the main stem). A spot of spray paint on the tree stem may also help for identifying measured trees on re-visit.

All trees tagged in the regeneration plot will get half-length tags, except for the last tree, which will get a full length tag indicating the last number used in the plot).

Newly established regeneration plots will use the regeneration subplot tree tagging numbers of **9001 to 9999**.

Note regeneration trees are <u>not</u> to be renumbered as they grow to become a “subplot” or “main plot” tree.

3.7 Data Collection

Data will be collected in three phases for each PGS Plot as follows:

1 – Plot Data
2 – Measurement Data
3 – Tree Data

3.7.1 Plot Data

The plot data relates to information that defines the constant attributes of the plot and the status of assessments completed on the plot. Table 5 identifies the plot information to be collected by the field crew at the time of establishment or re-establishment of PGS plots:

Table 5. Plot Data Requirements for Establishment or Re-establishment.

Plot Key	**Declination**	**Aspect**
HWP FMA	**Plot Number**	**Elevation**
Working Circle	**Establishment Number**	**Stem Mapped**
Compartment	**Establishment Status**	**Geo-referenced**
Installation Group	**Plot Size**	**Site Index Plot**
Cluster Number	**Plot Status**	**Regeneration Plot**
Azimuth CC to PC	**Slope Position**	**Comments**
Distance CC to PC	**Slope class**	

3.7.1.1 Plot Key

This field is used to identify the plot key. The plot key is the unique number that identifies the plot – it is a combination of the Working Circle (1 digit), Installation Number (2 digits) and the PGS Plot Number (4 digits). In the case of establishment, the plot key will be determined by HWP prior field establishment, and in the case of re-establishment, the plot key will remain the same as the previously established plot.

3.7.1.2 Hinton Wood Products FMA

This field is used to identify whether the plot is situated within the HWP FMA. Valid entries and their associated descriptions are defined in Table 6.

Table 6. HWP FMA Field Valid Codes.

HWP FMA Code	Description
Y	Yes – Within HWP Hinton FMA
N	No – Not within HWP Hinton FMA
U	U – Unknown if within HWP Hinton FMA

3.7.1.3 Working Circle

This field is used to identify the working circle that the plot is situated within. Valid entries and their associated descriptions are defined in Table 7.

Table 7. Working Circle Field Valid Codes.

Working Circle Code	Description
1	Athabasca
2	Marlboro
3	Embarras
4	McLeod
5	Berland

3.7.1.4 Compartment

This field is used to identify the compartment that the plot is situated within. Each compartment in the HWP FMA has a number assigned to it. These designated compartment numbers are unique in each of the five working circles.

3.7.1.5 Installation Group

This field is used to identify the installation group that each plot belongs to (refer to Table 1 for additional information on PGS Program installation groups. Valid entries and their associated descriptions are defined in Table 8.

Table 8. Installation Group Field Valid Codes.

Installation Group Code	Description
1	Original CFI /PGS Grid
2	1988 FMA Expansion Grid
3	Robb 1/10 Acre Plots (1/5 acre plots 995-999) – Embarras
4	McCardell Creek 1/10 Acre Plots – McLeod
5	Lynx Creek 1/10 Acre Plots (1/5 acre plots 990-995) – Marlboro
6	Canyon Creek Plots - Athabasca
7	Lambert Creek 1/10 Acre Aspen Plots – McLeod
8	Caribou Lichen Thinning Trial – Berland 16

3.7.1.6 Cluster Number

This field is used to identify the cluster number that each plot belongs to. A unique cluster number has been assigned to each of the PGS clusters on the Hinton FMA. The numbering of these clusters commences in the NW corner and ends in the SE corner of the Hinton FMA.

3.7.1.7 Azimuth from CC to PC

This field is used to identify the azimuth from the Cluster Centre to the Plot Centre. In the event that there is no cluster centre established, this field will be used to define the azimuth from the Tie-point to the Plot Centre.

3.7.1.8 Distance from CC to PC

This field is used to identify the distance in meters from the Cluster Centre to the Plot Centre. In the event that there is no cluster centre established, this field will be used to define the distance from the Tie Point to the Plot Centre.

3.7.1.9 Declination

This field is used to identify the declination setting on the compass that was used to determine the azimuth from Cluster Center to Plot Center and to set up the plot.

3.7.1.10 Plot Number

This field is used to identify the PGS plot number that is unique to the Installation Group and Working Circle. In the case of plot establishment, the plot number will be determined by HWP prior to field establishment, and in the case of re-establishment, the plot number will remain the same as the previously established plot.

3.7.1.11 Establishment Number

This field is used to identify the number of times the plot has been re-established.

3.7.1.12 Establishment Status

This field is used to identify the status of the forest at the time of plot establishment/re-establishment. Valid entries and their associated descriptions are defined in Table 9.

Table 9. Establishment Status Field Valid Codes.

Establishment Status Code	Description
F	Fire origin
R	Regenerated

3.7.1.13 Plot Size

This field is used to identify the size of the PGS main tree plot. Valid entries and their associated descriptions are defined in Table 10.

Table 10. Plot Size Field Valid Codes.

Plot Size Codes	Description

405	405 m2
810	810 m2

3.7.1.14 Plot Status

This field is used to identify the status of the plot. Valid entries and their associated descriptions are defined in Table 11.

Table 11. Plot Status Field Valid Codes.

Plot Status Code	Description
A	**Active** - Plot in good condition. Tree tags not near being overcome by tree growth. Plot intact and all markings visible.
I	**Inactive** – Plot in, or approaching poor condition. Tree tags being overcome by tree growth or otherwise missing. Plot still intact, but in need of maintenance.
L	**Lapsed** – Many tags no longer visible, making tree number determination uncertain. Plot markings have faded and are unrecognizable.
H	**Harvested** – All trees in the plot have been harvested.
P	**Partially harvested**. Not all plot trees were harvested.
X	**Destroyed by human** – ie. cutline, road, pipeline, landing etc.
B	**Destroyed by nature** – ie. burn, flood, windthrow etc.
C	**Within cutblock**, but not field confirmed
N	**Not found**
U	**Unknown**

3.7.1.15 Slope Position

This field is used to identify the average slope position of the plot relative to the immediate surrounding area. Valid entries and their associated descriptions are defined in Table 12.

Table 12. Slope Position Field Valid Codes.

Slope Position Code	Description
C	Crest
U	Upper slope
M	Middle slope
L	Lower slope
T	Toe
E	Level
D	Depression
R	Rolling

3.7.1.16 Slope Class

This field is used to identify the average slope class within the plot. This value will be assessed using a clinometer. Valid entries and their associated descriptions are defined in Table 13.

Table 13. Slope Class Field Valid Codes.

Slope Class Code	Description
0	< 11 %
1	11 – 20 %
2	21 – 30 %
3	31 – 40 %
4	41 – 50 %
5	51 – 60 %
6	61 – 70 %
7	71 – 80 %

8	81 – 90 %
9	> 90 %

3.7.1.17 Aspect

This field is used to identify the average aspect within the plot. Valid entries and their associated descriptions are defined in Table 14.

Table 14. Aspect Field Valid Codes.

Aspect Code	Description
F	Flat
N	North
NE	Northeast
NW	Northwest
E	East
W	West
SE	Southeast
SW	Southwest
S	South

3.7.1.18 Elevation

This field is used to identify the elevation (meters above sea level) at the plot centre. This measure will be completed using a calibrated and benchmarked altimeter.

3.7.1.19 Stem-mapped

This field is used to identify whether the trees in the plot have been stem-mapped (azimuth and distance from plot centre recorded for each tree). Valid entries for this field are: “Y” – plot has been stem-mapped, or “N” – plot has not been stem-mapped.

3.7.1.20 Geo-referenced

This field is used to confirm that the plot centre was geo-referenced using a global positioning system. Valid entries for this field are: “Y” – plot centre has been geo-referenced, or “N” – plot centre has not been geo-referenced.

3.7.1.21 Site Indexed

This field is used to identify whether a site index assessment has been completed on the plot. Valid entries for this field are: “Y” – site index assessment has been completed, or “N” – site index assessment has not been completed.

3.7.1.22 Regeneration Plot

This field is used to identify whether a regeneration plot has been established in the plot. Valid entries for this field are: “Y” – a regeneration plot has been established within the plot, or “N” – a regeneration plot has not been established in the plot.

3.7.2 Measurement Data

The measurement data captures information related to the actual assessment of the plot and the general plot attributes that will change over subsequent measurements. Table 15 identifies the measurement information to be collected by the field crew at the time of establishment or re-establishment of PGS plots:

Table 15. Plot Measurement Data Requirements for Establishment or Re-Establishment.

Plot Key	**Average Buffer Width**	**Field Broad Cover Type**
Measurement Number	**Buffer Representative**	**Uneven-aged Type**

Measurement Date	**Silviculture System**	**Plot Damage 1**
Measurement Company	**Field Overstorey Type**	**Plot Damage 2**
Tagging Limit	**Field Understorey Type**	**Subplot Size**

3.7.2.1 Plot Key

The unique plot key number will be the same as that in the Plot Data.

3.7.2.2 Measurement Number

This field is used to identify the number of times that the plot has been measured. In the case of establishment or re-establishments, the measurement number will be "1".

3.7.2.3 Measurement Date

This field is used to identify the date that the plot was measured. The valid date format for this field is "YYYYMMDD" – ie. July 5, 2003 = 20030705.

3.7.2.4 Measurement Company

This field is used to identify the name of the company that completed the measurements on the plot.

3.7.2.5 Tagging Limit

This field is used to identify the DBH tagging limits used in the main tree plot for the current measurement. Simply indicate the minimum acceptable DBH value (to the nearest 1/10th of a cm) for the trees within the mensuration plot – ie. if tagging limit is >7.0, record 7.1.

3.7.2.6 Average Buffer Width

This field is used to identify the average width of the buffer surrounding the main plot. The target buffer width is 20 m. Simply record the average buffer width to the nearest meter.

3.7.2.7 Buffer Representative

This field is used to identify whether or not he plot buffer is representative of the forest and ecological type present in the mensuration plot. Valid entries for this field are: "Y" – the buffer is representative of the mensuration plot, "N" – the buffer is not representative of the mensuration plot, or "X" – there is no buffer around the mensuration plot.

3.7.2.8 Silviculture System

This field is used to identify the silviculture system used to regenerate the stand containing the plot. Valid entries and their associated descriptions are defined in Table 16.

Table 16. Silviculture System Field Valid Codes.

Silviculture System Code	Description
N	No harvesting
CC	Clearcut
ST	Seed tree
SW	Shelterwood
RC	Release cut (understorey retention)
GS	Group selection
SS	Single-tree selection
CT	Commercial thinning

3.7.2.9 Field Overstorey Type

This field is used to identify the overall field overstorey type of the stand that the plot is situated within. The current Alberta Vegetation Inventory standards will be used for this assessment; and the required components are:

- Crown cover class
- Height class
- Species composition

Refer to Appendix 3 for AVI codes and descriptions.

3.7.2.10 Field Understorey Type (if understorey is present)

This field is used to identify the overall field understorey type of the stand that the plot is situated within. The same standards and information for understorey are required as for that of the field overstorey type.

3.7.2.11 Field Broad Cover Type

This field is used to identify the broad field cover type of the overall overstorey of the stand that the plot is situated in. Valid entries and their associated descriptions are defined in Table 17.

Table 17. Field Understorey Type Field Valid Codes.

Field Broad Cover Type	Description (% Coniferous)
C	>= 80 %
CD	< 80 % and >/= 50 %
DC	< 50 % and >/= 20%
D	< 20 %

3.7.2.12 Uneven-aged Type

This field is used to identify whether the portion of the stand within the plot is uneven-aged or even aged. Valid entries for this field are "Y" – yes, stand is uneven-aged, or "N" – no, stand is not uneven aged.

3.7.2.13 Plot Damage 1 and 2

These fields are used to identify the two most significant type(s) of damage found within the main tree plot. **Plot Damage 1** will identify the most significant damaging agent, and **Plot Damage 2** will identify the next most significant damaging agent. Valid entries and their associated descriptions are defined in Table 18.

Table 18. Plot Damage Fields Valid Codes.

Plot Damage Code	Description
A	Animal
D	Disease
F	Fire
F	Flooding
H	Human
I	Insects: non-MPB
M*	Mountain Pine Beetle
N	No Observable Damage
R	Weather
W	Wind

* - Over the next number of years MPB infestations are expected have a significantly greater impact on stand growth than a more typical (non-epidemic) insect infestation. Therefore, field crews are to use the "M" designation exclusively when MPB damage is observable within a plot. All uses of "I" will be assumed by data analysts to be indicative of non-MPB insects.

3.7.2.14 Subplot Size

This field is used to identify the size of the subplot established within the main tree plot. Valid entries and their associated descriptions are defined in Table 19.

Table 19. Subplot Size Field Valid Codes.

Subplot Size Code	Description
30	30 m2
50	50 m2
100	100 m2

3.7.3 Tree Data

The tree data captures information related to the actual assessment of the trees. Table 20 identifies which tree measurements are to be collected for trees within the Main Plot, Subplot and the Regeneration Plot. A description for each of the measurements and any qualifications relevant to the specific plots follows the table. In older plots subplot trees are identified by either a **"B"** or **"S"** in the *subplot* field.

Appendix 4 contains several aids for the assessment of tree related data.

Table 20. Tree Data Requirements for Main, Subplot and Regeneration Plots.

Measurement/Assessment	Main Tree Plot	Subplot	Regeneration Plot
Sector #	**X**	**X**	**X**
Species	**X**	**X**	**X**
DBH	**X**	**X**	
Root Collar Diameter			**X**
Height	**X**	**X**	**X**
Height to Live Crown	**X**	**X**	
Crown Fullness	**X**	**X**	
Crown Radii (4)	**X**	**X**	
Crown Position	**X**	**X**	
Mortality	**X**	**X**	
Damage	**X**	**X**	**X**
Damage Severity	**X**	**X**	**X**
Tree Status	**X**	**X**	**X**

3.7.3.1 Sector

This field is used to identify the main tree plot sector number that the tree falls in (as defined in Figure 3). Valid entries for this field are the numerical values 1 – 4.

3.7.3.2 Species

This field is used to identify the species of the tree. The valid species codes and their descriptions are defined in Table 21.

Table 21. Species Field Valid Codes.

Species Code	Description
AW	Trembling aspen
BW	White birch
FA	Alpine fir
FB	Balsam fir
FD	Douglas fir
LT	Larch
PB	Balsam poplar
PL	Lodgepole pine
SB	Black spruce

SE	Englemann spruce
SW	White spruce

3.7.3.3 DBH

This field is used to identify the stem diameter at breast height (1.3 m above the point of germination). The DBH is measured using a diameter tape and is recorded in centimetres to the nearest 1/10th cm. The diameter tape is to be positioned such that it is perpendicular to the general angle of the tree (in most cases level with the ground, except in the case of leaning trees). The tape is to be pulled tight, and have no obstructions between it and the bark (ie. branches). Refer to Appendix 4 – Section 8.1.

3.7.3.4 Root Collar Diameter

This field is used to identify the diameter of the root collar (point of germination) for trees that are part of the regeneration plot. The root collar diameter is measured using callipers and is recorded in centimetres to the nearest 1/10th cm.

3.7.3.5 Height

This field is used to identify the total height of the tree (from the point of germination to the tallest piece of living foliage (i.e. **do <u>not</u> include dead tops in height measurements**). The height is measured using either a Vertex, laser clinometer, or traditional clinometer and measuring tape for trees >= 7.5 m, and a telescopic height pole for trees < 7.5 m. All heights are measured in meters to the nearest 1/10th m.

Leaning trees must be assessed to account for the lean and its affect on the height. Refer to Appendix 4 – Sections 8.2 and 8.3.

3.7.3.6 Height to Live Crown

This field is used to identify the height to live crown (from the point of germination to the lowest point of the continuous live crown). The lowest point of the continuous live crown occurs at the point where the live crown is no longer continuous radially or horizontally. Refer to Appendix 4 – Section 8.4.

The height to live crown is measured using the same instruments and standards as total tree height.

3.7.3.7 Crown Fullness

This field is used to identify the percent of the crown shape that is filled with live branches and needles/leaves. The valid crown fullness codes and their associated descriptions are defined in Table 22. Refer to Appendix 4 – Section 8.5.

Table 22. Crown Fullness Field Valid Codes.

Crown Fullness % Code	Code
0	0 – 10 %
1	11 – 20 %
2	21 – 30 %
3	31 – 40 %
4	41 – 50 %
5	51 – 60%
6	61 – 70 %
7	71 – 80 %
8	81 – 90 %
9	91 – 100 %

3.7.3.8 Crown Radius

This field is used to identify the total length of the longest branches in the four cardinal directions (N, S, E and W). Measured using a measuring tape or stick and recorded in metres to the nearest 1/10th of a meter. Refer to Appendix 4 – Section 8.6.

3.7.3.9 Crown Position

This field is used to identify the crown position of the tree relative to the relative to the stand canopy. The valid crown position codes and their associated descriptions are defined in Table 23. Refer to Appendix 4 – Section 8.7.

Table 23. Crown Class Field Valid Codes.

Crown Pos Code	Crown Position	Description
V	Veteran	Signifies a tree that was part of the previous stand that survived the last stand destroying event. These trees are significantly older than the neighbouring trees. The usual characteristics of veterans include a crown that is almost entirely above the general level of the canopy and it is much larger than neighbouring trees with a more fully developed crown.
D	Dominant	Crown extends above the general level of the canopy and receives full light from above and partial light from the sides.
C	Co-dominant	Crown forms the general level of the canopy and receives full light from above but little light from the sides. Use this class where two or more trees of equal size are adjacent to one another.
I	Intermediate	Crown below (but extends into the lower region of) the general level of the canopy and receives direct light from above but not from sides. Trees in this class usually have small, crowded crowns.
S	Suppressed	Crown entirely below the general level of the canopy and receives no direct light either from the above or from the sides. Trees in this class normally display restricted height growth and may have elongated lateral branches, leaning terminal growth, or flat tops.
O	Open Grown	Tree has grown entirely in the open. Trees in this class receive full light from above and all sides. If a tree is in this category and is also a "veteran", the "veteran" call supersedes this category (crown position should be recorded as "V"). This designation should be used only when another category is not possible. **It should be a rare call.**

3.7.3.10 Mortality

This field is used to identify the cause of death to the tree, where applicable. The mortality valid codes and their associated descriptions are defined in Table 24.

Table 24. Mortality Field Valid Codes.

Mortality Code	Description
A	Animal
D	Disease
F	Fire
H	Human
I	Insects: non-MPB
M*	Mountain Pine Beetle

N	No Observable Damage
O	Flooding
R	Adverse Weather
S	Suppression
U	Unknown
W	Wind-throw

Note: If the cause of the mortality can be more precisely identified, record this in the comment field (ie. Western gall rust).

3.7.3.11 Damage 1 and 2

The fields Damage 1 and Damage 2 have different uses depending on if the tree is live or dead, as described in the following section.

3.7.3.11.1 Live Trees

In the case of live trees, these fields are used to identify the two most prevalent damaging agents to the tree. The field Damage 1 is to reflect the most significant damage, while Damage 2 is to reflect the next most significant damage. The live tree valid codes and their associated description are defined in Table 25.

Table 25. Damage 1 and Damage 2 Fields Valid Codes for Live Trees.

Damage Code	Description
AB	Animal: Ungulate browsing
AC	Animal: Beaver felling or chewing
AH	Animal: Horse trampling
AL	Animal: Rabbit chewing
AO	Animal: Other
AP	Animal: Porcupine chewing
AR	Animal: Ungulate rubbing
AS	Animal: Squirrel
AT	Animal: Bear tearing
AU	Animal: Bear
DA	Disease: Atropellis canker
DB	Disease: Blister rust
DC	Disease: Conks
DD	Disease: Dieback
DH	Disease: Hypoxylon canker
DI	Disease: Witches' broom
DM	Disease: Dwarf mistletoe
DN	Disease: Needle rust
DO	Disease: Other
DR	Disease: Armillaria root rot
DW	Disease: Western gall rust
FR	Fire: Fire damage
HM	Human: Human damage
IA	Insect: Aphid
IB	Insect: Wood borer
ID	Insect: Defoliators
IM	Insect: Mountain pine beetle
IO	Insect: Other
IR	Insect: Root collar weevil
IT	Insect: Lodgepole pine terminal weevil
PB	Physical: Lean
PC	Physical: Crook (previously included sweep as well)
PD	Physical: Dead or Damaged top
PF	Physical: Forked tree
PG	Physical: Spiral grain
PH	Physical: Heavy branching
PL	Physical: Dead top with lateral assuming dominance
PM	Physical: Broken or missing top
PO	Physical: Other (poor form – that does not fit into another category)
PR	Physical: Rot or decay

PS	Physical: Scar or catface
PT	Physical: Mechanical (ie. trees rubbing together)
PU	Physical: Suppressed tree with very poor vigor
PW	Physical: Sweep (previously included in PC – Physical: Crook or sweep)
UK	Unknown
WB	Weather: Blowdown
WC	Weather: Frost crack
WF	Weather: frost heaving
WH	Weather: Hail
WN	Weather: Snow or ice
WR	Weather: Red belt

3.7.3.11.2 Dead Trees

In the case of dead trees, the Damage 1 field is used to identify the physical attributes of the dead tree. The dead tree Damage 1 valid codes and associated descriptions are defined in Table 26.

Table 26. Damage 1 Field Valid Codes for Dead Trees.

Dead Damage 1 Codes	Description
A	Recently dead – still wet
B	Hard, main stem dry, fine branches present
C	Hard, main stem dry, fine branches absent
D	Hard, few or no branches present
E	Soft, no branches, stem decomposing
F	Decomposed

In the case of dead trees, the Damage 2 field is used to identify the proportion of the original bark that remains on the tree. The dead tree Damage 2 valid codes and their associated description are defined in Table 27.

Table 27. Damage 2 Field Valid Codes for Dead Trees.

Dead Damage 2 Codes	Description
A	76 – 100 % bark present
B	51 – 75 % bark present
C	26 – 50 % bark present
D	0 – 25 % bark present

3.7.3.12 Damage Severity 1 and 2

These fields are used to identify the severity of the damage identified in the fields Damage 1 and Damage 2. The valid codes and their associated descriptions are defined in Table 28.

Table 28. Damage 1 and Damage 2 Severity Fields Valid Codes for Live Trees.

Severity Code	Severity	Description
0	Unspecified	
1	Minimal	• Tree is expected to fully recover with little effect on tree growth or form. • Gall rust and mistletoe limited to lateral branches. • Forked top may not persist with growth.
2	Moderate	• Growth rate and/or tree form will be reduced. • Minor effect on log quality. • Damage becoming apparent on bole. • Forked top occurs above 5m.
3	Significant	• Growth rate and/or tree form will be considerably reduced. • Most damage on lower bole. • Forked top occurs below 5m.
4	Severe	• Tree will probably die or be rendered non-merchantable. Extensive bole damage. Extensive physical defects. Multiple

		forks along bole.

3.7.3.13 Tree Status

This field is used to identify the status of the tree. Valid codes and their associated descriptions are defined in Table 29.

Table 29. Tree Status Field Valid Codes.

Tree Status Code	Tree Status	Description
L	Live	Standing or down tree with live needles, leaves or buds.
S	Snag	Unsupported standing dead tree.
B	Stub	Unsupported standing dead tree with broken stem.
P	Stump	Sawn or otherwise man-made cut at or near base of tree.
G	Log	Down or externally supported dead tree not attached at the stump.
M	Missing	Tree cannot be found inside the plot.
T	Site Tree	Top height tree
F	First Measurement	First measurement on tree. **This code is used only on re-measurements.**
U	Below Tagging Limit	Tree was previously included and measured when minimum tagging limits were lower.

3.7.3.14 Planted

This field is used to distinguish planted trees from ingress. Valid codes and their associated descriptions are defined in Table 30.

Table 30. Tree Status Field Valid Codes.

Tree Status Code	Tree Status	Description
P	Planted	Tree was planted at site origin.
L	Later Planting	Tree was planted but after the original site origin. Likely due to failure of the original site treatments.
V	Ingress / Volunteer	Tree regenerated from natural seed on site.
S	Seeded	Tree regenerated from manufactured seed.
U	Unknown	Origin is unknown

3.8 Plot Photographs

Digital photographs will be taken at each plot at each establishment or re-establishment visit. The intent of the photographs is to capture the detail of stand structure and crown development, as well as facilitate the explanation of data anomalies. A minimum of four photographs will be taken at each plot as described below and as shown in Figure 4:

- **Level perspective (required):** From plot center, a photograph will be taken parallel to the ground from eye-level towards the southwest(GSW) and northeast(GNE) corners.
- **Crown perspective(required):** From the plot center, a photograph will be taken of the crown from eye-level towards the southwest(CSW) and northeast(CNE) corners.
- **Miscellaneous (optional):** Any pictures that may help explain unusual tree or plot conditions, ie. Unknown or unusual tree or plot damage.

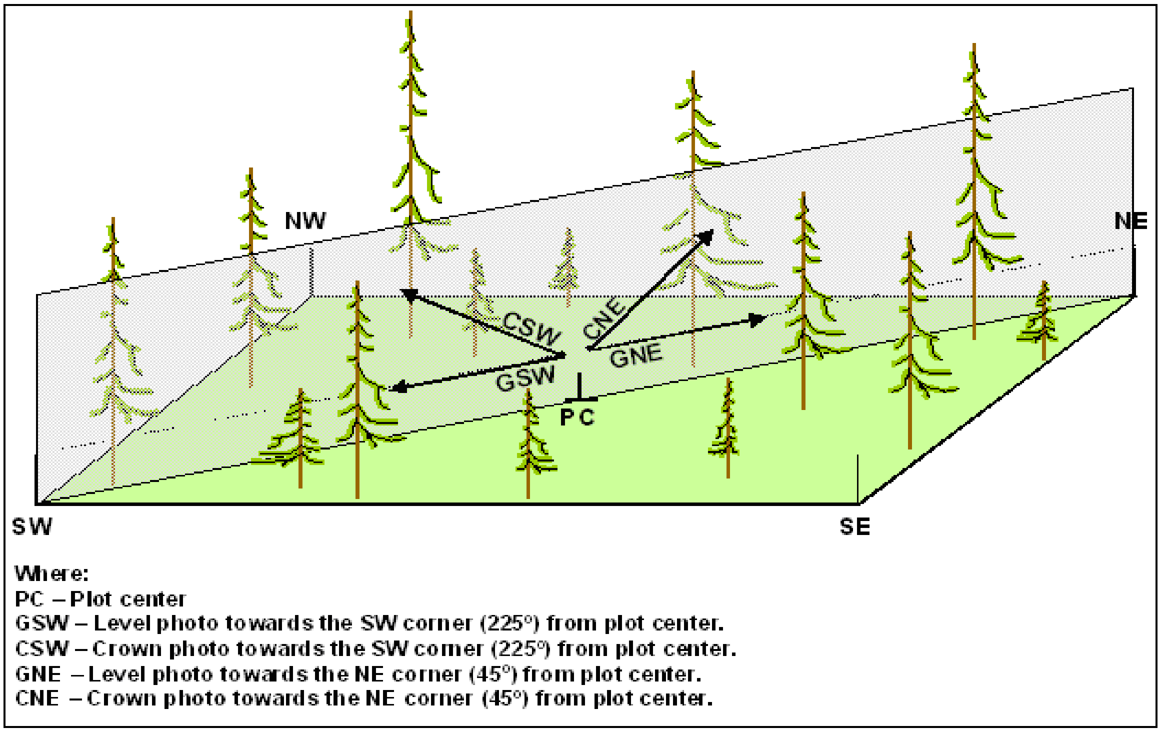


Figure 4. PGS Plot Photo requirements.

3.8.1 Formatting Guidelines

The following guidelines are to be adhered to when taking digital photographs for the PGS Program:

- Focal length: Between 20 – 50 mm (lower focal lengths preferred).
- Pixel size: Medium to fine.
- Picture size: Medium format (4 x 6)
- File format: JPEG Image (*.jpg)
- File size: 200 – 300 KB.

3.8.2 Naming Standards

The following naming standards will be adhered to for the submission of digital photographs:

Plot Key + "_" + Photo ID + "_" + Year

ie. 1020329_CSW_2003

When miscellaneous photos are taken, a brief descriptive term will be substituted in the position of the "Photo ID", ie. plotdamage.

3.8.3 Submission

PGS plot photographs for each established or re-established plot will be submitted at the end of each contract on CD ROM.

3.9 Ecological Land Classification Data

As of 2002, all existing PGS plots have been Ecologically Land Classified as per the standards set in the Field Guide to Ecosites of West Central Alberta.

When new PGS plots are established or re-established, Ecological Land Classification (ELC) will be completed on the main tree plot. The required ELC data be submitted digitally using the ELC data input template. The fields and their associated descriptions are located in Appendix 5.

3.9.1 Seasonal Considerations

ELC will only be completed during the summer season when all herbaceous and deciduous vegetation is thriving, and when the soil conditions are not frozen. Since the majority of the PGS related work is completed in the winter (or at least outside of the growing season), ELC assessment will require a second site visit during the summer.

3.9.2 Split Ecology Plots

A split ecology PGS plot is defined as a main tree plot that contains more than one distinct ecological plant community each representing >= 20 % of the area of the plot. A separate ecological assessment will be required for each ecological plant community that represents >= 20% of the area of the plot.

When establishing or re-establishing PGS plots the field crew is given the flexibility to move the plot position to locate it within a homogenous stand and ecological type, however, since this work is generally completed during the winter, it is possible that subtle ecological changes may exist in the plot, thereby requiring more than one ecological assessment.

3.9.3 Harvested Sites

When establishing or re-establishing PGS plots in harvested areas, two ELC's will be assigned to each distinct ecological type that represents > 20 % of the main tree plot area. The two ELC's to assign are:

1 – The present site conditions
2 – The predicted mature site conditions based on adjacent stand attributes.

3.9.4 Altered Soil Conditions

If soil conditions have been disturbed within the main tree plot (ie. seismic lines, site preparation, windthrow etc.) all the soil assessments will be completed in an area that is not directly affected by the soil disturbance(s)

3.10 Tie-points and Tie-Lines

The purpose of tie-points and tie-lines is to aid future field crews in locating PGS plots. Refer to Figure 5 for an illustration of the placement of tie-points and tie-lines.

3.10.1 Tie-points

The following general guidelines will be adhered to when establishing tie-points:

- Tie-points should be established on passable roads, in locations that are identifiable on aerial photographs and/or maps (ie. road junctions, seismic line/pipeline/powerline intersections).
- The first tie-point should be established at the point where the field crew leaves the truck to proceed on foot or ATV.

- Each tie point will only represent one distance and azimuth – this will either lead to the cluster centre/pot centre or to the next tie-point.
- In cases where there are more than one tie-points, the complete directions from each tie point to the final destination will be recoded on the tag at each tie-point (refer to Figure 5).

3.10.2 Tie-point Demarcation

A healthy large tree that is expected to live for at least another 10 years will be selected as the tie-point. The Tie-point Tree will be blazed with an axe on 4 sides at a height of approximately 1.6 m. Blazes will be a minimum of 30 cm long and 10 cm wide (depending on the size of tree) and will be painted blue. A metal Tag will be nailed to the tree, below the blaze, in the direction that the tie-line will proceed. The nails will be hammered into the tree such that a minimum of three centimetres is outside of the tree, thereby allowing room for growth. The metal tag will contain the following information:

- PGS Plot Tie Point
- Working Circle
- Date
- PGS Cluster Number
- PGS Plot Number(s)
- Azimuth(s) and horizontal distance(s) to cluster centre or plot centre (if no cluster centre)

3.10.3 Tie-lines

The following general guidelines will be adhered to when establishing tie-lines:

- Individual tie-lines leading from tie-point to tie-point or tie-point to final destination will always be straight (one azimuth).
- Tie-lines are used to lead the way to and from cluster centres and plot centres.

3.10.4 Tie-lines Demarcation

Tie-lines will be marked by painting a blue dot on both sides of the tree in the direction of the tie-line, spaced apart so that painted trees can easily bee seen in both directions when standing on the line. The blue dot will be approximately 25 cm in diameter and will be positioned at eye-level (approximately 1.5 m in height). The marking of the tie-line will cease within the plot buffers.

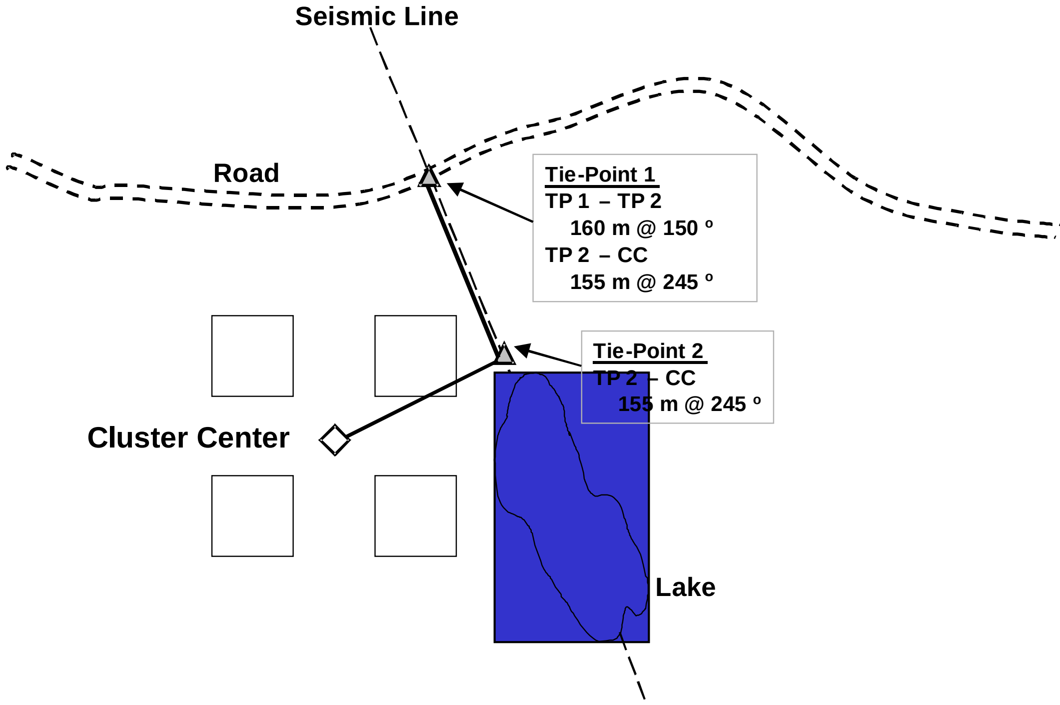


Figure 5. Tie-points and Tie-lines.

3.11 Plot Location Package

At the time of establishment, re-establishment or re-measurement, a Plot Location Packaged will be prepared or updated to reflect the current plot location and surroundings. The three requirements of the Plot Location Package are:

- Cluster Location Map
- Cluster Access Notes
- Cluster Layout Map

Refer to Appendix 6 for the templates used for Plot Location Packages as well as an example of a complete Plot Location Package.

3.11.1 Cluster Location Map

The purpose of the Cluster Location Map is to identify the location of the cluster centre, and the most efficient route to access it. The map will be a modified GIS map using a scale of 1:20,000 or 1:30,000. The following information is required on the Cluster Location Map:

- Scale, North arrow, Declination.
- Names and Kilometre marker of roads.
- Distance and direction to major road and major town.
- Historical harvest areas.
- Access modes for portions of the access route (ie. 4 WD, 2 WD, snowmobile, walk, etc).
- Water bodies.
- Tie point(s) with azimuth and distance.

The Cluster Location Map will be completed on the Cluster Location Template (Appendix 6).

3.11.2 Cluster Access Notes

The purpose of the Cluster Access Notes are to document the distance(s) and mode(s) of transportation used to access the PGS cluster centre. The notes are to document the route of travel from the town of Hinton to the PGS cluster centre. Distances are reported based on road mileage markers (vehicle odometers in the absence of road markers) and hip-chains.

The Cluster Access Notes will be completed on the PGS Cluster Access Notes template (Appendix 6)

3.11.3 Cluster Layout Map

The purpose of the Cluster Layout Map is to document the position of the plots within the cluster. It is particularly useful for identifying operational activity and major cover type changes, in the proximity of the plots. These maps do not need to be to scale, but should be drawn at an approximate scale of 1:2,500. The following information is required on the Cluster Layout Map:

- Scale, North arrow, declination.
- Cluster centre with description of cluster centre Tree.
- Existing plots and their associated buffers.
- Roads, seismic lines, pipelines, powerlines, etc.
- Water bodies.
- Significant cover type changes.
- Azimuth and distance to each plot from the cluster centre.
- Additional information that may be useful for accessing cluster centre or the plot centres.

The Cluster layout map is to be completed on the PGS Cluster Layout Map template (Appendix 6).

4. PGS Plot Re-measurement

This section describes the methodologies and standards for the maintenance and re-measurement of existing PGS plots.

4.1 Plot Re-measurement Schedule

Re-measurement of PGS plots will be completed outside of the growing season. In general the intent is to re-measure each plot at a 10 year interval. In some instances (young regenerating stands) a 5 year measurement interval may be beneficial.

4.2 PGS Plot Maintenance

Good plot maintenance is key to the long term viability of the PGS program. Well maintained plots make possible to link measurements to individual trees. Maintenance must be completed during each re-measurement. This section identifies the maintenance tasks to be completed by the re-measurement crew.

4.2.1 Plot Buffer

The plot buffer will be re-established at a distance of 20 m from the mensuration plot boundary. If there are obstacles that prevent the establishment of the buffer at a distance of 20 (ie. road, pipeline), the buffer boundary will be marked along the obstacle where necessary. If the previously established buffer was established at a distance of less than 20 m from the plot boundary, and there is sufficient area, the buffer will be re-established at a distance of 20 m from the plot boundary.

Plot Buffer maintenance markings are to follow the standards described under Section 3.5.1.

4.2.2 Tie Points

All tie-points are to be re-tagged if the tag is missing, has been damaged, or if any of the information on the tag has changed (ie. Tie information).

4.2.3 Tie Lines

All tie-lines are to be re-painted.

4.2.4 Tree Tags / Nails

All damaged and/or missing tree tags will be replaced and all tags that are either restricting branch or stem growth, or likely will be within 5 to 10 years will be adjusted to allow for future growth. Tags must never be tied around the main stem of the tree. All trees must be re-adjusted to be a minimum of 3 cm out of tree.

4.2.5 Corner Posts

All damaged and/or missing corner posts will be replaced. All corner posts will be re-painted and will have a ribbon affixed to both the post and a nearby tree or shrub to allow easier sighting of the corner.

4.2.6 Centre Post

Damaged and or missing centre posts will be re-established as described under Section 3.2. Care must be taken to ensure that the plot centre post is positioned in the exact position as the original. The centre post will be re-painted and will have a ribbon affixed to both it and a nearby tree or shrub to allow easier sighting of the plot centre.

4.2.7 Plot Centre Tree

The plot centre tree is to be re-tagged if the tag is missing, has been damaged, or if any of the information on the tag has changed (ie. Tie information). The required information and the positioning of the tag are described in Section 3.2. In addition to assessing the tag, the centre tree will be re-painted as described in Section 3.2.

4.2.8 Corner Witness Trees

The corner witness trees will be re-painted as described in Section 3.5.1.

4.3 Plot Set-up

Following the plot maintenance, the field crew will layout the main tree and subplot boundaries and the sector divisions using string, as described in Section 3.5.1. This will facilitate navigating the plot and assessing which trees are now eligible for inclusion and which sector they are in.

4.4 Data Collection

Data collection for plot re-measurement is similar to that for plot establishment, however, there are fewer fields to assess.

4.4.1 Plot Data

The majority of the plot data will not change over the life of the plot, therefore, only a portion needs to be assessed at the time of re-measurement. Table 31 identifies all the fields in the plot data table, where the shaded fields will be provided for reference, and the non-shaded fields will be assessed and updated only if necessary. Refer to Section 3.7.1 for information on each field.

Table 31. Plot Data Requirements for Re-measurements.

Plot Key	**Declination**	**Aspect**
HWP FMA	**Plot Number**	**Elevation**
Working Circle	**Establishment Number**	**Stem Mapped**
Compartment	**Establishment Status**	**GPS'd**
Installation Group	**Plot Size**	**Site Index Plot**
Cluster Number	**Plot Status**	**Regeneration Plot**
Azimuth CC to PC	**Slope Position**	**Comments**
Distance CC to PC	**Slope class**	

4.4.2 Measurement Data

All of the measurement data will need to be assessed as this information can change between measurements. Table 32 identifies all the fields in the measurement data table where the shaded fields will be provided for reference, and the non-shaded fields will be assessed and populated. Refer to Section 3.7.2 for information on each field.

Table 32. Plot Measurement Data Requirements for Re-measurements.

Plot Key	**Average Buffer Width**	**Previous Plot Damage 1**
Prev. Measure. Number	**Buffer Representative**	**Plot Damage 1**
Measurement Number	**Silviculture System**	**Previous Plot Damage 2**
Measurement Date	**Field Overstorey Type**	**Plot Damage 2**
Measuring Company	**Field Understorey Type**	**Subplot Size**
Previous Tagging Limit	**Field Overstorey Cover Type**	**Crown Closure %**
Tagging Limit	**Uneven-aged Type**	

4.4.3 Tree Data

All of the tree data will need to be assessed, as this information will change as new trees enter the plot and as existing trees status, size and condition change. Table 33 identifies all the fields in the tree data table where the shaded fields will be provided for reference and the non-shaded fields will be assessed and populated. Refer to section 3.7.3 for information on each field.

Table 33. Tree Data Requirements for Re-measurements.

Plot Key	**DBH**	**Crown Radius South**
Previous Measure Number	**Previous Crown Class**	**Crown Radius West**
Measurement Number	**Crown Class**	**Crown Fullness**
Tree Number **Subplot (when valid)**	**Previous Height**	**Mortality Cause**
Previous Species	**Height**	**Damage 1 ID**
Species	**Previous Height to Live Crown**	**Damage 1 Severity**
Previous Tree Status	**Height to Live Crown**	**Damage 2 ID**
Tree Status	**Crown Radius North**	**Damage 2 Severity**
Previous DBH	**Crown Radius East**	**Comments**

4.4.3.1 Previous Measurement Data

As indicated in Table 33, the previous measurement data will be provided for several fields. This will provide the field crew the opportunity to compare the previous and current measures/attributes, and will provide an opportunity to assess potential data errors. Some of the fields in the data logger will alert the field crew when there is a suspicious value/code entered relative to the previous value/code.

The field crew will record in the comments field any time that they re-checked values for a particular field.

4.4.3.2 New plot trees

New trees will be tagged and numbered using the next sequential number available in whichever plot the tree is entering (ie. main tree plot, subplot or regeneration pot). In most cases, the field crew will be able to determine the next sequential number to use by looking at the last number used in the previous measurement data, but this should always be confirmed by checking the number of the tree with the full-length tag (in the appropriate plot). Once a new tree has entered the plot, it will be assessed in the same manner as the other trees in the same plot. Once all new trees have been tagged and numbered, previous full-length tag will be replaced with a half-length tag, and the highest numbered ingress tree will get the full-length tag. Do not re-number trees that grow out of the regeneration plot or subplot.

4.4.3.3 Missing Tag Trees

Trees found to be above the tagging limit, but without tags may need to be evaluated. The field crew will need to reference the position of the tree relative to other tagged trees, and attempt to determine the consecutive number for the tree. If the tree cannot be logically associated with the existing data, it will be treated as ingress. If the tree positioning and attributes are consistent with a tree in the data that has not been accounted for, it will be tagged and re-numbered as that tree.

4.4.3.4 Missing Trees

If a tree cannot be found, the code "M" for missing will be assigned to the Tree Status field. The tree number will not be reassigned.

4.5 Plot Photographs

Plot photographs are required at each re-measurement visit. The standards for plot photographs to be taken at the time of re-measurement are consistent with those described under Section 3.8 – Plot Photographs (under PGS Plot Establishment / Re-establishment).

4.6 Ecological Land Classification Data

Ecological land classification data collection is generally collected at the time of installation/re-establishment, however, if the field crew is instructed to collect ELC data at timing of re-measurement, the methods will be consistent with those described under Section 3.

5. Site Index Measurements

This section describes the protocol for collecting site index information on PGS plots. Information is to be collected on the three top height trees of the leading AVI species within the site index plot (300m^2). In some cases, three suitable trees may not be available (e.g., due to a large number of damaged stems). In these cases an attempt should be made to collect data on one or two trees.

Until further notice there is a moratorium on destructive site index PGS sampling. All site index measurements will now be estimated by field counting a breast height (1.3m) increment core and measuring total tree height on three top height trees. The ~~strikethrough~~ font below is included so that the procedures of the historical destructive sampling program will not be lost.

5.1 Stands with breast height age <50 years

When the breast height age of the stand is less than 50 years old then both the DBH and total height will be measured on the 3 largest DBH trees of the leading AVI species. A 300 m^2 (9.77m radius) plot should initially be established 10m southwest from the southwest corner of the main plot. If the tree has a DBH greater than 10 cm then age the tree by an increment core. Trees less than 10cm DBH can be used as a site tree, as the tree age can be assumed to equal stand age.

If an SI plot cannot be successfully established in the SW then go to the NW, next NE, next SE. Trees in this plot are numbered 1001 through 1003.

~~When the breast height age of the stand being sampled is less than 50 years, measure the total height and breast height age by taking a ring count from a destructive sample at 1.3 m for the 3 largest DBH trees of the leading AVI species in a 300 m^2 (9.77m radius) plot established 10m southeast from the southeast corner of the main plot. Trees in this plot are numbered 1001 through 1003.~~

5.2 Stands with breast height age >50 years

When the breast height age of the stand being sampled is greater than 50 years, ~~section~~ increment core age (at breast height), measure the DBH and total height of the 3 largest DBH trees of the leading AVI species in a 300 m^2 (9.77m radius) plot established 10m southwest from the southwest corner of the main plot. Trees in this plot are numbered 2001 through 2003. ~~Protocols for stem sectioning are found in section 5.4.~~

If an SI plot cannot be successfully established in the SW then go to the NW, next NE, next SE.

5.3 Tree selection criteria

Top height trees are the largest diameter non-veteran trees which are free growing, relatively straight, without broken or damaged tops, appear healthy and show little to no signs of insect or disease damage. Western gall rust on dead branches or on live branches >10cm from the main stem is acceptable.

Based on the increments, the trees should not show signs of serious suppression (damage severity rating = 0 or 1). In some cases, the entire stand may show signs of suppression. It is critical that only dominant and/or co-dominant stems are used as site index samples.

If two appropriate stems are not available, the sample plot location should be dropped, and no site index information collected. In this case the plot is moved clockwise to the NW corner and evaluated. Continue moving the SI plot in a clockwise direction (SW, NW, NE, SE) until either two suitable trees are located within one plot or all locations have been ruled out as sources for SI data collection.

5.4 Tree sectioning protocol

No destructive sampling is to be done. The ~~strikethrough~~ font below is included so that the procedures of the historical destructive sampling program will not be lost.

~~The top height trees are to be felled and sectioned generally following the LFS stem analysis sectioning protocols. Eleven disks are obtained from each felled tree at the following heights:~~

- ~~Disk 1: 0.3 m above ground~~
- ~~Disk 2: 1.3m~~
- ~~Disk 3: 1.3m + 1/10 × (tree height – 1.3m)~~
- ~~Disk 4: 1.3m + 2/10 × (tree height – 1.3m)~~
- ~~Disk 5: 1.3m + 3/10 × (tree height – 1.3m)~~
- ~~Disk 6: 1.3m + 4/10 × (tree height – 1.3m)~~
- ~~Disk 7: 1.3m + 5/10 × (tree height – 1.3m)~~
- ~~Disk 8: 1.3m + 6/10 × (tree height – 1.3m)~~
- ~~Disk 9: 1.3m + 7/10 × (tree height – 1.3m)~~
- ~~Disk 10: 1.3m + 8/10 × (tree height – 1.3m)~~
- ~~Disk 11: 1.3m + 9/10 × (tree height – 1.3m)~~

~~Each disk is approximately 4 cm thick. All discs are to be properly labelled, with the working circle; PGS plot number and tree number.~~

~~The tree sectioning protocol is as follows:~~

1. ~~fall the tree at a stump height of 30 cm,~~
2. ~~delimb the tree, if necessary~~
3. ~~string measurement tape along tree stem,~~
4. ~~mark the first section at 1m from the stump using lumber crayon or spray paint,~~
5. ~~mark the remainder of stem at calculated intervals using lumber crayon or spray paint,~~
6. ~~begin to cut the sections and their representative disks (approximately 4 cm thick)~~
    i. ~~cut a disk from the top of the stump section (Disk 1) (record identification information on bottom side of disk, to facilitate aging from the top of the disk; this sequence may have to be reversed, if branch whorls make this difficult, the objective is to determine age from the side of the disk closest to the target length).~~
    ii. ~~cut stem at breast height mark (1.3 m = stump height plus first 1 m section mark, Disk=2) (record identification information on bottom side of disk, to facilitate aging from the top of the disk; this sequence may have to be reversed, if branch whorls make this difficult, the objective being to determine age from the side of the disk closest to the target length).~~
    iii. ~~continue to cut stem at marked intervals (steps 4 and 5 above).~~
    iv. ~~try to keep measurement side of the disks as clean as possible.~~
7. ~~place disks in burlap, or other breathable bags and label the bag with working circle, compartment, plot number, and tree number.~~

5.5 Site index data collection

Table 34 identifies all the fields in the site index data collection template that will be assessed and populated for each tree. Refer to section 5.5.1 for information on each field.

Table 34. Tree Data Requirements for site index measurements

Plot Key	Crown Class
Working Circle	Height
PGS Plot Number	Crown Fullness
SI Plot Location	Damage 1 ID

SI Plot Area	Damage 1 Severity
SI Tree Number	Damage 2 ID
Species	Damage 2 Severity
DBH	Comments

5.5.1 Site index data collection fields

Fields specific to the collection of site index are described below, fields relating to tree measurement are discussed in section 3.7.3.

5.5.1.1 SI Tree Number

Record the number of the tree being measured, acceptable ranges are from 1001-1003 for stands <50 years breast height age, and 2001-2003 for stands >50 years breast height age

5.5.1.2 SI Plot Area

Record the size of the plot used to identify the top height trees. Plots will be $300m^2$ unless otherwise specified

5.5.1.3 Measurements for plots < 50 years breast height age

Record the age at breast height and the total height for trees as described in section 5.1.

5.5.1.4 SI Plot Location

Record the location of the SI plot in relation to the main PGS plot. Eg. SW

6. Quality Assurance

Quality Assurance (QA) is an integral part of HWP's PGS plot program. The main objectives of the QA protocol are to:

1. Provide a quality control mechanism for data collected.
2. Ensure that data collected are consistent, complete, and accurate.
3. Define precision targets to provide a degree of comfort in data reliability.

This protocol describes the standards and procedures to provide QA on established PGS plots. The standards for package completion, plot and tree measurements are outlined in Appendix 7.

6.1 Sampling Intensity

Quality assurance is broken down into two components: an office component that includes a review of cluster location packages and tally cards for completeness, and a field component that monitors the accuracy of field measurements. 100 % of the cluster location packages submitted will be reviewed for completeness and a total of 10% of the plots completed will be field checked.

Selection of plots for field checking is typically random, but may be influenced by erroneous or suspect data identified during the office review. Within the plots selected for field audits, 10% of the trees, to a maximum of 15 trees per plot, will be sampled for QA. The trees in this sample will be subject to an audit of all measured and estimated attributes.

6.2 Scheduling Audits

A pre-work meeting will be held with all contractors prior to commencing fieldwork. This meeting will provide an opportunity to clearly communicate expectations and answer technical questions regarding sampling methods and standards of measurement.

The frequency of QA audits will also be discussed in the pre-work meeting. All audits will be conducted within two weeks of receipt of the original data and ideally within two weeks of the original measurement. Measurement crews will always have the opportunity to be present during QA audits.

6.3 QA Procedures

A quality control program will be implemented:

i. Completed plot measurements will be submitted in groups of 10 for quality control review.
ii. Ten percent of plots will be randomly selected for quality control measurements.
iii. The main tree plot, the subplot, and the regeneration plot should each be evaluated for QA.
iv. If the quality-measured plot fails, all 10 plots within the submission will be considered failed. The contractor will need to address the deficiencies at their own cost and re-submit all 10 ten plots for a second quality control measurement.

Details of the quality standards and tolerances used in the audit are described in Appendix 7. The contractor will receive a report detailing any issues found for each audit, using the format found in Appendix 7.

6.3.1 PGS Cluster Location Package

The cluster location map and access notes will be checked for accuracy when accessing the plots. This includes verification of distances traveled, landmarks and other reference points. Refer to Appendix 6 and sections 3.10 and 3.11 for cluster location package protocol.

6.3.2 Cluster/Plot Layout

Quality control crews/contractor will ensure that the plot location and plot identification markers are properly labelled in the field. This includes an inspection of all tie lines and tie points, plot center locations and markings, azimuths, distances, plot identification tags, and plot buffers. For re-establishment of plots after harvest, the plot location will be checked to ensure that it coincides with the procedures outlined in section 3.1.

6.3.3 Tree Measurements

Measurements that do not meet the standards identified on the PGS measurement tolerances summary found in Appendix 7 will be recorded. Measurements that exceed the precision standards are averaged over the entire sample. If greater than 10% of the quantitative tree measurements (DBH, height, etc.) exceed the measurement precision standards the plot will be considered failed. Additionally, for some qualitative tree measurements (such as: species and mortality code) any errors will result in the plot being designated as failed. Where a problem with measurements is identified, the number of stems audited may be increased to determine the scope and severity of the problem.

6.4 Protocol for Failed Quality Audits

HWP will address quality control by one of the following options: 1) through HWP staff, or: 2) through an independent third party contractor, or; 3) in instances where field contractors have solid experience and history with the PGS program, then HWP may allow field contractors to establish their own internal quality assurance program.

Payment on any submission will be held until the package passes both the office and the field component of the audit. A failed office audit will not normally delay the field audit.

6.4.1 Failed Office Component

If a submission fails the office component of an audit, the package will be returned to the original measurement contractor for re-working. When it is resubmitted, it will undergo a 100% audit.

6.4.2 Failed Field Component

If a submission fails the field audit, the following procedure will be used:

i. The original contractor will be given a detailed explanation of the reason for the failures. All plots within the submission will be considered failed. The contractor must address the deficiencies at their own cost and re-submit all plots for a second quality control measurement.

ii. The second quality control will include the failed plot from the first quality control and one additional randomly selected plot. Both plots will need to pass audit for the group of 10 to pass. Steps ***i*** and ***ii*** will be repeated until the audit is passed.

iii. To ensure all parties understand the quality control parameters, a one month grace-period will begin (provided there are no gross errors) as soon as the field measurement contractor receiving the first audit for the sample year. During the grace-period, HWP will cover all costs to the quality control contractor (regardless if audits are passed or failed). However after the grace period or in the case of gross error, HWP reserves the right to charge the original field measurement contractor all costs incurred to either the quality control contractor or HWP staff for follow-up quality control re-measurements caused due to failed audits.

iv. Persistent failed audits denote poor quality and will be grounds for termination of the contract.

If the field measurement contractor wishes to formally dispute the audit findings, the HWP contract manager will visit plots along with a representative from both the field measurement contractor and the quality control crew/contractor to work through any misunderstandings. All complaints about the audit should be discussed directly with the HWP contract manager – who will be the final arbiter in all such matters.

References

Beckingham, J.D., *et al*. 1996. *Field Guide tro Ecosites of West-Central Alberta.* UBC Press, British Columbia.

Crossley, D.I. 1983-1984. *Edited version for the Weldwood history project reference containing the text related to the Hinton Operations and Government of Alberta*. As interviewed by Peter J. Murphy and Hames M. Parker. The University of Alberta. 51 pp.

Lands and Forest Service. 1998. *Permanent Sample Plot Field Procedures Manual.* 110 pp.

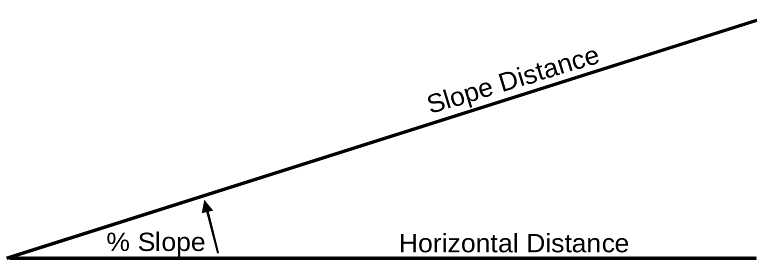
Ontario Ministry of Natural Resources. 1994. *PSP Establishment Manual for Northeastern Ontario*. p16-17.

7. Appendix 1 – Slope Correction Tables and Examples

7.1 Slope Correction Factor Table

% Slope	Slope Factor	% Slope	Slope Factor	% Slope	Slope Factor	% Slope	Slope Factor	% Slope	Slope Factor
6	.999	35	.944	64	.842	93	.732	122	.634
7	.998	36	.941	65	.838	94	.729	123	.631
8	.997	37	.938	66	.835	95	.725	124	.628
9	.996	38	.935	67	.831	96	.721	125	.625
10	.996	39	.932	68	.827	97	.718	126	.622
11	.995	40	.928	69	.823	98	.714	127	.619
12	.994	41	.925	70	.819	99	.711	128	.616
13	.993	42	.922	71	.815	100	.707	129	.613
14	.992	43	.919	72	.812	101	.705	130	.610
15	.990	44	.915	73	.808	102	.700	131	.607
16	.989	45	.912	74	.804	103	.697	132	.604
17	.986	46	.908	75	.800	104	.693	133	.601
18	.984	47	.905	76	.796	105	.690	134	.598
19	.982	48	.902	77	.792	106	.686	135	.595
20	.981	49	.898	78	.789	107	.683	136	.592
21	.987	50	.894	79	.785	108	.679	137	.590
22	.977	51	.891	80	.781	109	.676	138	.587
23	.975	52	.887	81	.777	110	.673	139	.584
24	.972	53	.884	82	.733	111	.669	140	.581
25	.970	54	.880	83	.769	112	.666	141	.587
26	.968	55	.876	84	.766	113	.663	142	.576
27	.965	56	.873	85	.762	114	.659	143	.573
28	.963	57	.869	86	.758	115	.656	144	.570
29	.960	58	.865	87	.754	116	.653	145	.568
30	.958	59	.861	88	.751	117	.650	146	.565
31	.955	60	.857	89	.747	118	.647	147	.562
32	.952	61	.854	90	.743	119	.643	148	.560
33	.950	62	.860	91	.740	120	.640	149	.557
34	.947	63	.846	92	.736	121	.637	150	.555

7.2 Slope Correction Calculation Examples



Determination of Slope Distance to achieve desired Horizontal Distance:
Example:
- **% Slope = 30 %**
- **Desired Horizontal Distance = 20 m**

Slope Distance = Desired Horizontal Distance / Slope Correction Factor (from table)
= 20 m / 0.958 = 20.88 m.

Determination of Horizontal Distance from Slope Distance:
Example:
- **% Slope = 30 %**
- **Slope Distance = 20 m**

Horizontal Distance = Slope Distance X Slope Correction Factor (from table)
= 20 X 0.958 = 19.16 m.

8. Appendix 2 – Main Tree Plot and Subplot Boundary Installation

8.1 Plot Boundary Layout Procedures.

1 – Determine plot centre and size of plot.

2 – Mark plot centre with a non-metallic temporary stake (to prevent interference with compass readings).

3 – Holding the compass directly above the plot centre, determine the 45 ^{o} azimuth. Using a metal measuring tape, measure half the diagonal distance of the selected plot size from the plot centre – install a temporary non-metallic stake at this position. This will be the Northeast corner of the plot (Table 14 – page 14).

4 – Complete the step 3 for the following azimuths: 135 ^{o}, 225 ^{o} and 315 ^{o} for the Southeast, Southwest and Northwest corners respectively.

5 – To check the accuracy of the plot corner positions, using a metal measuring tape, measure the length of each side (from corner to corner). The length of each side should be equal to that defined for the appropriate plot size.

6 – If the sides are not the appropriate length for the particular plot size, the field crew will re-do the plot set-up to achieve the desired dimensions and accuracy.

7 – Once the plot centre and corners are accurately established, the temporary non-metallic stakes will be replaced with permanent metal stakes.

9. Appendix 3 – AVI Requirements within PGS Program

9.1 AVI Standards Associated with Weldwood's PGS Program

Field calls are required for the overstorey and understorey (where applicable). Only four components of the AVI descriptor are required for the purposes of the PGS Program:

1 – Crown Closure Class

Assess the proportion of the ground that is covered by the needles/leaves of the trees during the growing season. Qualify this proportion using the following codes:

Crown Closure Class	Descriptor
A	6 – 25 %
B	26 – 50 %
C	51 – 75 %
D	75 – 100%

2 – Average Height Class

The average height in meters of the dominant and co-dominant trees in the plot.

3 – Species Composition

The top five most prominent species in the plot (species codes are consistent with those of the PGS Program).

4 – Species Proportion.

In descending order, identify the species composition (using the approved species codes), followed by the proportion that species contributes to the overall crown closure within the stand:

Species Proportion Code	Descriptor
1	1 – 10 %
2	11 – 20 %
3	21 – 30 %
4	31 – 40 %
5	41 – 50 %
6	51 – 60 %
7	61 – 70 %
8	71 – 80 %
9	81 – 90 %
10	91 – 100 %

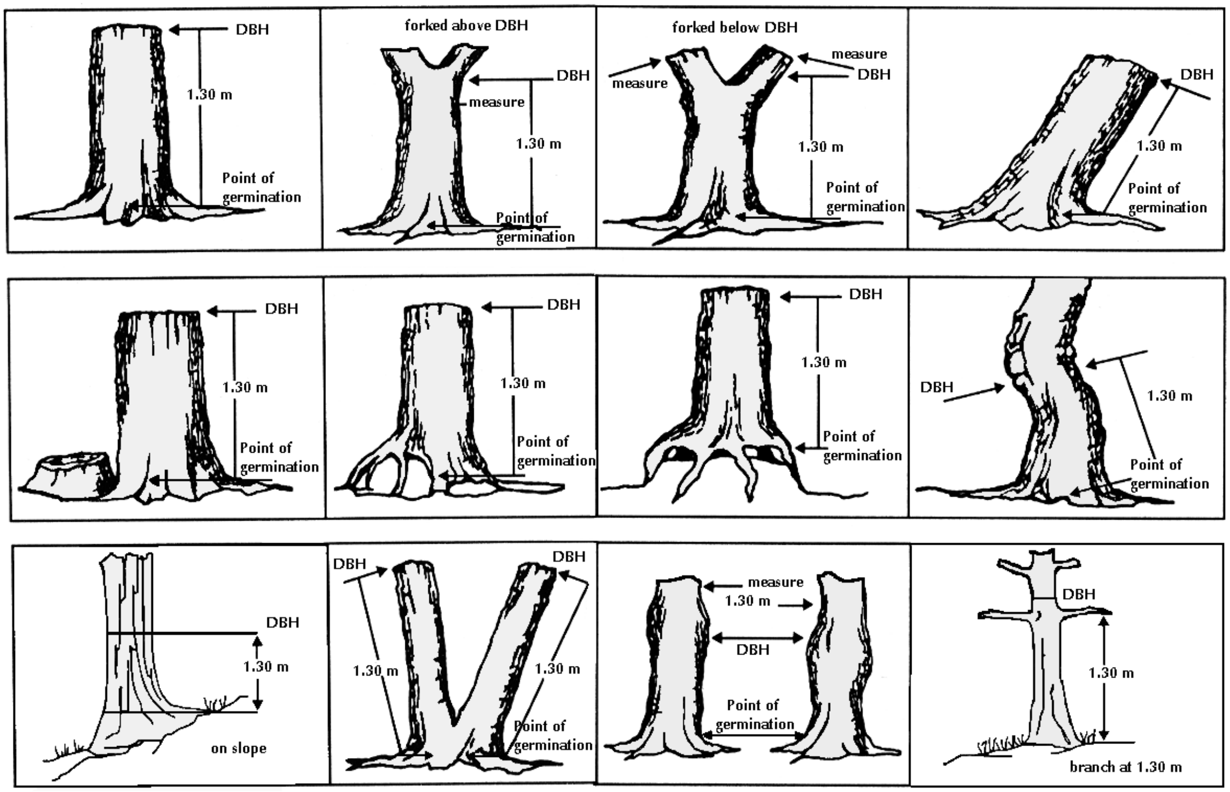
Example:

C 23 Pl5 Aw3 Sw1 Sb1 →

Attribute	Descriptor
C	Dom & Codom crown closure between 50 – 75 %
23	Dom & Codom avg. height = 23 m
Pl5	Lodgepole pine between 41-50 %
Aw3	Aspen between 21-30 %
Sw1	White spruce between 0-10 %
Sb1	Black spruce between 0-10 %

10. Appendix 4 – Tree Assessment

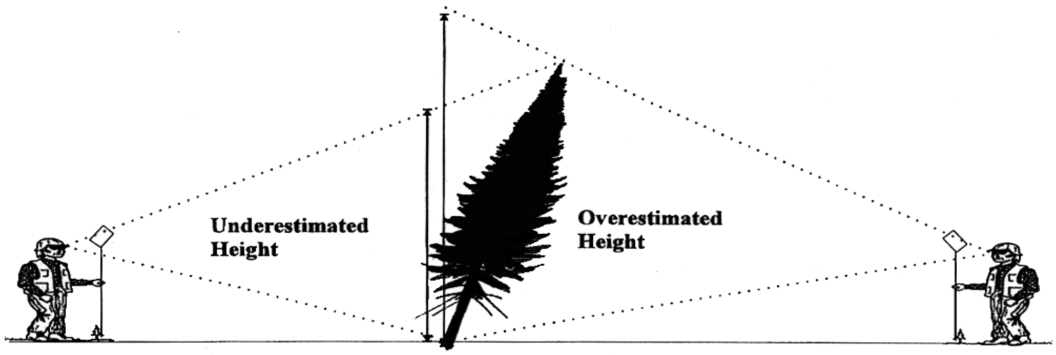
10.1 DBH Positioning



Modified from: Ontario Ministry of Natural Resources. 1994. PSP Establishment Manual for Northeastern Ontario. P.16-17.

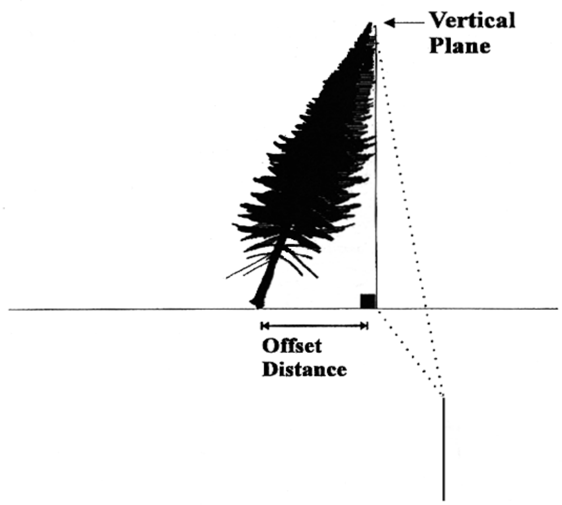
10.2 Height Measurement of Leaning Tree

INCORRECT METHOD TO MEASURE TREE HEIGHT



OBSERVERS ARE PARALLELL TO THE LEAN OF THE TREE

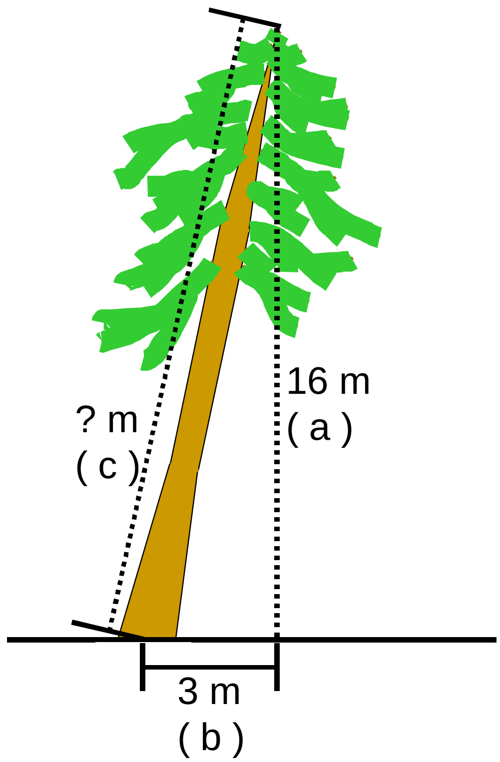
CORRECT METHOD TO MEASURE TREE HEIGHT



OBSERVER IS PERPENDICULAR TO THE LEAN OF THE TREE

Modified from: Ontario Ministry of Natural Resources. 1995. Field Manual for Establishing and Measuring Permanent Sample Plots. P.E-12.

10.3 Measurement and Calculation of Leaning Tree Hieght.



Using Pythagoras' Theorem:

$a^2 + b^2 = c^2$

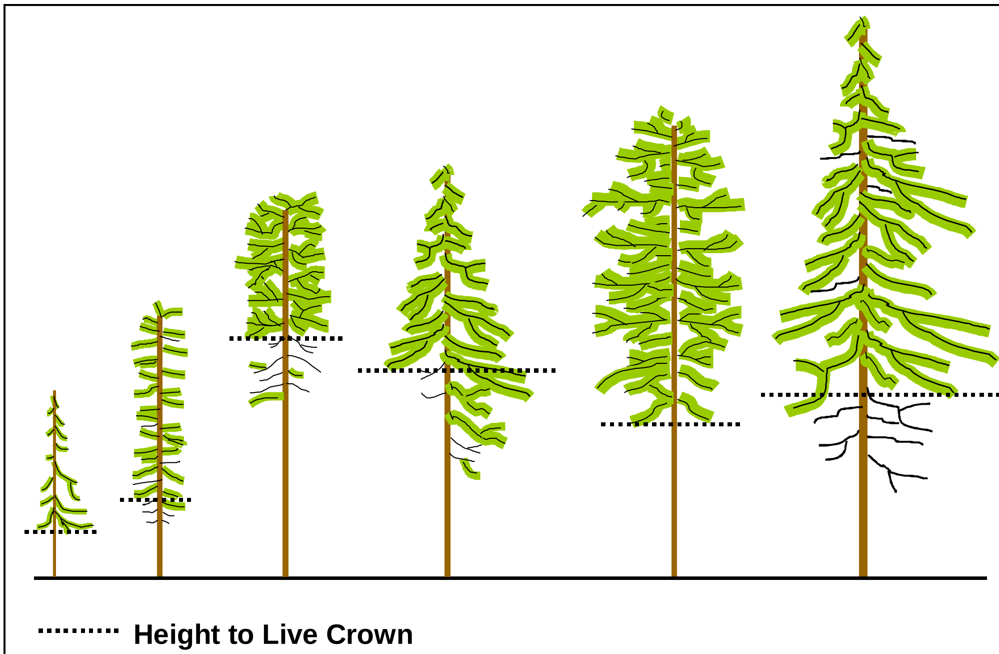
$16^2 + 3^2 = c^2$

$\sqrt{265} = \sqrt{c^2}$

$\underline{\mathbf{16.28 = c}}$

<u>Height of Leaning Tree: 16.3m</u>

10.4 Height to Live Crown



10.5 Crown Fullness Factor Assessment

i) The Crown Fullness Factor is a code that represents a quantitative assessment of the proportion of the crown that is filled with live branches and needles/leaves.

This assessment is completed along with the assessment of 1) height to live crown, and 2) crown radius, to provide a means of relatively comparing crowns.

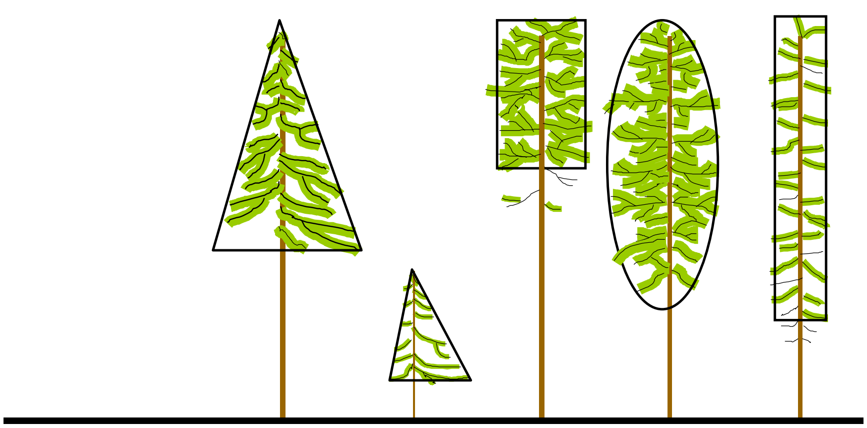
Crown fullness factor assessment can be completed on trees of any size or species (however, for deciduous trees, the assessment must be completed while the needles or leaves are still on).

Methodology

1. Envisage the selected crown encompassing the live crown, and assess what portion of the shape is filled with live branches and needles/leaves as opposed to empty space.

2. Based on the percent of the imaginary shape that is filled with live branches and needles/leaves, assign a crown fullness % code, as defined in the following table:

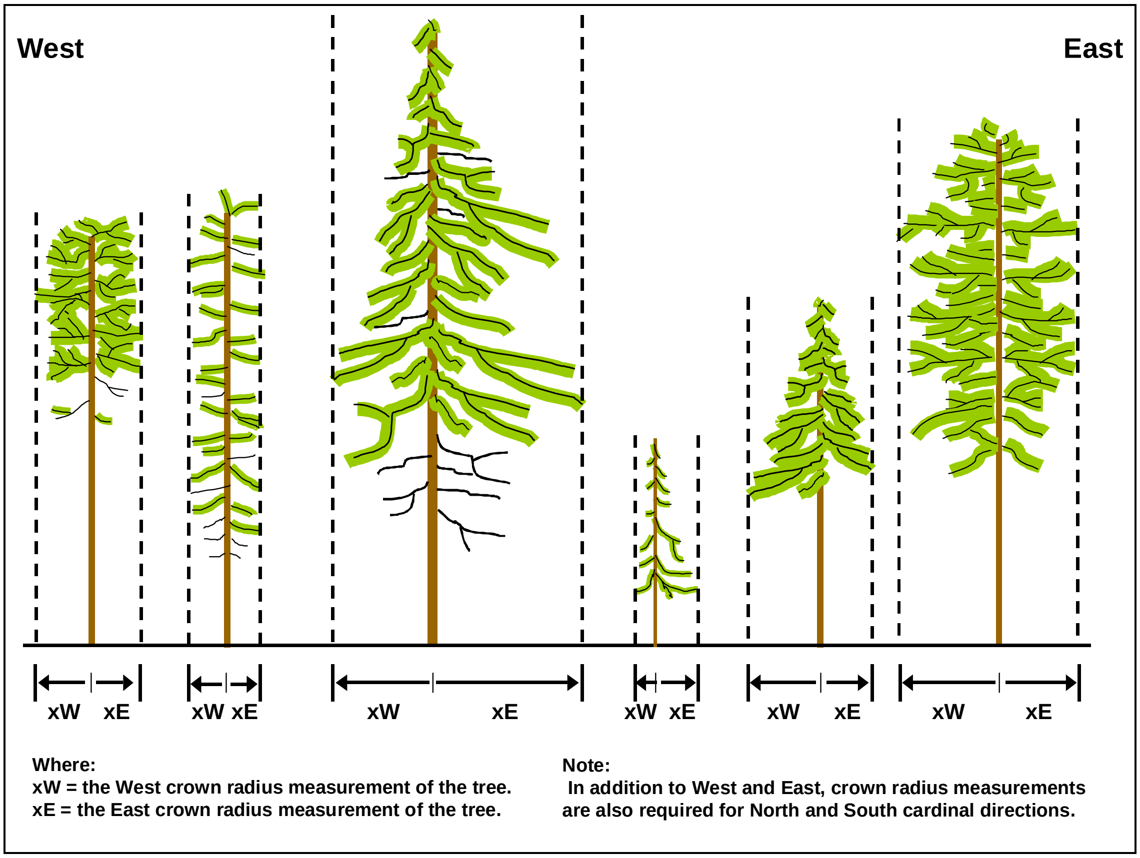
Crown Fullness %	Code
0 – 10 %	0
11 – 20 %	1
21 – 30 %	2
31 – 40 %	3
41 – 50 %	4
51 – 60%	5
61 – 70 %	6
71 – 80 %	7
81 – 90 %	8
91 – 100 %	9



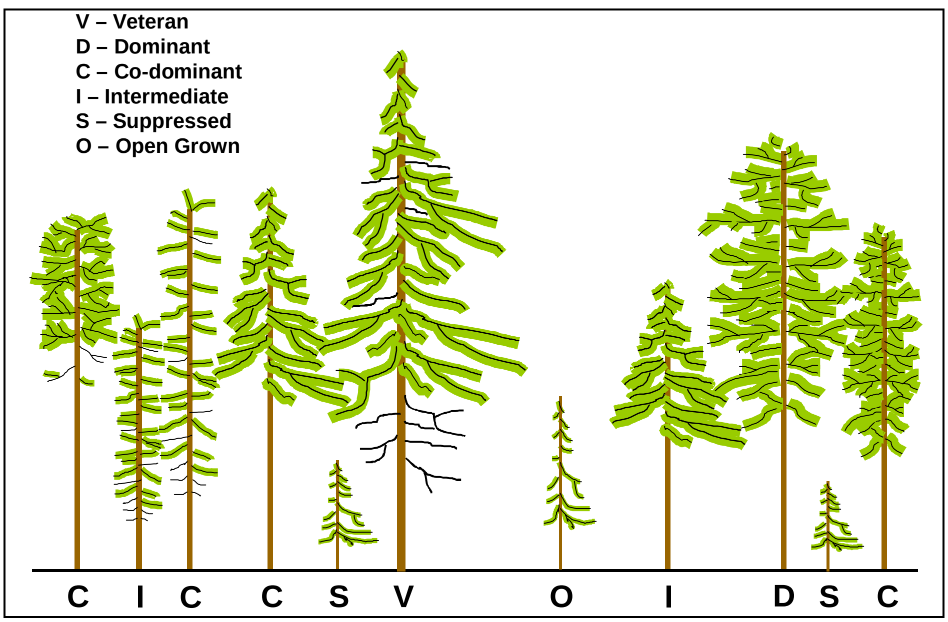
Crown Shape	Triangle	Triangle	Rectangle	Ellipse	Rectangle
Crown Shape Code	T	T	R	E	R
Crown Fullness %	43 %	16 %	71 %	64 %	22 %
Crown Fullness % Code	4	1	7	6	2

Figure 6. Crown Fullness Factor Assessment

10.6 Crown Radius Assessment



Crown Position Assessment



11. Appendix 5 – Ecological Land Classification

11.1 ELC Tally Card. Page 1

ECOLOGICAL ASSESSMENT FORM Page of

Plot No. ____ Location ____ Date (Yr Mo Day) ____

Strip Line ____ Surveyed by: ____

SITE

Ecoregion	Aspect Class	Edatopic Grid Position
Ecosite	Slope Pos. C U M L T D E	MR 1 2 3 4 5 6 7 8 9
Phase	Slope Class	NR A B C D E F
Community		Surface Expression A B F H I L M R S T U V
Ecosite Fit G F P		Parent Material M L E F GF O R
Ecosite Prediction		

SOILS

Duff Depth cm	
Humus Form Mor Moder Mull	

Layer 1:
Thickness (cm): ____
Texture: ____
Coarse Frag.: % ____
Coarse Frag. Type: G C S B

Depth to:	
Water	cm
Mottles	cm
Gleying	cm
Calcar.	cm
ERD	cm
Bedrock	cm

Layer 2:
Thickness (cm): ____
Texture: ____
Coarse Frag.: % ____
Coarse Frag. Type G C S B

Soil Type: ____

Layer 3:
Thickness (cm): ____
Texture: ____
Coarse Frag.: % ____
Coarse Frag. Type G C S B

VEGETATION

Forest Cover Type: ____ Breast Height Age: ____

Vegetation Structure	SW	SE	SB	PL	PJ	FB	LT	FD	AW	PB	BW	
Main Canopy												
Understory > 10m												
Understory 4 - 10m												
Understory < 4m												

Cover Classes (%) A: < 1 B: 1 - 5 C: 6 - 20 D: 21 - 50 E: > 50

PAIRED PLOT LINKAGE & SITE INDEX

Pair Plot Linkage: Yes No | Link to Plot #:

Site Index Information

Tree #	Species	G.I.(yrs)	G.I.(cm)	D.B.H.(cm)	B.H. Age (yrs)	Height(m)

Comments:

11.2 ELC Tally Card. Page 2

VEGETATION TABLE					
SHRUB LAYER			**HERB LAYER**		
Common Juniper	junicom		Stiff Clubmoss	lycoann	
Kinnikinnick	arctuva		Ground-Cedar	lycocom	
Bog Cranberry	vaccvit		Showy Aster	astecon	
Labrador Tea	ledugro		Lindsey's Aster	astecil	
Shrubby Cinquefoil	potefru		Heart-Leaved Arnica	arnicor	
Blueberry	vaccmyr		Wild Strawberry	fragvir	
Dwarf Bilberry	vacccae		Bunchberry	corncan	
Tall Bilberry	vaccmem		Fireweed	epilang	
White Meadowsweet	spirbet		Twinflower	linnbor	
Saskatoon	amelaln		Northern Bedstraw	galibor	
Buffalo-berry	shepcan		Cream-colored Peavine	lathoch	
Beaked Hazel	corycor		Wild Vetch	viciame	
Prickly Rose	rosaaci		Yarrow	achimil	
Low-bush Cranberry	vibuedu		Common Pink Wintergreen	pyroasa	
White Rhododendron	rhodalb		One-sided Wintergreen	orthsec	
False Azalea	menzfer		Lily-of-the-Valley	malacan	
Elderberry	sambrac		Tall Mertensia	mertpan	
Mountain Ash	sorbsco		Wild Sarsaparilla	aralnud	
Wild Raspberry	rubuida		Running Raspberry	rubupub	
Thimbleberry	rubupar		Sweet-scented Bedstraw	galitri	
Black Current	ribelac		Palmate-leaved Coltsfoot	petapal	
Choke Cherry	prunvir		Baneberry	actarub	
Snowberry	sympalb		Bishop's Cap	mitenud	
Bracted Honeysuckle	loniinv		Kidney-leaved Violet	violren	
Twining Honeysuckle	lonidio		Twisted-stalk	streamp	
Green Alder	alnucri		Oak Fern	gymndry	
Devil's Club	oplohor		Tall Larkspur	delpgla	
Red-Osier Dogwood	cornsto		Cow-parsnip	heralan	
Willow	salispp		Large-leaved Avens	geummac	
Bog Birch	betugla		Woodland Horsetail	equisyl	
Small Bog Cranberry	oxycmic		Common Horsetail	equiarv	
			Meadow Horsetail	equipra	
			Dwarf Scouring Rush	equisci	
MOSSES/LICHENS			Cloudberry	rubucha	
Haircap Moss	polycom		Three-leaved False Solomon's Seal	smiltri	
Red-stem Feathermoss	pleusch		Buck-bean	menytri	
Stair-step Moss	hylospl				
Knight's Plume Moss	ptilcri				
Glow Moss	aulapal		**GRASSES/SEDGES**		
Golden Moss	tomenit		Hairy Wild Rye	elyminn	
Peat Mosses	sphaspp		Marsh Reed Grass	calacan	
Reindeer Lichen	cladspp		Sedges	carespp	
Green Dog Lichen	peltspp		Cotton Grasses	eriospp	

Cover Classes (%) A: < 1; B: 1-5; C: 6-20; D: 21-50; E: > 50

Note: Within each category the species are arranged by moisture requirements. Dry (top) to Wet (bottom)

General Shrub/Herb height: ________ m General Shrub/Herb vigor: G F P

11.3 ELC Tally Card Attributes

Plot – Record the Working Circle and the unique plot number.
i.e., Plot # 21 in the Marlboro: 2-021.

Location – Record the Working Circle and the Compartment number.
i.e., Marlboro 6: 2-06

Date – Record the date that the field assessment was completed.
i.e., June 3rd, 1999: 06/03/99

Strip Line – This field is used when the ELC is completed in conjunction with the operational ELC done within the FMA area. The Working Circle, Compartment and Strip Line number are recorded.
i.e., Strip line 18 in Marlboro 6: 2-06-18

If the ELC is not completed in conjunction with the operational ELC, record "N/A" in the field.

Surveyed by – Record the surveyor(s) and the company's name that completed the ELC assessment.

Site Characteristics
The following fields are to be completed according the FGTEWCA:
- Ecoregion
- Ecosite
- Phase
- Community
- Moisture regime
- Nutrient regime
- Parent Material

The following fields are to be completed according to Section 5.1.2 of this manual (Site information):
- Aspect class
- Slope position
- Slope class

Ecosite Fit – Indicate how accurately the determined ecological classification corresponds to that described in the FGTEWCA, by circling one of the following alpha codes:
G – Good
F – Fair
P - Poor

Surface Expression – Indicate the surface expression of the site by circling the appropriate alpha codes (Description of each surface expression can be found in this section):
A – apron
B – Blanket
F – Fan
H – Hummocky
I – Inclined
L – Level
M – Rolling
R – Ridged
S – Steep
T – Terraced

U – Undulating
V - Veneer

Soil Characteristics
The following fields are to be completed according to the FGTEWCA:

- Organic Matter Thickness
- Depth to "x"
- Soil type
- Soil layer ID
- Soil layer thickness
- Soil layer texture
- Soil layer coarse fragment %

Soil layer coarse fragment type – Indicate the predominant category to coarse fragment found in each soil layer, by circling the appropriate code (as defined by the Canadian System of Soil Classification, 2nd Edition):
G – Gravel: less than 8 cm in diameter
C – Cobbles: greater than 8 cm and less than 25 cm in diameter
S – Stones: greater than 25 cm and less than 60 cm in diameter
B – Boulders: greater than 60 cm in diameter

Vegetation Characteristics
Forest cover type – Complete this field according to the methods described in Section 6.1, Stand Information, of this manual.

Breast Height Age – Determine the breast height (1.3 m above germination) age of the site trees within the plot, as per section 3.7.3 – age measurements. For trees less than 1.3 m, the whorls of the tree should be counted to determine the age.

Vegetation Structure – Complete the Vegetation Structure Table by inserting the following cover classes in the appropriate structural level for the appropriate species:
A - <1 %
B – 1–5 %
C – 6–20 %
D – 21–50 %
E - >50 %

Pair Plot Linkage & Site Index
Pair Plot Linkage – When two plots within a cluster, one in a mature stand and one in a regenerating stand, are found to have the same ecosite they will be considered "paired plots". However, the surveyor must be confident that the plot in the regenerated stand had the same ELC as the plot in the mature timber.

Paired plots linkages within a cluster should be indicated by circling either "Yes" or "No". If an ecological linkage exists, record the plot number in the "Link to Plot" field.

Site Index Information – This section is targeted at collecting site quality information for regenerating stands. Site index data is to be collected from PGS plots located within regenerating stands that are less than or equal to 60 years in age. To collect site index information, the PGS plot should be split into 4, square quadrants (NW,SW,SE,SW) from which one site tree should be selected from each quadrant (see section 3.6.6). In the case that a site tree cannot be found within the quadrant, then no tree will be selected in that quadrant.

Site Index Tree Sample Selection:
Species – Determine the dominant crop species, which is healthy and expected to survive to rotation age.

DBH – Select the largest diameter tree of the site index species in each plot.
Age – Minimum of three years of annual growth above breast height.
Stem Condition – Dominant or co-dominant and not overtopped by competing vegetation.
Ring width – Vigorous; uniform from pith to bark (at breast height).

Once the site tree has been selected in each quadrant, each tree should be flagged and identified as a site tree. If the site tree's first three to five annual whorls above BH can be determined, then both the growth intercept and site index measurements should be taken; meaning, all columns in the Site Index Information table are to be completed. If the first three to five annual whorls above breast height cannot be determined, no measurements will be taken. Consistent data collection and database/analysis issues are the basis for this decision.

Tree # – Record the Site Tree number you have assigned to the tree (#1- 3), in this field. If the site tree has a tag from the last measurement, record the tree number as well.

Species – Record the species of the site tree. All three site trees are to be of the same species – the dominant tree species in both composition and crown positioning.

G.I. Age (growth increment age) – Record the number of years included in the length measurement. A minimum of three and a maximum of five years is used for this particular method. Choose the higher growth increment age where available (i.e. 5 whorls instead of 3 whorls).

G.I. Length (length of the chosen G.I. Age) – Record the length of the growth increment in centimeters. From the first whorl above DBH, measure to the whorl, which ends the annual growth of the last year in the growth increment age. i.e., if G.I. age = 4, measure the length of the section from the first whorl above DBH, to the top of the fourth section of annual growth.

D.B.H. (diameter at breast height) – Record the diameter at breast height as described in Section 5.2, PGS Plot Tally Sheet.

B.H Age (age at breast height) - Record the age of the tree at breast height as described in section 5.2, PGS Plot Tally Sheet. If these measurements are taken in the middle of the growing season, the height should be taken at the end of the previous growing season.

Height (total height of tree) – Record the total height of the tree as described in section 5.2, PGS Plot Tally Sheet. If these measurements are taken in the middle of the growing season, the height should be taken the end of the previous growing season.

Vegetation Table
Vegetation List – Complete the vegetation list by recording the cover class codes as described in Section 3.7.1.4, next to the appropriate species.

General Shrub/Herb Layer – Record the average height of the shrub/herb layer on site. This estimate is recorded to the nearest 1/10 of a meter.

General Shrub/Herb Height – Indicate the overall vigor of the shrub/herb layer on the site by circling one of the following condition codes:

G – Good
F – Fair
P – Poor

Surface Expression

The surface expression of genetic materials is their form (assemblage of slopes) and pattern of forms. Form as applied to unconsolidated deposits refers specifically to the product of the initial mode of origin of the materials. When applied to consolidated materials, form refers to the product of their modification by geological processes. Surface expression also indicates the manner in which unconsolidated genetic materials relate to the underlying unit.

Classes for unconsolidated and consolidated mineral components

a—Apron	h—Hummocky
m—Rolling	t—Terraced
b—Blanket	i—Inclined
r—Ridged	u—Undulating
f—Fan	l—Level
s—Steep	v—Veneer

Apron: A relatively gentle slope at the foot of a steeper slope and formed by materials from the steeper, upper slope.
Examples: two or more coalescing fans, a simple slope.

Blanket: A mantle of unconsolidated materials thick enough to mask minor irregularities in the underlying unit but still conforming to the general underlying topography.
Examples: lacustrine blanket overlying hummocky moraine.

Fan: A fan-shaped form similar to the segment of a cone and having a perceptible gradient form the apex to the toe.
Examples: alluvial fans, talus cones, some deltas.

Hummocky: A very complex sequence of slopes extending from somewhat rounded depressions or kettles of various sizes to irregular to conical knolls or knobs. There is a general lack of concordance between knolls or depressions. Slopes are generally 9-70% (5-35°).
Examples: hummocky moraine, hummocky glaciofluvial.

Inclined: A sloping, unidirectional surface with a generally constant slope not broken by marked irregularities. Slopes are 2-70% (1-35°). The form of incline slopes is not related to the initial mode of origin of the underlying material.
Examples: terrace scarps, river banks.

Level: A flat or very gently sloping, unidirectional surface with a generally constant slope not broken by marked elevations and depressions. Slopes are generally less than 2% (1°).
Examples: floodplain, lake plain, some deltas.

Rolling: A very regular sequence of moderate slopes extending from rounded, sometimes confined concave depressions to broad, rounded convexities producing a wavelike pattern of moderate relief. Slope length is often
1.6 km or greater and gradients are greater than 5% (3°).
Examples: bedrock controlled ground moraine, some drumlins.

Ridged: A long, narrow elevation of the surface, usually sharp crested with steep sides. The ridges may be parallel, sub parallel, or intersecting.
Examples: eskers, crevasse fillings, washboard moraines, some drumlins.

Steep: Erosional slopes, greater than 70% (35°), on both consolidated and unconsolidated materials. The form of a steep erosional slope on unconsolidated materials is not related to the initial mode of origin of the underlying material.
Examples: escarpments, river banks, escarpments, river banks, and lakeshore bluffs.

Terraced: Scarp face and the horizontal or gently inclined surface (tread) above it.
Examples: alluvial terrace.

Undulating: A very regular sequence of gently slopes that extends from rounded, sometimes confined concavities to broad rounded convexities producing a wavelike pattern of low local relief. Slope length is generally less than 0.8 km and the dominant gradient of slopes is 2-5% (1-3°).
Examples: some drumlins, some ground moraine, lacustrine veneers and blanket over morainal deposits.

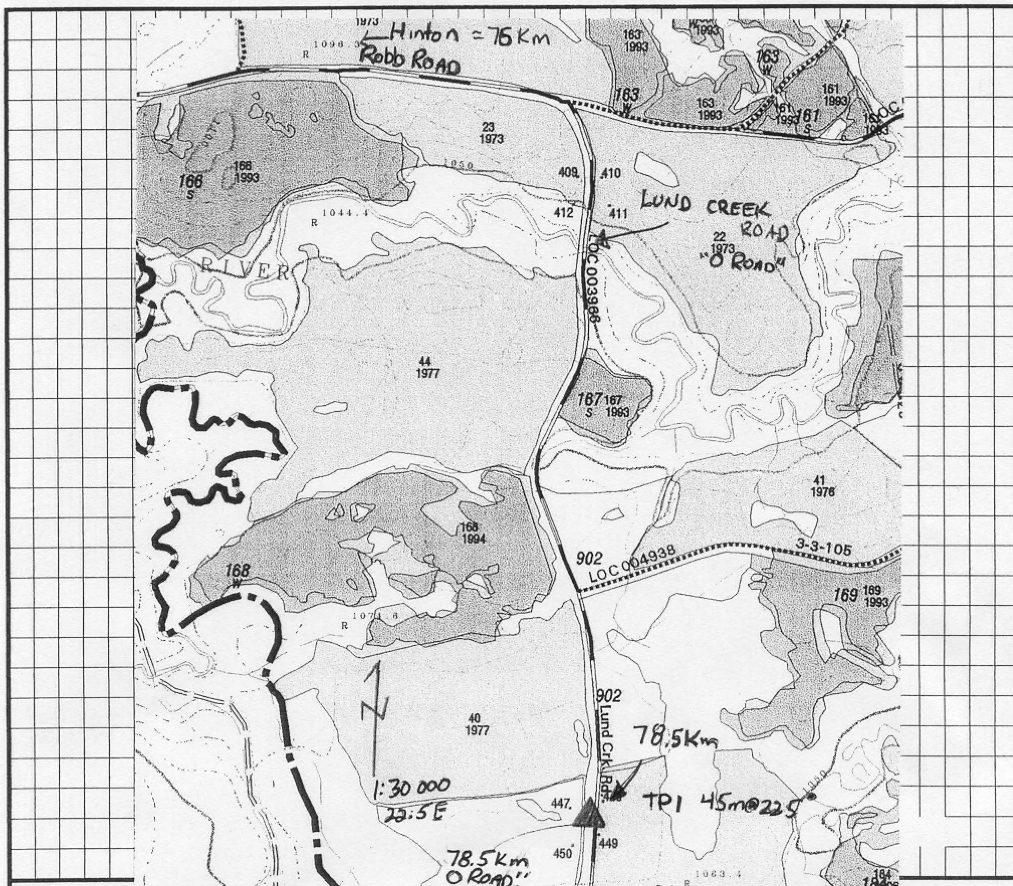
Veneer: Unconsolidated materials too thin to mask the minor irregularities too thin to mask the minor irregularities of the underlying unit surface. A veneer will range from 10 cm to 1 m in thickness and will possess no form typical of the material's genesis.
Examples: shallow lacustrine deposits overlying glacial till, loess cap, etc.

12. Appendix 6 – Plot Location Package

12.1 Example of Completed PGS Cluster Access Map

Weldwood PGS Cluster Access Map

Working Circle	3	**Twn / Rng**	4 8 1 8/1 9
Installation	1	**Photo #**	2 2 E - 1 6 6
PGS Plot Numbers	4 4 7 - 4 5 0	**Drawn by**	
Compartment	0 3	**Date drawn**	F E B 0 1



Notes:

Plot 3-449 Destroyed By Handcut SL

12.2 Example of Completed PGS Cluster Access Notes

Weldwood PGS Plot Establishment Program

Access Notes

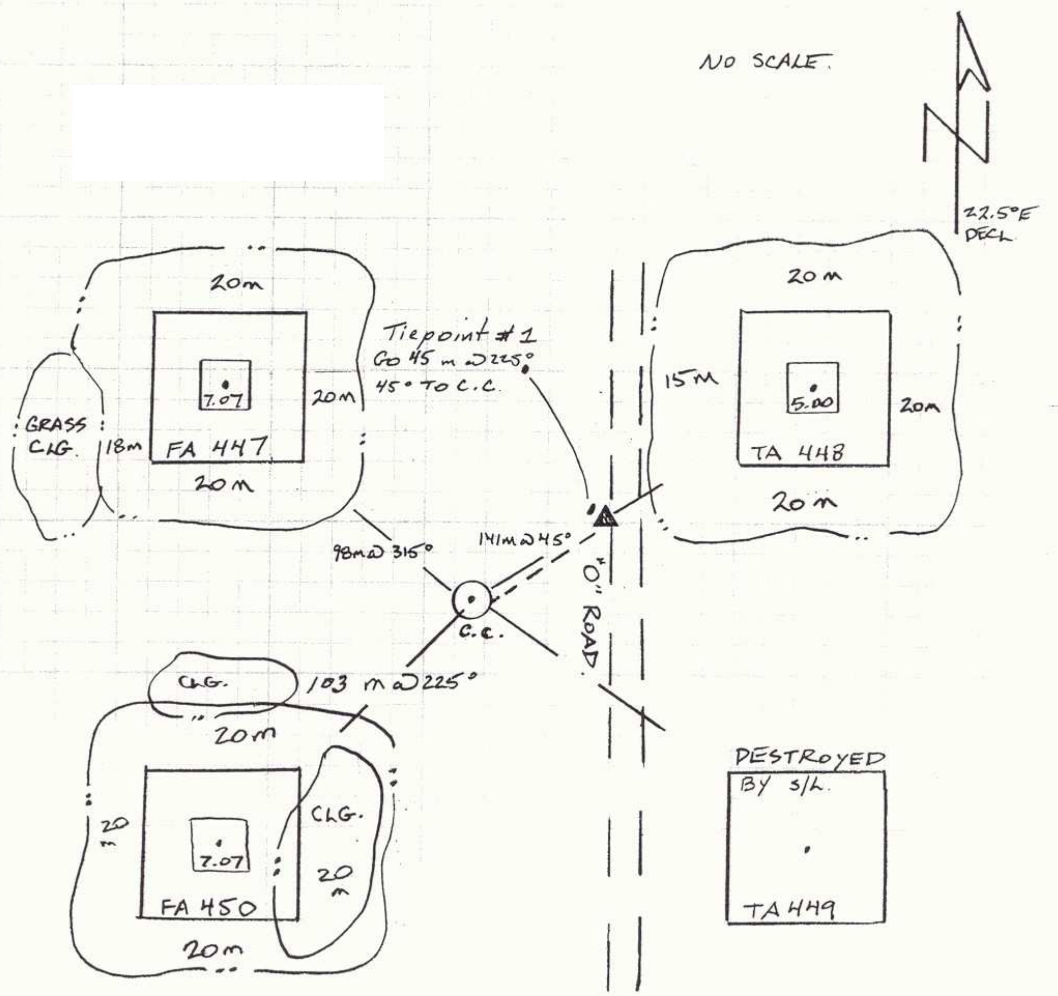
Working Circle	4	Twp/Rng	50/26,27
Installation	1	Date	February 1,2001
PGS Plot Numbers	257-260	Written by	
Compartment	1		

Km	Description
0	At junction of Highway 16W and Highway 40N drive west on Highway 16. 2WD.
10.9	Drive north on Kinky Lake Road. 2WD.
Reset	
2.45	Turn north (right) at fork in road. 2WD.
5.2	Turn northwest (left) on road. 2WD.
6.5	Turn southwest (left) on road. 2WD.
Reset	
1.05	Tie-point on north side of road. Walk 60m @ 360 degrees to cluster center.

12.3 Example of Completed PGS Cluster Access Notes

Weldwood PGS Cluster Layout Map

Working Circle	3	**Twn / Rng**	48 18/19
Installation	1	**Photo #**	22E– 166
PGS Plot Numbers	447 - 450	**Drawn by**	
Compartment	03	**Date drawn**	FEB 01



* ORIGINAL PLACEMENT OF 448, 449
MUST HAVE BEEN DESTROYED BY ROAD
PLOTS WERE MOVED FURTHER EAST

12.4 PGS Cluster Access Map Template

Weldwood PGS Cluster Access Map

Working Circle		**Twn / Rng**	
Installation		**Photo #**	
PGS Plot Numbers		**Drawn by**	
Compartment		**Date drawn**	

N

Scale

Notes:

12.5 PGS Cluster Access Notes Template

Weldwood PGS Cluster Access Notes			
Working Circle		Twn / Rng	
Installation		Date	
PGS Plot Numbers		Written By	
Compartment			

Km	Description
0.0	

12.6 PGS Cluster Layout Map Template

Weldwood PGS Cluster Layout Map

Working Circle		**Twn / Rng**	
Installation		**Photo #**	
PGS Plot Numbers		**Drawn by**	
Compartment		**Date drawn**	

Scale

Notes:

13. Appendix 7 - PGS Measurement Tolerances Summary

13.1 PGS audit summary

PGS Audit Summary			
Contractor	Audit date	Submission status	
AUDIT ELEMENT	**COMMENTS**	**PASS**	**FAIL**
ACCESS NOTES			
CLUSTER LOCATION MAPS			
CLUSTER LAYOUT MAPS			
AERIAL PHOTOS			
FIELD DEMARCATION			
PLOT DATA			
MEASUREMENT DATA			
TREE DATA			
COMMENTS			

13.2 PGS field audit summary

PGS Plot Field Audit Summary					
Contractor	Submission date	Audit date			
Field work date	Plot #				
FIELD DEMARCATION	**STANDARD**	**PLOT NUMBERS WITH ERRORS**			
Tie point tag	Includes all required information, no errors				
Plot center tag	Includes all required information, no errors				
Cluster center tag	Includes all required information, no errors				
Improper plot dimensions	+ / - 5% of correct dimension				
Tie line azimuth TP to CC and CC to PC	+ / - 2 degrees				
Tie line distance TP to CC and CC to PC	+ / - 5%				
Improper 20m outer plot buffer	+ / - 2m				
Accuracy of access notes	+/- 10% on distance, no missed steps				
PLOT DATA	**STANDARD**	**PLOT NUMBERS WITH ERRORS**			
Establishment status	No errors				
Plot size	No errors				
Plot status	No errors				
Slope position	+ /- one class of proper code				
Slope class	+ /- one class of proper code				
Aspect	+ /- one class of proper code				
Elevation	+ /- one class of proper code				
MEASUREMENT DATA	**STANDARD**	**PLOT NUMBERS WITH ERRORS**			
Buffer representative	No errors				
Silviculture system	No errors				
Field overstorey type	Crown cover - +/- one AVI class				
	Height - +/- 2 meters				
	Composition - +/- 10% for each species included				
Field understorey type	Crown cover - +/- one AVI class				
	Height - +/- 2 meters				
	Composition - +/- 10% for each species included				
Field broad cover type	No errors				
Uneven aged type	No errors				
Plot damage 1 and 2	No errors				
Subplot size	No errors				
TREE DATA	**STANDARD**	**TREE NUMBERS WITH ERRORS**			
Sector number	No error				
Species	No error				
Diameter	+/- 0.2 cm, or 2%				
Root collar diameter	+/- 0.2 cm, or 2%				
Height	+/- 0.2 m + 2%				
Height to live crown	+/- 10% of tree height				
Crown fullness	+ / - one class				
Crown radius (4 directions)	+/- 30cm				
Crown position	+/- one class, up to 10% of check sample				
Mortality code	No error				
Damage 1 and 2	Living - No error				
	Dead- +/- one class, up to 10% of check sample				
Damage severity 1 and 2	+/- one class, up to 10% of damages				
Status	No error				

TREE NUMBERS WITH ERRORS

TREE #	Meas	ORIG	CHECK	TREE #	Meas	ORIG	CHECK	TREE #	Meas	ORIG	CHECK

13.3 PGS Cluster Location Package Audit Summary

PGS Cluster Location Package Audit Summary							
Contractor	Submission date		Audit date				
Submission #	Re-submission of previous package?						
ACCESS NOTES	**STANDARD**	**PLOT NUMBERS WITH ERRORS**					
Names of roads	No errors						
Access modes for each section	No errors						
Significant landmarks, and their location	No errors						
Location of tie point	No errors						
Where the access notes terminate (CC or PC)	No errors						
CLUSTER LOCATION MAPS	**STANDARD**	**PLOT NUMBERS WITH ERRORS**					
Scale	No errors						
North arrow with declination	No errors						
Tie point with azimuth and distance to PGS plot	No errors						
Roads with identifying labels	No errors						
Direction and distance to major road or town	No errors						
Kilometer markings	No errors						
Water bodies	No errors						
Historical harvest areas	No errors						
CLUSTER LAYOUT MAPS	**STANDARD**	**PLOT NUMBERS WITH ERRORS**					
North arrow with declination	No errors						
Cluster center location indicated	No errors						
Individual plot numbers labelled	No errors						
Plot locations with azimuth and distance to each	No errors						
Proportional plots with proportional buffers	No errors						
Buffer width indicated	No errors						
Roads in immediate vicinity	No errors						
Seismic lines in immediate vicinity	No errors						
Pipelines in immediate vicinity	No errors						
Powerlines in immediate vicinity	No errors						
Water bodies in immediate vicinity	No errors						
Significant stand type changes	No errors						
AERIAL PHOTOS	**STANDARD**	**PLOT NUMBERS WITH ERRORS**					
Individual plot centers pin pricked	No errors						
Plot centers labelled on back with WC/Plot #	No errors						

Appendix C – Pseudo-Permanent Sample Plot Measurement Schedule

2014 FMP (2016-2025)

Per Survey Year	Meaurement Year	Base 10 Strata	Strata Area (Ha) *Estimated areas shown in italics*	# of Plots Established	# of Plots Re-measured	Total Plots	Age at Measure
2009-2012	2018	Pl	21,330.43	45	0	45	20-23
		Sw	5,444.10	25	0	25	
		HwPl/PlHw	575.04	5	0	5	
		HwSw/SwHw/SbHw	1,004.78	5	0	5	
2013-2017	2021	Pl	*27,352.68*	45	0	45	18-22
		Sw	*6,397.23*	25	0	25	
		HwPl/PlHw	*747.59*	5	0	5	
		HwSw/SwHw/SbHw	*1,143.82*	5	0	5	
2009-2012 (ReMeas 1)	2023	Pl	21,330.43	0	45	45	25-28
		Sw	5,444.10	0	25	25	
		HwPl/PlHw	575.04	0	5	5	
		HwSw/SwHw/SbHw	1,004.78	0	5	5	
2018-2022	2025	Pl	*27,352.68*	45	0	45	17-21
		Sw	*6,397.23*	25	0	25	
		HwPl/PlHw	*747.59*	5	0	5	
		HwSw/SwHw/SbHw	*1,143.82*	5	0	5	
FMP Period Totals		Pl		135	45	180	
		Sw		75	25	100	
		HwPl/PlHw		15	5	20	
		HwSw/SwHw/SbHw		15	5	20	
		All		240	80	320	

2026 FMP (2026-2035)

Per Survey Year	Meaurement Year	Base 10 Strata	Strata Area (Ha) *Estimated areas shown in italics*	# of Plots Established	# of Plots Re-measured	Total Plots	Age at Measure
2013-2017 (ReMeas 1)	2026	Pl	*27,352.68*	0	45	45	23-27
		Sw	*6,397.23*	0	25	25	
		HwPl/PlHw	*747.59*	0	5	5	
		HwSw/SwHw/SbHw	*1,143.82*	0	5	5	
2009-2012 (ReMeas 2)	2028	Pl	21,330.43	0	45	45	30-33
		Sw	5,444.10	0	25	25	
		HwPl/PlHw	575.04	0	5	5	
		HwSw/SwHw/SbHw	1,004.78	0	5	5	
2023-2027	2030	Pl	*27,352.68*	45	0	45	17-21
		Sw	*6,397.23*	25	0	25	
		HwPl/PlHw	*747.59*	5	0	5	
		HwSw/SwHw/SbHw	*1,143.82*	5	0	5	
2018-2022 (ReMeas 1)	2030	Pl	*27,352.68*	0	45	45	22-26
		Sw	*6,397.23*	0	25	25	
		HwPl/PlHw	*747.59*	0	5	5	
		HwSw/SwHw/SbHw	*1,143.82*	0	5	5	
2013-2017 (ReMeas 2)	2031	Pl	*27,352.68*	0	45	45	28-32
		Sw	*6,397.23*	0	25	25	
		HwPl/PlHw	*747.59*	0	5	5	
		HwSw/SwHw/SbHw	*1,143.82*	0	5	5	
2009-2012 (ReMeas 3)	2033	Pl	21,330.43	0	45	45	35-38
		Sw	5,444.10	0	25	25	
		HwPl/PlHw	575.04	0	5	5	
		HwSw/SwHw/SbHw	1,004.78	0	5	5	
2028-2032	2035	Pl	*27,352.68*	45	0	45	17-21
		Sw	*6,397.23*	25	0	25	
		HwPl/PlHw	*747.59*	5	0	5	
		HwSw/SwHw/SbHw	*1,143.82*	5	0	5	
2018-2022 (ReMeas 2)	2035	Pl	*27,352.68*	0	45	45	27-31
		Sw	*6,397.23*	0	25	25	
		HwPl/PlHw	*747.59*	0	5	5	
		HwSw/SwHw/SbHw	*1,143.82*	0	5	5	
2023-2027 (ReMeas 1)	2035	Pl	*27,352.68*	0	45	45	22-26
		Sw	*6,397.23*	0	25	25	
		HwPl/PlHw	*747.59*	0	5	5	
		HwSw/SwHw/SbHw	*1,143.82*	0	5	5	
FMP Period Totals		Pl		90	315	405	
		Sw		50	175	225	
		HwPl/PlHw		10	35	45	
		HwSw/SwHw/SbHw		10	35	45	
		All		160	560	720	

Next FMP (2036-2045)

Per Survey Year	Meaurement Year	Base 10 Strata	Strata Area (Ha) *Estimated areas shown in italics*	# of Plots Established	# of Plots Re-measured	Total Plots	Age at Measure
2013-2017 (ReMeas 3)	2036	Pl	*27,352.68*	0	45	45	33-37
		Sw	*6,397.23*	0	25	25	
		HwPl/PlHw	*747.59*	0	5	5	
		HwSw/SwHw/SbHw	*1,143.82*	0	5	5	
2033-2037	2040	Pl	*27,352.68*	45	0	45	17-21
		Sw	*6,397.23*	25	0	25	
		HwPl/PlHw	*747.59*	5	0	5	
		HwSw/SwHw/SbHw	*1,143.82*	5	0	5	
2018-2022 (ReMeas 3)	2040	Pl	*27,352.68*	0	45	45	32-36
		Sw	*6,397.23*	0	25	25	
		HwPl/PlHw	*747.59*	0	5	5	
		HwSw/SwHw/SbHw	*1,143.82*	0	5	5	
2023-2027 (ReMeas 2)	2040	Pl	*27,352.68*	0	45	45	27-31
		Sw	*6,397.23*	0	25	25	
		HwPl/PlHw	*747.59*	0	5	5	
		HwSw/SwHw/SbHw	*1,143.82*	0	5	5	
2028-2032 (ReMeas 1)	2040	Pl	*27,352.68*	0	45	45	22-26
		Sw	*6,397.23*	0	25	25	
		HwPl/PlHw	*747.59*	0	5	5	
		HwSw/SwHw/SbHw	*1,143.82*	0	5	5	
2038-2042	2045	Pl	*27,352.68*	45	0	45	17-21
		Sw	*6,397.23*	25	0	25	
		HwPl/PlHw	*747.59*	5	0	5	
		HwSw/SwHw/SbHw	*1,143.82*	5	0	5	
2023-2027 (ReMeas 3)	2045	Pl	*27,352.68*	0	45	45	32-36
		Sw	*6,397.23*	0	25	25	
		HwPl/PlHw	*747.59*	0	5	5	
		HwSw/SwHw/SbHw	*1,143.82*	0	5	5	
2028-2032 (ReMeas 2)	2045	Pl	*27,352.68*	0	45	45	27-31
		Sw	*6,397.23*	0	25	25	
		HwPl/PlHw	*747.59*	0	5	5	
		HwSw/SwHw/SbHw	*1,143.82*	0	5	5	
2033-2037 (ReMeas 1)	2045	Pl	*27,352.68*	0	45	45	22-26
		Sw	*6,397.23*	0	25	25	
		HwPl/PlHw	*747.59*	0	5	5	
		HwSw/SwHw/SbHw	*1,143.82*	0	5	5	
FMP Period Totals		Pl		90	315	405	
		Sw		50	175	225	
		HwPl/PlHw		10	35	45	
		HwSw/SwHw/SbHw		10	35	45	
		All		160	560	720	

Appendix D – Hinton Wood Products Temporary Sample Plot Program Manual

Hinton Wood Products
A Division of West Fraser Mills Ltd.

Temporary Sample Plot Program for 2026 Forest Management Plan Yield Curve Development

DRAFT

May 19, 2017

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Introduction

The goal of this sampling program is to collect data to support development of yield curves for the Hinton Wood Products 2026 Forest Management Plan (FMP). The sampling area is the E14 Forest Management Unit (FMU), which includes the Hinton Wood Products Forest Management Area (FMA), as well as other green zone land.

The proposed approach is to use a series of temporary sample plots (TSPs), with separate programs for Natural and Regenerated Stands. It is expected that the protocols developed in the program will also be used for yield monitoring in the future.

This document describes the elements of the program, including sampling intensity, plot locations, field procedures and quality control.

Plot Allocation

A TSP data collection program to gather data for the estimation of managed (harvested) and unmanaged (natural fire origin) yield curves for the next FMP will be initiated in 2023. The 2023 sampling program includes both Unmanaged (natural fire origin) and Managed (harvested) stands. Sampling procedures are described in this document.

2023 Plots – Unmanaged Stands

Stand and Plot Selection Process

Locations for plot establishment will be selected using a systematic random sampling approach. A 500m grid will be established across the E14 FMU. The grid will be overlaid with the contributing land base, and points that are in non-contributing areas will be excluded from the potential sampling population, along with points that are in any harvested areas.

Points that were within 10 meters of a land base boundary will be excluded.

Each remaining point in the grid is a potential TSP location and will be assigned a random number for plot establishment. The points will then be stratified at minimum by:

- RSA Base 10 Yield Strata
- Natural Sub-region group:
    - The Upper Foothills group includes Upper Foothills, Montane, Subalpine and Alpine.
    - The Lower Foothills group includes Lower Foothills.
- Age class:
    - Young = 15 to 39
    - Immature = 40 to 79
    - Mature = 80 to 119
    - Old = > 120

Major strata (i.e. Pine) will be further stratified by the following categories:

- Density:
  - A & B density stands grouped together (crown closure 6-50%)
  - C density stands (crown closure 51-70%)
  - D density stands (crown closure 71-100%)
- Timber Productivity Rating (TPR):
  - Fair
  - Medium
  - Good

The target number of plots in each of the Base 10 yield stratum is 90, with the exception of the Pine strata (8), which will be assigned additional plots. These plots will be distributed based on the proportion of the points in each Natural Sub-region, Age Class, Density, and Timber Productivity Rating (TPR) combination. After the number of plots within each stratum is determined, the plot locations will be determined by sorting the random numbers assigned to the points, and choosing them sequentially until the required number of plots in each stratum has been selected.

2023 Plots – Managed Stands

Stand and Plot Selection Process

Locations for plot establishment will be selected using a systematic random sampling approach. A 500m grid will be established across the E14 FMU. The grid will be overlaid with the contributing land base, and points that are in non-contributing areas will be excluded from the potential sampling population, along with points that do not fall within harvested areas.

Points that were within 10 meters of a land base boundary will be excluded.

Each remaining point in the grid is a potential TSP location and will be assigned a random number for plot establishment. The points will then be stratified at minimum by:

- RSA Base 10 Yield Strata
- Natural Sub-region group:
  - The Upper Foothills group includes Upper Foothills, Montane, Subalpine and Alpine.
  - The Lower Foothills group includes Lower Foothills.
- Age class:
  - Young = 20 to 39
  - Immature/Mature = > 40

Major strata (i.e. Pine) will be further stratified by the following categories:

- Density:
  - A & B density stands grouped together (crown closure 6-50%)
  - C density stands (crown closure 51-70%)
  - D density stands (crown closure 71-100%)
- Timber Productivity Rating (TPR):
  - Fair
  - Medium
  - Good

The target number of plots in each of the Base 10 yield stratum is 90, with the exception of the Pine strata (8), which will be assigned additional plots. These plots will be distributed based on the proportion of the points in each Natural Sub-region, Age Class, Density, and Timber Productivity Rating (TPR) combination. After the number of plots within each stratum is determined, the plot locations will be determined by sorting the random numbers assigned to the points, and choosing them sequentially until the required number of plots in each stratum has been selected.

All Programs

The final plot allocation will occur after the development of the next landbase, scheduled to be completed once the next AVI is completed in 2023. The number of plots needed for each strata and possible strata groupings will be looked at in further detail at that time.

Plot Centre Establishment

Plots will be established within 10 meters of the planned location, using a GPS to locate the plot centre. The plot will be moved if too close to a stand edge or near an unmapped seismic line, pipeline or other lineal disturbance. The plot movement priority is to:

a) Move the plot 20 m north of the original location
b) Move the plot 20 m east of the original location
c) Move the plot 20 m south of the original location
d) Move the plot 20 m west of the original location
e) If none of the alternate locations are suitable, the plot will be abandoned and a new location selected.

Plots will not be established if they fall within a disturbed area (including cut blocks). Plots that fall within unmapped cut blocks or disturbed areas will be abandoned without attempting to move them. This is because the area may have been harvested or disturbed after plot allocation was completed, and moving the plot would compromise the integrity of the sampling design. In such a case another plot will be selected and a new location provided.

Plot Layout

Fire origin stand TSPs consist of 3 nested plots as illustrated in Figure 1:

- 300 m^2 top height plot
- 200 m^2 main tree plot
- 50 m^2 sapling plot

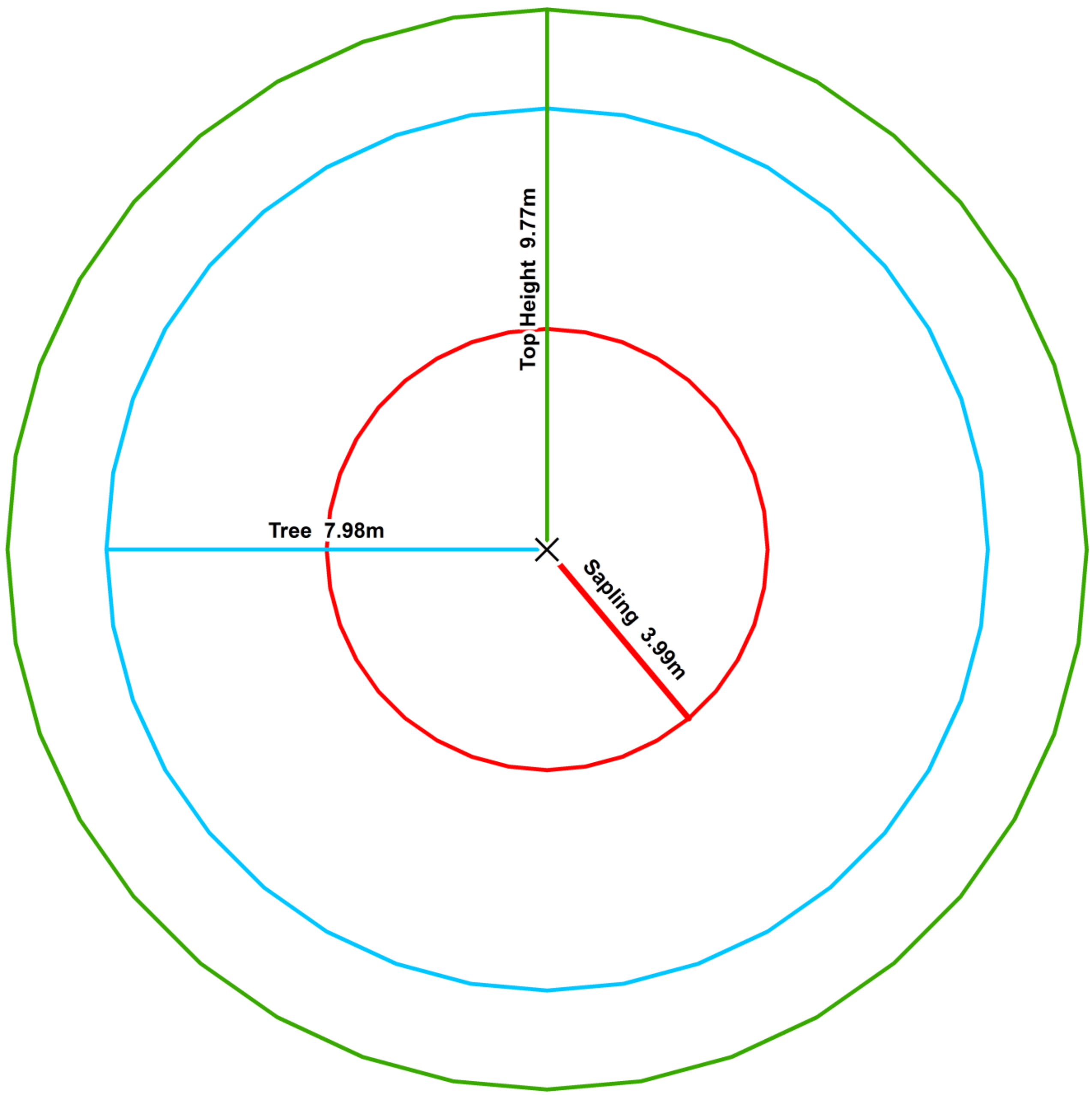

Figure 1 Plot layout for fire origin plots.

Plot Data Collection

Plot Information

The following plot information will be recorded:

- GPS location: NAD83 UTM Zone 11 North
    - To ensure accuracy of the plot location, a minimum of 60 GPS observations must be recorded in the collection of the plot centre GPS point
- Tie Point: Direction to the plot from the last main access point
- Plot access code: See table 1
- Access notes

Measurement Information

The following measurement information will be recorded:

- Measurement date
- Company
- Names of up to two cruisers
- Relevant comments about the measurement, such as if the measurements are taken on a particularly windy day, plot movement decisions, etc.

Tree Information

All acceptable trees greater than 5.1 cm DBH in the 200 m^2 main tree plot will be numbered. In the sapling subplot, trees > 1.3 m in height and <= 5 cm DBH will be numbered. Acceptable trees are all living trees.

For each numbered tree in the tree and sapling plots, the following will be recorded:

- Tree number
- Tree location (Main plot, sapling plot, outside plot)
- Species (Pl, Sw, Sa, Fa, Fb, Sb, Lt, Aw, Pb, Bw)
- Diameter at breast height to the nearest 0.1 cm
- Record the height to the nearest 0.1 m for **every fifth tree** for each species group
- Crown Class (D, C, I, S)
- Condition code - record up to two for each tree
- Cause - required for each condition recorded unless the tree is healthy
- Severity - required every time a cause is recorded

The condition, cause and severity codes will be based on those used in the Provincial Growth and Yield Initiative and are listed in Appendix 1. Details on how to interpret the codes are in Appendix 2.

Top Height Trees

Top height trees are the three largest diameter trees of each species group in the 300 m^2 top height plot that are:

- Alive
- Do not have a broken or dead top

- Do not have western gall rust encircling more than 50% of the main stem

Species groups are:

- Pine group: lodgepole pine and larch
- White spruce group: white spruce, balsam fir, alpine fir, Engelmann spruce
- Black spruce group: black spruce
- Aspen group: trembling aspen, balsam poplar

For top height trees that are outside the main plot, the following will be recorded:

- Tree number
- Location (Outside Plot or Main Plot)
- Species
- Height to the nearest 0.1 m
- DBH to the nearest 0.1 cm
- Breast height age (increment bore)

Quality Control

A quality control (QC) program will be used to ensure that high quality data is collected following the program specifications. Quality control will be conducted periodically while crews are working to ensure any errors are identified as soon as possible.

Five percent (5%) of plots established by each contractor will be audited. The following table outlines the measurements that will be checked and the rework triggers.

Attribute	Tolerance	Re-work Trigger
Tie point	Must be easy to locate accurately	
Plot Centre	Marked with steel pin and 30cm above ground level	
Plot location	Within 10 m of planned location	>10 m off
Measurement Date	Required	Must be present for all plots
Cruiser	Required	At least one cruiser for each plot
Site tree age	Within 2 years for conifer, 5 years for deciduous	More than 10%
Number of trees	No variance allowed	Incorrect on > 5% of plots
Number of sapling	No variance allowed	Incorrect on > 5% of plots
Number of regen trees	No variance allowed	Incorrect on > 5% of plots
Top height trees	Must be correctly identified	Any incorrect tree
Species	No variance allowed	>5% of trees incorrect
DBH	Within 0.3cm	>5% of DBH inaccurate
Height	Within 3%	>5% of heights inaccurate
Crown Class	Within one crown class	>5% of trees incorrectly assigned
Condition/cause/severity	No variance	>10% of trees incorrectly assigned

Data Submission

Contractors will collect and record data using any method that they choose. Data will be submitted in a MS Access database that will be provided by Hinton Wood Products.

The database contains routines for data validations that identify both data errors and warnings that there may be an issue with the data. Data validation will be run prior to submission to catch any errors that may be present. Warnings will be explained using comment fields.

Appendix 1: Data Codes

PlotAccessID	Plot Access Description
1	All Weather Road
2	Dry Weather Road
3	Deteriorating Road
4	All Terrain Vehicles
5	Helicopter Only
6	Lengthy Walk
7	Boat

ConditionID	Tree Condition
0	Live and healthy
1	Dead but standing
3	Broken or dead top
4	Bole damage
5	Crown damage
6	Root damage
7	Crook
8	Sweep
9	Fork
10	Lean
11	Poor form
12	Same stump

CauseID	Description
0	None
1	Spruce budworm
2	Defoliator
3	Mountain pine beetle
4	Root Collar weevil
5	Terminal weevil
6	Armillaria root disease
7	Shepard's crook
8	Dwarf Mistletoe
9	Stem disease
10	Western gall rust (WGR)
11	Animal damage

12	Wind damage
13	Snow/ice/frost damage
14	Hail damage
15	Fire damage
16	Mechanical damage
17	Improper planting
18	Poor ground conditions
19	Competition
20	Insect (other)
21	Disease (other)
22	Climate/weather/flood damage
23	Anthropogenic damage
99	Unknown

SeverityID	Severity Description	Definition
1	Minor	obvious condition but expected to have no long-lasting damage
2	Medium	(long-lasting damage but not severe, e.g., broken or dead top <1/3 of the tree
3	Severe	long-lasting damage, possible mortality, e.g., gull rust circling ≥50% of main stem, leaning ≥20^0 off the vertical axis

Appendix 2: Condition Code Descriptions

Table 1. Descriptions of tree condition codes, causal agents and severity of condition (part 1 of 3).

General Tree Condition Codes		
Code	**Condition**	**Description of Use**
0	Live and Healthy	A tree is live and has no noticeable defect or damage.
1	Dead But Standing	A tree is completely dead (i.e., no live buds or foliage) but remains standing.
3	Broken or Dead Top	The upper portion of the tree has died or broken off.
4	Bole Damage	The main stem of a tree is damaged as a result of mechanical or abiotic factors or from animal, insect, disease or anthropogenic activity.
5	Crown Damage	A tree's crown is damaged as a result of mechanical or abiotic factors or from animal, insect, disease or anthropogenic activity.
6	Root Damage	The root system of a tree is damaged as a result of mechanical or abiotic factors or from animal, insect, disease or anthropogenic activity.
7	Crook	The bole of a tree exhibits an abrupt curvature.
8	Sweep	The bole of a tree exhibits a gradual curvature. This includes "pistol grip" trees which have a large horizontal displacement at their base.
9	Fork	Used for all prominent forks above DBH. Forks occur where there has been damage to the main leader, and must not be confused with the natural branching patterns on hardwoods. Stems which have multiple leaders originating above DBH will also be given this code.
10	Lean	A tree that is leaning a minimum of 10 degrees from vertical.
11	Poor Form	This applies to trees which have form defects other than crooks, sweeps and forks. This includes excessively limby trees (wolf trees), trees with multiple leaders (where no distinct fork is present) and various other tree form anomalies.
12	Same Stump	Used when two or more trees share the same stump (i.e., forked below DBH). Note that all trees originating from the same stump receive the 12 code.

Table 2. Descriptions of tree condition codes, causal agents and severity of condition (part 2 of 3).

Causal Agents		
Code	**Cause**	**Description of Use**
1	Spruce Budworm	Tree shows evidence of Eastern Spruce Budworm (*Choristoneura fumiferana (Clemens))* attack. Symptoms include: webbing, frass and rust colouring on the tree crown. Primary hosts are white spruce, black spruce and balsam fir.
2	Defoliator	Tree shows evidence of attack from any defoliating insect other than spruce budworm.
3	Mountain Pine Beetle	Tree shows evidence of mountain pine beetle attack (*Dendroctonus ponderosae (Hopkins*)). Symptoms include: evidence of entrance or exit holes and accumulations of pitch and sawdust. Primary hosts are lodgepole pine and jack pine.
4	Root Collar Weevil	Tree shows evidence of attack from any species of root collar weevil. Identified by presence of resin flow and tunnels in the bark and cambium at or below the duff layer. Most conifer species are susceptible to root collar weevil attack.
5	Terminal Weevil	Tree shows evidence of attack from any species of terminal weevil. Identified by presence of bent-over leaders with obvious exit holes. Most conifer species are susceptible to terminal weevil attack.
6	Armillaria Root Disease	Tree shows evidence of attack from Armillaria root disease (*Armillaria spp*.). Identified by the presence of mycelial fans around the root collar.
7	Shepherd's Crook	Tree shows evidence of aspen leaf and twig blight (*Venturia spp*.) which causes terminal shoots and leaves to wilt and turn black, ultimately forming a shepherd's crook.
8	Dwarf Mistletoe	Tree shows evidence of dwarf mistletoe (*Arceuthobium spp*.), notably the characteristic witches broom associated with this parasitic plant. Most species of conifer are susceptible.
9	Stem Disease	Tree shows evidence of a stem pathogen typically caused by canker, heart rot and sap rot diseases. Evidence is usually in the form of a canker (sunken or swollen lesion), conk or other fruiting body on the stem.
10	Western Gall Rust	Tree shows evidence of western gall rust (*Endocronartium harknessii (J.P. Moore) Y. Hairatsuka,)* most notably woody swellings (galls) on the main stem and/or branches. Primary hosts are lodgepole pine and jack pine.
11	Animal Damage	Tree has been damaged by any type of mammal or bird. This includes small mammal feeding, ungulate rubs, ungulate browsing, beaver damage, woodpecker and sapsucker damage, etc.
12	Wind Damage	Tree exhibits signs of wind damage.
13	Snow/Ice/Frost Damage	Tree has been damaged by snow, ice or frost. This may result from ice build-up, heavy snow loads and early or late frosts which damage trees that are not properly hardened off. This includes: snow press, frost cracks and frost heave.

14	Hail Damage	Tree has been damaged by hail. Signs of hail damage may include stripped branches and extensive scarring on stems and branches. Damage is greatest on younger shoots, making younger trees more susceptible.
15	Fire Damage	Tree has been damaged as a result of burning or scorching
16	Mechanical Damage	Tree has been damage by the natural mechanical action of trees contacting each other, resulting in scarring or crown damage.
17	Improper Planting	Tree has been planted in a manner that is adversely affecting growth. This includes J-rooted trees, shallow or deeply planted trees, trees that are planted loosely or trees planted at an acute angle.
18	Poor Ground Conditions	Tree has been planted in an inappropriate location (i.e., poor microsite selection) or where the seedbed is unsuitable for growing trees (I.e., hardpan, rotten logs, deep organic soil, etc.).
19	Competition	Tree is suffering from excessive competition from herbaceous or woody vegetation. It applies only to seedlings shorter than 1.30 m.
20	Insect (Other)	Tree shows evidence of attack from an insect other than those listed in 1 through 5 or from an unidentified insect.
21	Disease (Other)	Tree shows evidence of attack from an insect other than those listed in 6 through 10 or from an unidentified disease.
22	Climate, Weather or Flood Damage	Tree exhibits damage resulting from climate, weather or flooding. This includes damage caused by lightning, drought, sunscald and desiccation
23	Anthropogenic Damage	Tree exhibits damage resulting from some type of human activity. This includes damage from harvesting, land clearing, herbicide and other human caused activities.
24	Unknown	Tree has been damaged by some sort of unknown cause.

Table 3. Descriptions of tree condition codes, causal agents and severity of condition (part 3 of 3).

Severity of Condition		
Code	**Severity**	**Description of Use**
1	Minor	Condition is **noticeable** but is **unlikely** to have an adverse impact the long-term survival, growth or form of the tree. Impacts on fibre quality and yield at the time of harvest are expected to be negligible.
2	Moderate	Condition is **obvious** and **could potentially** have an adverse impact the long-term survival, growth or form of the tree. If the tree survives, some minor to moderate impacts on fibre quality and yield at the time of harvested can be expected.
3	Severe	Condition is **prominent** and is **almost certain** to affect the long-term survival, growth or form of the tree. If the tree survives, major impacts on fibre quality and yield at the time of harvest can be expected.
9	Unknown/Not Applicable	The severity of the condition is not known or unquantifiable.