Millar Western Forest Products Ltd.

Growth and Yield Plan

2007-2016 Detailed Forest Management Plan

July 31, 2007

EXECUTIVE SUMMARY

Millar Western Forest Products Ltd.'s (Millar Western) Forest Management Agreement (FMA) area is located in west-central Alberta. Its two main subunits are Forest Management Units (FMUs) W13 and W11, which have a combined gross landbase of approximately 478,500 ha.

Millar Western is currently undertaking the development of a 2007-2016 DFMP that encompasses both FMUs. As part of the DFMP planning process, this Growth and Yield Plan has been developed to outline growth and yield needs and to describe the means by which these needs will be met. To do so, a description of existing and planned growth and yield data sources has also been developed.

The main growth and yield issues and how they are addressed in this Growth and Yield Plan are as follows:

1. A plan for inventory updates must be developed.

    - ✓ Commitment to providing inventory updates as required by the Alberta Forest Management Planning Standard.

2. Data are required for assessing managed stand Site Index.

    - ✓ Paired plot sampling programs (FGYA Paired Plot Sampling and 2000 DFMP Paired Plot Sampling) provide data from contemporaneous stands (harvested and unharvested portions of the same original polygon) at a single point in time.

    - ✓ Permanent sample plots (FGYA Regenerating Lodgepole Pine PSPs and Millar Western PPSPs and EFMPSPs) provide data from the same physical location both before and after harvesting.

3. Regeneration status and productivity on in-block roads must be assessed.

    - ✓ In-Block Road TSPs provide information on stocking status and species composition of in-block roads relative to cutblock areas at establishment age.

- ✓ In-Block Road PSPs provide information on height growth on in-block roads relative to cutblocks over an extended time period (up to 30 years).

4. Data are needed to validate and improve yield curves.

   - ✓ Permanent Sample Plot, Temporary Sample Plot, and Special Area Temporary Sample Plot data provide volume estimates suitable for development and validation of empirical yield curves. These data may also be used to provide other metrics of interest (*e.g.*, density, height, basal area). These data, particularly PSP data, are suitable for calibration of other growth models if deemed of interest in the future.

5. Data are required to assess response to commercial thinning activities.

   - ✓ EFMPSPs established under the Millar Western PSP program provide data from both control and treated areas over time. The plot design provides data from thinned stands 1) both before and after thinning at a single locale and 2) simultaneously from treated and untreated plots within the same original stand type.

6. Data are needed to provide a linkage between juvenile stand performance and predicted yields for managed stands, to support the development of an Alternate Regeneration Standards (ARS) process.

   - ✓ A continuum of temporary sample plot data across a range of stand types and ages is available to create linkages between juvenile and mature stand types:

     i. Juvenile Harvested Stands: ASRD regeneration surveys provide baseline data describing the condition (height, age, density, stocking) of harvested regenerating stands at both establishment and performance ages.

     ii. Juvenile Fire Origin Stands: Virginia Hills and Roche Lake Burn surveys provide comparable data (height, age, density, stocking) from post-fire, naturally regenerating stands.

     iii. Juvenile to Mature (transition) Harvested Stands: Pre-91 Harvest Block regeneration surveys provide comparable data (height, age, density, stocking) from harvested stands that are past performance age (up to 30+ years of age).

     iv. Mature Fire Origin Stands: Temporary Sample Plot data provide comparable data (height, age, density) from mature stands (generally 30 years or older).

   - ✓ Mortality and Ingress plots provide information suitable for estimating mortality from 0 to 15 years post harvest, which is useful for describing changes in density over time in harvested regenerating stands.

   - ✓ Permanent Sample Plot data (Millar Western PSPs and FGYA Regenerating Lodgepole Pine PSPs) provide data from stand initiation through to maturation; these data will be invaluable for validation of ARS targets set using temporary sample plot data.

7. Expected yield increases due to tree improvement must be validated.

    - ✓ Data collected under Millar Western's Tree Improvement Progeny Trials will be used to validate assumptions regarding expected gains in volume.

    - ✓ Grid-based PPSPs in stands planted to improved stock, paired with control PPSPs, will monitor growth and mortality of white spruce tree improvement stock relative to that of non-improved planted stock.

8. Data are needed to model forest stand dynamics and succession in both the managed and unmanaged landbase.

    - ✓ The Millar Western PSP program and FGYA Regenerating Lodgepole Pine PSPs will provide growth data suitable for calibrating models of forest succession, including stand development in unmanaged stand types.

    - ✓ Mortality and Ingress PSPs will provide data that can be used to model mortality of planted and natural conifer seedlings.

9. Information on mortality and ingress are needed to support both model calibration and validation, but also to support planting density targets for ARS development.

    - ✓ Mortality and Ingress PSPs will provide data that can be used to model mortality of planted and natural conifer seedlings, and provide a means of developing a relationship linking juvenile and mature stand densities.

    - ✓ Millar Western PSPs will track mortality and ingress across a range of stand types.

10. Data on nontimber attributes (*e.g.*, biodiversity, fire fuels, wildlife habitat) are required for planning for multiple values.

    - ✓ Biodiversity Assessment Project data collected under the Temporary Sample Plot Program and the Millar Western PSP program are suitable not only for characterizing nontimber attributes of interest, but are also suitable for input into various landscape-level modelling endeavors.

Growth and yield needs change as a function of changing priorities and increased understanding of forest systems. As such, changes to this Growth and Yield Plan are anticipated. A revised Growth and Yield Plan will be submitted to Alberta Sustainable Resources Development for approval by February 2008.

In the future, when major changes occur, this document will be updated and resubmitted to Alberta Sustainable Resources Development for review and approval.

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1. Introduction

1.1 Background

Millar Western Forest Products Ltd.'s (Millar Western) Forest Management Agreement (FMA) area is located in west-central Alberta. Its two main units are Forest Management Units (FMUs) W13 and W11, which have a combined gross landbase[1] of approximately 478,500 ha.

Millar Western received FMA tenure over FMU W13 in 1997, and has already developed one Detailed Forest Management Plan (DFMP) for the FMU (Millar Western 2000) which expires in 2006. Forest Management Unit W11 was incorporated into Millar Western Forest Products Ltd.'s FMA area in 2002. A Preliminary Forest Management Plan (PFMP) for this FMU was completed in 2004 (The Forestry Corp. 2004c).

Millar Western is currently undertaking the development of a 2007-2016 DFMP that encompasses both FMUs. As part of the DFMP planning process, this Growth and Yield Plan has been developed to outline Millar Western's FMA area growth and yield needs, and to describe the means by which these needs will be met.

A Growth and Yield Plan was submitted in June 2006. All data are current to December 2004. This Growth and Yield Plan reflects changes to the 2006 submission, undertaken to address comments provided by Alberta Sustainable Resource Development (ARS). Following submission and approval of the Millar Western DFMP, a revised Growth and Yield Plan will be developed, and submitted for approval by February 2008.

1.2 Growth and Yield Needs

A Growth and Yield Plan must be able to address a number of growth and yield issues and data needs. Some of these needs are specific to the Alberta Forest Management Planning Standard (ASRD 2005),

[1] The *gross landbase* is the total area within the boundaries of FMUs W11 and W13.

while others relate to operational or planning information needs. The main growth and yield needs to be addressed in this plan are:

1. A plan for inventory updates must be developed.
2. Data are required for assessing managed stand Site Index.
3. Regeneration status and productivity on in-block roads must be assessed.
4. Data are needed to validate and improve yield curves.
5. Data are required to assess response to commercial thinning activities.
6. Data are needed to provide a linkage between juvenile stand performance and predicted yields for managed stands, to support the development of an Alternate Regeneration Standards (ARS) process.
7. Expected yield increases due to tree improvement must be validated.
8. Data are needed to model forest stand dynamics and succession in both the managed[2] and unmanaged landbase.
9. Information on mortality and ingress are needed to support both model calibration and validation, but also to support planting density targets for ARS development.
10. Data on nontimber attributes (*e.g.*, biodiversity, fire fuels, wildlife habitat) are required for planning for multiple values.

Section 2 describes existing programs and data. Section 3 describes planned programs for ongoing data collection. Section 4 describes how these programs and existing data will fulfill the growth and yield needs outlined here, and identifies plans for the ongoing evolution of the Growth and Yield Plan.

Note that all data summaries in this document are current to 2005 except where otherwise indicated.

1.3 Millar Western 2007-2016 DFMP Yield Strata

Yield strata are used as a means of classifying the landbase for a specific purpose. Yield strata vary depending on the goals of classification, and are temporal in nature; that is, yield strata classification changes over time. Millar Western DFMP yield strata developed for the 2007-2016 Detailed Forest Management Plan are presented in Table 1.

Different yield strata were used for the 1997-2006 DFMP (FMU W13) and the 2004 PFMP (FMU W11). Data collection programs may have used altogether different yield strata, depending on when data were collected and what the purpose of data collection was. For the upcoming DFMP, however, all data used

[2] The *managed landbase* is comprised of areas that are available for forest management activities. Within the *managed landbase*, there are both *natural stands* (non-anthropogenic stand origin, *e.g.*, fire, pest or pathogen) and *managed stands* (anthropogenic stand origin, *e.g.*, harvest or other human activities). All areas outside of the managed landbase are defined as the *unmanaged landbase*, which is generally comprised of natural stands and/or nonforested areas.

in analyses will be reassigned to the 2007-2016 DFMP yield strata. As such, all reporting in this document will be by 2007-2016 DFMP yield strata (hereafter referred to as DFMP yield strata).

Although this Growth and Yield Plan discusses planned data collection in terms of the current DFMP yield strata, the data described herein are adaptable to changes in yield stratification. Growth and yield programs/needs identified here will not be detrimentally affected by changes to yield stratification, should they occur.

Note that DFMP yield stratum assignment is a more complex process than is encapsulated in Table 1. For full information on Millar Western DFMP yield stratum assignment, refer to The Forestry Corp. (2005b).

Table 1. Millar Western DFMP yield strata by FMU, 2007-2016 DFMP.

FMU	DFMP Yield Stratum	Broad Cover Group	Crown Closure Class	Description
W11	AW_AB	D	AB	Aspen or poplar leading deciduous stand, open crown closure
	AW_CD	D	CD	Aspen or poplar leading deciduous stand, closed crown closure
	BW	D	ABCD	Birch leading deciduous stand
	APAS_ABCD	DC	ABCD	Deciduous leading mixedwood stand
	PASA_ABCD	CD	ABCD	Coniferous leading mixedwood stand
	LT	C	ABCD	Larch leading conifer stand
	PL_AB	C	AB	Pine leading conifer stand, open crown closure
	PL_CD	C	CD	Pine leading conifer stand, closed crown closure
	SB	C	ABCD	Black spruce leading conifer stand
	SW_AB	C	AB	White spruce leading conifer stand, open crown closure
	SW_CD	C	CD	White spruce leading conifer stand, closed crown closure
W13	AW	D	ABCD	Aspen or poplar leading deciduous stand
	BW	D	ABCD	Birch leading deciduous stand
	AP	DC	ABCD	Deciduous leading pine mixedwood
	AS	DC	ABCD	Deciduous leading spruce mixedwood
	PA	CD	ABCD	Coniferous leading pine mixedwood
	SA	CD	ABCD	Coniferous leading spruce mixedwood
	LT	C	ABCD	Larch leading conifer stand
	PL	C	ABCD	Black spruce leading conifer stand
	SB	C	ABCD	Pine leading conifer stand
	SW	C	ABCD	White spruce leading conifer stand

1.4 Millar Western 2007-2016 DFMP Landbase

The current managed landbase area is 86,607 ha for FMU W11[3] (Table 2) and 211,857 ha for FMU W13 (Table 3). These areas represent the total area within the managed landbase at the beginning of the 2007-2016 planning period.

[3] Landbase areas reported here are based on Landbase Version 9, developed for the upcoming 2007-2016 DFMP.

Table 2. Current area within the managed landbase, FMU W11.

DFMP Yield Stratum	Stand Origin		Total
	Natural	Managed	
AW_AB	8,996	-	8,996
AW_CD	41,607	3,289	44,896
BW	124	-	124
APAS_ABCD	4,468	977	5,445
PASA_ABCD	5,165	1,476	6,640
PL_AB	3,597	-	3,597
PL_CD	6,962	806	7,768
SB	-	-	-
SW_AB	2,878	-	2,878
SW_CD	5,209	1,053	6,262
Total	79,006	7,601	86,607

Table 3. Current area within the managed landbase, FMU W13.

DFMP Yield Stratum	Stand Type					
	Natural	Managed	Thinning[1]	Crop Plan	Selective Logging[2, 3]	Total
AW	56,458	5,427	2	-	-	61,888
BW	1,021	-	1	-	-	1,022
AP	5,288	192	17	-	-	5,497
AS	13,845	852	4	-	-	14,700
PA	7,522	2,995	45	-	61	10,623
SA	10,276	7,263	8	-	624	18,171
PL	44,385	17,428	1,132	3,217	-	66,162
SB	16,719	179	74	-	-	16,973
SW	12,029	3,972	3	816	-	16,820
Total	167,544	38,309	1,285	4,034	685	211,857

[1] Salvage and commercial thinning in natural stands; excludes selective logging.

[2] Selective logging took place in the Athabasca Flats vicinity of the Athabasca river using horse logging methods.

[3] DFMP yield strata are based on post-harvest assignment.

2. Existing Growth and Yield Programs/Data

2.1 Forest Inventory

The objective of developing forest inventories is to assign attributes to the landbase that can be used for operational and planning purposes. Traditional inventories have been in the form of photo-based aerial inventories, which can provide a census of the entire population; emerging technologies include LIght Detection And Ranging (LIDAR).

2.1.1 FMU W13 Alberta Vegetation Inventory

Aerial photos of the FMU W13 landbase were flown in 1994. These photos were originally interpreted to Alberta Vegetation Inventory (AVI) 2.2 standards (Nesby 1997), but were later altered to AVI 2.1 standards (Alberta Lands Information Division 1991). New aerial photos for the FMU were flown in summer 2004, however, these photos have not yet been interpreted. As such, the 1994 AVI coverage will be used for the 2007-2016 DFMP.

2.1.2 FMU W11 Alberta Vegetation Inventory

Aerial photos of the FMU W11 landbase were flown in 1994. Photos were interpreted to AVI 2.1 standards by Alberta Sustainable Resources Development (ASRD), which was managing the FMU at that time. Aerial photos were flown under the direction of Millar Western in 2004 but have not yet been interpreted. The 1994 AVI coverage will be used for the 2007-2016 DFMP.

2.2 Temporary Sample Plot Program

The objectives of the Temporary Sample Plot Program were to 1) collect data on merchantable trees within natural stands in the managed landbase, for the purposes of developing volume estimates for

empirical yield curve development, and 2) collect additional data on small trees, shrubs, vegetation, snags and woody debris for the Biodiversity Assessment Project (BAP).

2.2.1 Millar Western (MW) Temporary Sample Plots

Millar Western TSP data collection was undertaken in 1997, 1998, and 2004. Data collection in 1997 and 1998 was restricted to FMU W13 (prior to incorporation of FMU W11); data collection in 2004 was undertaken in both FMUs (for more information, see The Forestry Corp. 2004b, 2004d). Various MWFP data collection protocols have been used. Information for all programs is summarized in Table 4:

Table 4. Summary of Millar Western TSP programs to date.

	Program Type			
	TSP 1997	**TSP 1998**	**TSP 2004**	**TSP 'BAP ONLY' 2004**
Sampling Frame	Operable landbase; minimum stand height = 8 m	Operable landbase; minimum stand height = 8 m	Operable landbase; minimum age=40 years (no minimum height)	All forested stands; all ages
Sampling Location	W9 (subset of W13)	W5 (subset of W13)	W13 and W11	W13 and W11
Stand Selection	Random, area-weighted, by height class and yield stratum	Random, area-weighted, by height class and yield stratum	Random, area-weighted, by age class and yield stratum	Random, area-weighted, by BAP habitat type
Plot Selection	Random within stand; 15 m buffer along edge of stand to prevent straddle plots	Random within stand; 15 m buffer along edge of stand to prevent straddle plots	Random within stand; buffer width set to plot radius to ensure entire plot within stand	Random within stand; buffer width set to plot radius to ensure entire plot within stand
Number of Plots	3/stand	3/stand	3/stand	1-3/stand (varies)
Plot Design	Tree and snag plot: 5.64/7.98/11.28 m radius depending on AVI crown closure and stand height	Tree and snag plot: 5.64/7.98/11.28 m radius depending on AVI crown closure and stand height	Tree and snag plot: 5.64/7.98/11.28 m radius depending on AVI crown closure and stand height	Tree and snag plot: 5.64/7.98/11.28 m radius depending on AVI crown closure and stand height
	Sapling plot = 2.82 m radius	Sapling plot = 2.82 m radius	Sapling plot = 3.99 m radius	Sapling plot = 3.99 m radius
	Shrub and ground vegetation plot = 1.78 m radius	Shrub and ground vegetation plot = 1.78 m radius	Shrub and ground vegetation plot = 1.78 m radius	Shrub and ground vegetation plot = 1.78 m radius
	Coarse woody debris = 2 x 10 m transects	Coarse woody debris = 2 x 10 m transects	Coarse woody debris = 3 x 30 m transects	Coarse woody debris = 3 x 30 m transects
			Snag cruise = 100 m transect	Snag cruise = 100 m transect
Data Collection: All Plots	Trees - species, DBH, height, height to live crown, height to dead crown, crown class, number of dead limbs, presence of bark crevice cavities, lichen cover class, quality codes, subsample of breast height ages	Trees - species, DBH, height, height to live crown, height to dead crown, crown class, number of dead limbs, presence of bark crevice cavities, lichen cover class, quality codes, subsample of breast height ages	Trees - species, DBH, height, height to live crown, crown class, lichen cover class, quality codes, number of coppice suckers, crown development code	Trees - species, DBH, estimated height, estimated height to live crown, crown class, lichen cover class, quality codes, number of coppice suckers, crown development code
Data Collection: Additional BAP	Snags - species, DBH, height, decay class, bark class	Snags - species, DBH, height, decay class, bark class	Snags - species, DBH, height, decay class, bark class	Snags - species, DBH, height, decay class, bark class
	Saplings - same as for trees	Saplings - same as for trees	Saplings - same as for trees	Saplings - same as for trees
	Shrubs - species/species class, percent cover class, average height	Shrubs - species/species class, percent cover class, average height	Shrubs - species/species class, percent cover class, average height, total shrub percent cover, total shrub average height	Shrubs - species/species class, percent cover class, average height, total shrub percent cover, total shrub average height
	Ground vegetation - species group, percent cover class	Ground vegetation - species group, percent cover class	Ground vegetation - species group, percent cover class, total percent herb cover, total percent moss cover	Ground vegetation - species group, percent cover class, total percent herb cover, total percent moss cover
	Coarse woody debris - species group, diameter at intersection, decay class, inclination, stump top diameter, stump height, height above ground	Coarse woody debris - species group, diameter at intersection, decay class, inclination, stump top diameter, stump height, height above ground	Coarse woody debris - species group, diameter at intersection, decay class, inclination	Coarse woody debris - species group, diameter at intersection, decay class, inclination
			Snag cruise - species group, DBH, estimated height, decay class, bark class, lichen cover class	Snag cruise - species group, DBH, estimated height, decay class, bark class, lichen cover class
Year(s) Collection	1997	1998	2004, 2005	2004
Important Notes		1) BAP data not collected on all plots	1) BAP data not collected on all plots; 2) Minor additional birch stand sampling occurred in 2005 under the 2004 TSP protocols	1) Stand selection within W11 not completely random: selected random stands, then discarded those in NW corner of the FMU in order to improve access for sampling
Overall Notes	Yield stratum was used as a stratification category for each sampling design; however, yield strata were different in each of the three sample years.			

A total of 584 TSPs were established in the 1997/1998 field seasons and a total of 598 TSPs were established in the 2004/2005 field seasons. Existing plots are summarized in Table 5 (see Section 2.2.3).

2.2.2 Alberta Sustainable Resources Development (ASRD) Temporary Sample Plots

Initial TSP sampling in FMU W11 was undertaken by Alberta SRD in 2000 (ASRD 1999). The objective of this sampling was to obtain data sufficient for development of empirical yield curves.

Stands were selected proportionally to the occurrence of crown density, species and age classes. Three volume sampling plots were placed within each selected stand. The center of the stand was located, and each plot was located 50 m from plot center at bearings of 0, 120 and 240 degrees. Plots were offset to avoid all anthropogenic disturbances (*e.g.*, roads, seismic lines, well sites) and naturally non-vegetated areas (*e.g.*, lakes, rivers, rock outcroppings). Plots were circular, with a fixed, 5.64 m radius (0.01 ha) main plot and a 2.82 m radius (0.0025 ha) circular subplot nested within the main plot.

Within the main plot, all trees greater than or equal to 9.1 cm DBH were measured. Species, height, height to live crown, DBH, stump diameter, crown class and condition codes were recorded for each tree. On selected trees, breast height age and increment width (0-10 years and 11-20 years) were recorded. Within the subplot, the same data were collected on trees under 9.1 cm DBH and greater than 1.3 m in height. Presence of slash, arboreal lichen, fire scars, stand structure, fuel continuity, woody shrub density class, average woody shrub height and dominant shrub species were recorded for each plot.

A total of 359 TSPs were established in 2000. Existing plots are summarized in Table 5 (see Section 2.2.3).

2.2.3 Current Number of Temporary Sample Plots

Table 5 summarizes the number of existing TSP plots by data collection program (Millar Western and ASRD programs combined).

Table 5. Current number of TSPs by data collection program.

Data Collection Program		Number of Plots
Millar Western TSPs 1997/1998		584
Millar Western TSPs 2004/2005	Initial Sampling	562
	Additional Birch Sampling	36
	Total	598
Alberta SRD TSPs 2000		359
Total		1,541

Table 6 summarizes the number of existing temporary sample plots collected under the Temporary Sample Plot Program by plot type. Managed stand TSPs were established after harvesting took place, and therefore sampling reflects managed stand conditions in the regenerating cutblock (required for BAP modeling purposes).

Through discussions with Alberta SRD, it was decided that plots which had been burned or harvested following sampling would not be used for fitting standing volume yield curves. As such, these plots are tabulated separately as "Burned or Harvested Since Sampling" (these plots are not used in standing volume empirical yield curve development).

Table 6. Current number of TSPs by plot type[4,5].

FMU	Plot Type	Number of Plots
W11	Nonforested, Unmanaged Landbase	14
	Landbase Deletion, Unmanaged Landbase	97
	Natural Stand, Managed Landbase	544
	Managed Stand, Managed Landbase	9
	Burned or Harvested Since Sampling	23
W11 Total		687
W13	Nonforested, Unmanaged Landbase	22
	Landbase Deletion, Unmanaged Landbase	90
	Natural Stand, Managed Landbase	598
	Managed Stand, Managed Landbase	7
	Burned or Harvested Since Sampling	137
W13 Total		854
Grand Total		**1541**

Table 7 summarizes temporary sample plots that fall within nonforested stand types. Nonforested attributes were assigned using version 6 of the landbase being developed for the upcoming DFMP (2007-2016).

Table 7. Current number of TSPs that fall within nonforested stand types.

FMU	Nonforested Stand Type	Number of Plots
W11	Anthropogenic Nonvegetated	5
	Herbaceous Grasses	3
	Closed Shrub	2
	Open Shrub	4
W11 Total		14
W13	Anthropogenic Nonvegetated	19
	Waterbody/Wetland	3
W13 Total		22
Grand Total		36

Table 8 summarizes temporary sample plots that fall within landbase deletions. Landbase deletion information was assigned using version 6 of the landbase being developed for the upcoming DFMP (2007-2016).

[4] Plot classification is based on Landbase Version 6, developed for the upcoming 2007-2016 DFMP.
[5] Plot types are defined as follows:

1) Nonforested: as defined according to AVI 2.1 manual – see Table 7 for breakdown.
2) Landbase Deletion: deletion from the net landbase – see Table 8 for breakdown.
3) Natural Stand: plot was established in a fire origin (natural) stand that is still standing (in contrast to item 5, Burned or Harvested Since Sampling).
4) Managed Stand: plot was established within a regenerating cutblock (to provide data for the BAP program).
5) Burned or Harvested Since Sampling: plot was established within a natural stand that has since been burned or harvested; this plot would be ineligible for standing volume yield curve development as per the Alberta Forest Management Planning Standard (ASRD 2005).

Table 8. Current number of TSPs that fall within landbase deletions.

FMU	Plot Type	Number of Plots
W11	Larch stand	7
	Park	7
	Black spruce stand	69
	TPR U	8
	Watercourse buffer	6
W11 Total		97
W13	Grazing Lease/Permit	15
	Larch stand	2
	Non-DFA	14
	Black spruce A density stand	14
	Black spruce structural deletions	11
	TPR U	21
	Watercourse buffer	13
W13 Total		90
Grand Total		187

Table 9 summarizes the number of managed landbase TSPs by DFMP yield stratum and stand origin (natural vs. managed stand), excluding TSPs that were burned or harvested following sampling. Managed stand plots were primarily sampled to address BAP data needs. Natural stand TSPs were sampled to address both BAP and volume sampling needs. Natural stand TSPs are those that would be eligible for use in the development of standing volume yield curves.

Table 9. Current number of managed landbase TSPs by DFMP yield stratum and stand origin.

FMU	DFMP Yield Stratum	Number of Natural Stand Plots	Number of Managed Stand Plots
W11	AW_AB	54	
	AW_CD	91	2
	BW	6	
	APAS_ABCD	70	2
	PASA_ABCD	76	3
	PL_AB	66	
	PL_CD	62	2
	SW_AB	59	
	SW_CD	60	
W11 Total		544	9
W13	AW	82	2
	BW	32	
	AP	55	
	AS	87	
	PA	49	1
	SA	49	4
	PL	132	
	SB	44	
	SW	68	
W13 Total		598	7
Grand Total		1142	16

2.3 Special Area Temporary Sample Plot Programs

Special Area Temporary Sample Plot Programs are one-time sampling programs used to address specific research questions or data needs. There is no ongoing sampling component to these programs, although similar sampling may occur in the future if new questions arise.

2.3.1 Windfall Burn (WB) Temporary Sample Plots

The objective of the Windfall Burn sampling program was to gather data sufficient to determine if pine stands within the Windfall Burn were exhibiting signs of repression, and to develop an empirical yield curve within the Windfall Burn if necessary (Millar Western 2005a).

The sampling population was comprised of all single story pine-dominated conifer stands with 50% crown closure or greater (higher crown closures were presumed to be the stand types with potential for repression) within the Windfall Burn fire boundary (fire year = 1956). The population was stratified into crown closure class (5, 6, 7 or 8) and TPR class (F, M, G). The desired sample size was determined for each crown closure class/TPR combination based upon total area, knowledge of stand variability and number of stands available for sampling, with a minimum of 10 plots per combination.

Sampling occurred in 2003. Within each selected stand, one plot was established. Each plot had three separate point counts arranged in an equilateral triangle with 20 m sides. At each point, all trees ≥ 6 cm DBH were tallied using a BAF 2 prism, and DBH was measured for each. At each plot, height, DBH and age at stump height (30 cm) was recorded for an average DBH tree.

A total of 498 points (166 plots) were sampled.

2.3.2 Athabasca Flats Selective Logging (AFSL) Temporary Sample Plots

The Athabasca Flats Selective Logging area is a contiguous area of high productivity, generally white spruce leading, stands located along the southern edge of the Athabasca river. The area is approximately 920 ha in size, 685 ha of which is currently within the managed landbase following landbase deletions (based on Version 9 of the landbase). Roughly 2/3 of this area has already undergone selective logging. The objective of this sampling program was to gather data sufficient to develop a yield projection specific to these areas (The Forestry Corp. 2004a).

Data collection was undertaken in 2005. All areas in which selective logging had been completed were sampled. A grid of 57 points was established across this area, irrespective of polygon boundaries.

At each grid point, a 5.64 m radius (100 m^2) plot was established. For all live trees ≥ 10 cm DBH, species, DBH, height, response increment (diameter increment since harvesting) and preharvest increment (diameter increment prior to harvesting) were recorded. For all live trees ≥ 1.3 m in height and < 10 cm DBH, species and DBH were recorded. Species and stump diameter were recorded for all stumps with a diameter of ≥ 15 cm at stump height (30 cm).

2.4 Permanent Sample Plot Program

The objective of the Millar Western PSP program is to provide long-term, forest-wide, unbiased estimates of forest vegetation change, both in terms of timber and non-timber values (Millar Western 2004).

Permanent sample plot establishment began in 1995. In 1995 and 1996, PSPs were established using a combination of systematic and stratified random sampling. After 1996, a 3000 m x 3000 m grid (oriented N-S and E-W) was established across the Millar Western FMA area, and all subsequent PSPs have been established on this grid, with the exception of Enhanced Forest Management PSPs.

There are four types of permanent sample plots within the PSP program: Standard Permanent Sample Plots (SPSPs), Plantation Permanent Sample Plots (PPSPs), Non-Productive Permanent Sample Plots (NPSPs) and Enhanced Forest Management Permanent Sample Plots (EFMPSPs). Currently, all PSPs are on either a five or a ten year remeasurement schedule, depending on type of plot and years since establishment (see Table 15, page 24).

PSP data collection protocols vary slightly depending on the type of stand the grid point falls in, or whether or not it is an EFMPSP. Data collection protocols are described in the following sections. For more information, refer to Millar Western (2004).

2.4.1 Standard Permanent Sample Plots (SPSPs)

Standard PSPs are established when a grid point falls on a natural stand within the managed landbase.

An 11.28 m radius (0.04 ha) main plot is established with a 20 m buffer. Within this plot, all trees ≥ 1.3 m in height are tagged, stem mapped and measured (species, DBH, height, height to live crown, crown class, crown development, quality codes, number of coppice suckers, and lichen class). Breast height age is collected from four top height trees of the main species; in mixedwood stands, both the leading conifer and deciduous species are sampled. A 30.9 m radius (0.3 ha) snag plot is centered at the main plot, within which all snags ≥ 30 cm DBH are measured (species class, DBH, height, decay class and bark class).

A 1.78 m radius (10 m^2) high shrub plot is used to sample all shrubs ≥ 3.0 m in height (percent cover and average height by species, total percent shrub cover). Eight 1 m^2 plots (four pairs placed 10 m from plot center at 45˚, 135˚, 225˚ and 315˚) are established for sampling lower vegetation: shrubs ≥ 0.5 m and < 3 m in height (percent cover, average height and count by species), trees ≥ 0.2 m and ≤ 1.3 m in height (percent cover, average height and count by species), and herbaceous/short shrubs (< 0.5 m)/short trees (< 0.2 m)/other nonwoody plants (percent cover by species group, total percent moss cover, total percent herbaceous cover). Three 30 m transects are used to sample woody debris ≥ 7.5 cm at the point of intersection (diameter, position, decay class).

2.4.2 Plantation Permanent Sample Plots (PPSPs)

Plantation PSPs are established when a grid point falls on a managed stand within the managed landbase, or when a Standard PSP is harvested and the PSP is subsequently re-established. In other words, PPSPs sample regenerating (post-harvest) stands. Reestablishment will occur immediately after planting in order to track seedling growth and survival; in leave for natural (LFN) stands, reestablishment will occur as soon as possible after harvesting in order to capture vegetation and site dynamics.

All protocols outlined for SPSPs will be followed for PPSPs, with the following exceptions:

1. In addition to tagging all seedlings ≥ 1.3 m in height, all planted seedlings under 1.3 m in height will be tagged. Unlike other tagged seedlings, these seedlings will not be assessed for height to live crown, DBH, crown class, lichen class or breast height age.

2. Regeneration type (natural, planted, advance, unknown) will be assigned to all tagged stems.

2.4.3 Non-Productive Permanent Sample Plots (NPSPs)

Non-Productive PSPs are established when a grid point falls on a natural stand within the unmanaged landbase. All protocols outlined for SPSPs will be followed, although for certain NPSP types (*e.g.*, shrubs or grasses), the plot will be devoid of trees.

2.4.4 Enhanced Forest Management Permanent Sample Plots (EFMPSPs)

EFMPSPs are established to monitor the growth response to commercial and/or salvage thinning in natural stands. EFMPSPs are not established on a grid; rather, plots are located within stands selected for thinning treatments. In addition, rather than a single PSP, four EFMPSPs are established in selected stands. One EFMPSP is randomly located within a control (unaltered) portion of the stand. Three additional EFMPSPs are established within the thinned portion of the stand: the first plot is randomly located prior to harvest within the treated area, and the remaining two plots are established following harvest to create a triangular layout within the treated area. The triangular layout was selected to insure that all conditions created within thinned stands would be represented both within an installation as well as between installations.

All protocols outlined for PPSPs are followed for EFMPSPs, with the addition of crown width measurements on all tagged stems.

There are currently seven sets of EFMPSPs in thinned stands, five of which have five-year remeasurement data and two of which have establishment data only. Four of these sets are located within salvage thinned stands[6] and three of these sets are located within commercially thinned stands. There are five additional sets of EFMPSPs established as plot pairs (five plot pairs - one control PSP and one treated PSP – total 10 EFMPSPs); the plot pair EFMPSPs are comprised of one pair of plots in commercially thinned stands and four pairs of plots in salvage thinned stands. All plot pairs have five-year remeasurement data. There is also a single EFMPSP (treated – no control) located within a salvage thinned stand.

2.4.5 Current Number of Permanent Sample Plots

Table 10 summarizes the number of PSP plots by DFMP yield stratum and plot type. Note that the number of EFMPSPs represent individual plots; in terms of installations, 13 separate stands are sampled. There are 12 control PSPs, each with either one or three treated PSPs located in the same original stand type, and a single treated PSP with no control (PL stratum).

[6] One of the set of salvage thinned EFMPSPs is located outside of the Millar Western FMA area, in FMU S20.

Table 10. Current number of PSPs by DFMP yield stratum and plot type.

FMU	DFMP Yield Stratum	SPSPs	PPSPs	NPSPs	EFMPSPs Control	EFMPSPs Treated	Total PSPs
W11	AW_AB	9					9
	AW_CD	16					16
	BW						0
	APAS_ABCD	2					2
	PASA_ABCD	4					4
	LT						0
	PL_AB	5					5
	PL_CD	1					1
	SB						0
	SW_AB						0
	SW_CD	3					3
	Herb. Forb						0
	Herb. Grass						0
	Closed Shrub						0
	Open Shrub						0
W11 Total		40	0	0	0	0	40
W13	AW	28	7				35
	BW			2			2
	AP	2					2
	AS	10					10
	PA	12					12
	SA	8	2				10
	LT			6			6
	PL	42	6		7	20	75
	SB	17		10	3	3	33
	SW	4	1		1	1	7
	Herb. Forb						0
	Herb. Grass						0
	Closed Shrub			1			1
	Open Shrub						0
W13 Total		123	16	19	11	24	193
NON-DFA					1	3	4
NON-DFA Total					1	3	4
Grand Total		163	16	19	12	27	237

2.5 Regeneration Surveys

2.5.1 Alberta Sustainable Resource Development (ASRD) Regeneration Surveys

ASRD regeneration surveys are mandated by the Alberta government. The objective of ASRD regeneration surveys is to ensure prompt reforestation and a sufficient level of stocking, survival and growth is attained (ASRD 2003). These levels were set in order to ensure a level of performance that emulates natural yields.

Data collection is ongoing. Every harvested block is subjected to an Establishment survey and, with the exception of deciduous blocks, also subjected to a Performance Survey (only conditionally restocked deciduous blocks require Performance surveys). Within each block, a grid of 10 m^2 circular plots is established. Sampling intensity and grid spacing is determined based on block size, using rules outlined in the ASRD Regeneration Survey Manual (ASRD 2003).

At the Establishment survey, height and age are recorded for one crop tree per species (if present) in the plot. Density by species and capped deciduous density (maximum 10) are also recorded. The same data are collected during the Performance survey, with the additional assessment of competition and measurement of root collar diameter on provisionally free-to-grow pines and larches. The timing of surveys depends on intended broad cover group and survey type: Establishment surveys occur between 4-8 years for C, CD, and DC stands and 3-5 years for D stands; Performance surveys occur between 8-14 years for C, CD, and DC stands and 10-14 years for conditionally stocked D stands. Currently, minimum targets (*e.g.*, height) are identified in the ASRD Regeneration Survey Manual.

2.5.2 Virginia Hills Burn (VHB) Regeneration Surveys

The objective of this program was to gather information on unsalvaged, post-burn areas within the Virginia Hills fire boundary (1998 fire year) that were left to reforest naturally. The data were to be used to support assignment of some unsalvaged areas to natural stands in the managed landbase (since the AVI was flown prior to the fire and is therefore unsuitable) and to assign DFMP yield strata to these areas.

Potential polygons were delineated using aerial photos flown in 2004. Delineation of potential polygons focused on areas which showed regeneration or potential for regeneration based on site type.

All potential polygons were field surveyed using a modified ASRD regeneration survey (The Forestry Corp. 2005d). Plots were 1.78 m radius (10 m^2) in size and were established in a square grid. The number of plots was at ½ the intensity required under the ARDS Regeneration Survey Manual. In each plot, seedlings were tallied by species, height class and density class. Height minima were lower than those used in ASRD regeneration surveys. The average deciduous height (irrespective of species) and average height for each deciduous species was estimated to the nearest 0.5 m.

A total of 6187 ha were delineated and field sampled in 2004; an additional 5750 ha were delineated and field sampled in 2005.

2.5.3 Roche Lake Burn (RLB) Regeneration Surveys

The objective of this program was to gather information on post-burn areas within the Roche Lake fire boundary (1998 fire year) that were left to reforest naturally. This includes unsalvaged areas as well as harvested areas that have no regeneration liability. The data were to be used to support assignment of some of these areas to natural stands in the managed landbase (since the AVI was flown prior to the fire and is therefore unsuitable) and to assign DFMP yield strata.

Sampling protocols were the same as those used to sample Virginia Hills fire areas. See Section 2.5.2.

Data collection occurred in 2005. A total of 498 ha were delineated and field sampled.

2.5.4 Pre-91 Harvest Block (Pre-91) Regeneration Surveys

The objective of this program was to gather sufficient information to assign Millar Western DFMP yield strata to blocks harvested prior to 1991 (The Forestry Corp. 2005c). Specifically, to obtain information on blocks which either 1) lack an AVI call to a forested cover type or 2) have been treated since the AVI was flown and thus the AVI call may not reflect the appropriate stand type.

Data collection followed ASRD Regeneration Survey Manual protocols (ASRD 2003), except that plots were established at half the intensity normally required under the manual.

Approximately 9,000 ha of pre-91 blocks were included in the population. A total of 2,000 ha were sampled, and results were extrapolated to the remaining 7,000 ha. Data collection and analysis were completed in late fall of 2005.

2.6 Mortality and Ingress

2.6.1 Mortality and Ingress (MI) Permanent Sample Plots

The objective of this program is to measure the mortality rate of planted and naturally regenerated conifer seedlings in new cutblocks, and to measure the level of conifer and deciduous ingress into new cutblocks (Millar Western 2003). This program is active in FMU W13 only, where Millar Western has conifer rights.

Establishment of MI PSPs began in 2003. During this year, five randomly chosen blocks were completed. After 2003, sampling increased to eight planted blocks per year, selected randomly from the population of harvested blocks. Each year, four planted pine and four planted white spruce are selected randomly for sampling.

Within selected blocks, three 10 m x 10 m plots are established. Plots are only established within areas of the block that were planted. At establishment, all planted seedlings are pinned and numbered; natural conifer regeneration ≥ 30 cm in height is also pinned and numbered. All deciduous regeneration ≥ 30 cm in height is assigned to density classes. At each remeasurement, pinned seedlings are assessed as live or dead, new ingress is pinned and numbered, and deciduous regeneration is tallied.

Plots are sampled at establishment and at years 2, 4, 6, 10 and 15. Year of planting is considered the year of establishment.

2.7 Tree Improvement

2.7.1 Tree Improvement Progeny Trials

The objective of tree improvement progeny trials is to provide accurate family and provenance rankings, precise estimates of genetic parameters, a new population for advanced generation selections, scientific information on regional geographic variation and genetic diversity, and an *ex situ* germplasm archive (Renaud *et al*. 2005b). Tree improvement activities are restricted to FMU W13 only.

Millar Western currently has investments in two seed orchards. The black spruce orchard is only partially intensively selected, and no realized gains are assumed. The white spruce orchard is fully intensively selected and has an assumption of realized gains, which will increase once first rouging is completed.

The white spruce seed orchard was established in 1998, and progeny tests were initiated in 2001 on 5 member sites, one of which is within the MWFP FMA area (Virginia Hills) (Renaud *et al*. 2005b). Measurements will begin at age 12 (in 2011).

Seedling trials were generally planted at spacings of 2.2 x 2.2 m (exceptions are the Weyerhaeuser site, planted at 2.0 x 2.0 m, and the Linaria site, planted at 1.0 x 3.0 m), and sites were fenced to prevent browse. Data collected will include survival, height, vigour, and insect and disease occurrence. DBH may also be assessed beginning at 16 years, when variation in DBH begins to be expressed as a trait.

A progeny trial was also established for the Black Spruce seed orchard, which was established in 1999, with replacements made in 2004 (Renaud *et al*. 2005a). The progeny trial is in Weldwood's FMA area; no progeny trial has been established within the Millar Western FMA area to date.

2.8 In-Block Roads

2.8.1 In-Block Road (IBR) Temporary Sample Plots

The objective of IBR TSP data collection is to assess stocking, density and height on in-block roads. This sampling program is a temporary "add on" to ASRD regeneration surveys (The Forestry Corp. 2005a).

All blocks scheduled for Establishment surveys in 2005-2007 will be subjected to additional IBR TSP data collection, including surveys in quota holder and miscellaneous timber use licenses within the FMA area. Following the first year of sampling, the intensity and focus of data collection may be altered in order to fill specific data gaps (*e.g.*, attempt to sample more spruce stands if mostly pine stands were sampled in year one).

In each sampled block, ASRD regeneration survey plots which fall on in-block roads will be marked as IBR TSPs. Additional IBR TSPs will be established every second time a survey line crosses an in-block road during the ASRD regeneration survey. Plot size and data collection protocols will follow the ASRD Regeneration Survey Manual (ASRD 2003).

2.8.2 In-Block Road (IBR) Permanent Sample Plots

The objective of this program is to assess regenerated in-block road productivity relative to block productivity, in terms of height growth (The Forestry Corp. 2005a).

IBR PSP establishment will commence in the 2006 field season. Over five years, 15 blocks will be selected for sampling, with stratification designed to obtain a range of species and road treatments. Within each selected block, three 100 m^2 plot pairs will be established. Three circular plots will be established within the block, and three rectangular plots (dimensions adjusted to fit the road width) will be established along the in-block road. All plots will have a 10 m^2 circular plot centered within the 100 m^2 plot.

Within each 100 m^2 plot, the total height of the largest diameter tree and the total height of ten randomly selected trees will be measured. No trees will be tagged. Within the 10 m^2 plot, the number of stems > 1.3 m in height will be tallied by species and density class.

Establishment will occur at 5 years post-harvest based on skid clearance date; IBR PSPs will be remeasured at 10, 20 and 30 years post-harvest.

2.9 Managed Stand Site Index Study

The objective of this study was to assess whether lodgepole pine showed an increase in Site Index in managed stands, relative to natural stands (The Forestry Corp. 1999).

The study used paired plot data from both Millar Western's FMA area (20 stands) and Blue Ridge Lumber's FMA area (4 stands), with three plot pairs per stand. Stands were eligible if there existed both a harvested and unharvested portion of an original stand, the stand was predominantly lodgepole pine, and regeneration occurred at least 10 years prior to sampling.

Three plots were randomly located within the unharvested parent stand, with three additional plots randomly located within the harvested portion of the stand.

In the unharvested stand, all trees greater than or equal to 7.0 cm DBH were measured (species, DBH, crown class, quality code). From within these trees, one top height tree and two healthy free growing lodgepole pine trees were selected within the plot and measured (species, height, DBH, breast height age).

In the harvested stand, all trees greater than or equal to 2.0 cm DBH were measured (species, DBH, quality code). From within these trees, one top height tree and two healthy free growing lodgepole pine trees were selected within the main plot and measured (species, height, DBH, height of first five nodes past breast height). If two healthy lodgepole pine trees could not be found within the plot, trees outside of but close to the plot were selected. All three trees were then felled and sectioned for stem analysis (ring count, radius inside bark, radius outside bark, height along stem, and annual increments from DBH disk).

Data collection occurred in 1998. Twenty-four blocks were sampled, with a total of 6 plots per block (3 plot pairs). A total of 175 useable samples were obtained from stem analysis, out of a potential 216 (24 blocks x 3 trees/plot x 3 harvest block plots/block). Rot and a lack of suitable sample trees were the reasons for this reduction.

2.10 Foothills Growth and Yield Association

The Foothills Growth and Yield Association (FGYA) is a co-operative initiative with the mandate to forecast and monitor the growth and yield of managed lodgepole pine stands. Millar Western is a voting and sponsoring member of the FGYA. The mandate of the Association is to continually improve the assessment of lodgepole pine growth and yield in managed stands.

2.10.1 FGYA Regenerating Lodgepole Pine (RLP) Permanent Sample Plots

As part of the Association's work, a number of Regenerating Lodgepole Pine (RLP) permanent sample plots have been established. These plots are designed to answer questions relating to early stand conditions, subsequent growth and yield, responses to initial spacing and precommercial thinning, and effects of site on lodgepole pine stands (FGYA 2003). A total of 102 installations were established by FGYA members; 6 of these are within Millar Western's FMA area. Each installation represents one of 6 initial planting densities, within which four treatments are applied to subsections of the installation.

Installations are 1 ha in size, divided into 4 – 0.25 ha treatment areas, within which one of four treatments is applied (control, weed, thin, weed and thin). Centered within each 0.25 ha treatment area is a 0.10 ha

measurement area. Data collected within each measurement area include: planting density, coniferous density, coniferous stocking, shrub and herb competition, deciduous competition, size and growth, vigour, health, and age.

Installations were established between 2000 and 2002, prior to completion of the first growing season (growing season=0). Measurements were made at establishment and every year thereafter. The following schedule has been approved through to at least the 2009 field season (the eighth growing season for the Millar Western plots) (Dick Dempster, Pers. Comm.):

- ✓ Mortality and health checks will be conducted annually;
- ✓ Full measurements will be conducted every other year (tree dimensions, ingress, vegetation); and
- ✓ Additional (annual) vegetation checks may be made on installations approaching treatment thresholds.

2.10.2 FGYA Paired-Plot Sampling

The objective of the FGYA paired-plot sampling was to compare pre- and post-harvest Site Index for five "ecosite categories" of interest (FGYA 2004).

Under this program, 50 cutblocks were identified throughout members' tenures, in which regeneration was at least five years breast height age and portions of the original stand were still standing on the same ecosite as the regenerating portion of the stand. Three of these cutblocks were within the Millar Western FMA area.

Field data were collected in 2002. Three plot pairs were placed within each cutblock, with three plot pairs in the associated residual (parent) stand. Plots were 9.77 m radius (0.03 ha) in size. In the parent stand, the three largest DBH suitable lodgepole pine trees were sampled for total height and breast height age. Stand density and other mensurational data were also collected. The same protocols were applied to the cutblock plots, with one added measurement: recording of the last five annual internode lengths.

2.11 Mixedwood Management Association of Alberta

Millar Western is a voting member of the Mixedwood Management Association of Alberta (MWMA). The MWMA is an Association of primary forest industry companies working collectively towards the application of mixedwood management in Canada's western boreal forest, and to advance the science and implementation of mixedwood forestry in the western boreal forests of Canada (MWMA 2005).

The MWMA is involved in a number of research projects, including the installation of Strip Shelterwood Understory Protection Permanent Sample Plots. Millar Western is not currently undertaking understory protection harvesting, and as such, has not installed any Understory Protection PSPs within their FMA Area.

The MWMA is also involved in supporting Mixedwood Growth Model (MGM) development and other research projects.

3. Ongoing Growth and Yield Program

3.1 Forest Inventory

3.1.1 FMU W11 Alberta Vegetation Inventory

Future inventory updates will be scheduled to occur as required based on the Alberta Forest Management Planning Standard (ASRD 2005).

3.1.2 FMU W13 Alberta Vegetation Inventory

Future inventory updates will be scheduled to occur as required based on the Alberta Forest Management Planning Standard (ASRD 2005).

3.2 Temporary Sample Plot Program

3.2.1 Millar Western (MW) Temporary Sample Plots

TSPs were sampled in 2000 and 2004. No additional natural stand TSPs are currently contemplated. Prior to the next planning period, the number of plots available for analysis will be reassessed. At that time, some TSPs may be established in order to fill data gaps as they are encountered, or as required to address BAP data needs.

3.3 Permanent Sample Plot Program

Additional PSPs will be established to satisfy the sampling requirements of the Millar Western PSP grid.

3.3.1 Standard Permanent Sample Plots (SPSPs)

New SPSPs will be placed wherever an unsampled grid points fall on a natural stand within the managed landbase. SPSPs are not eligible for harvest until two remeasurements have occurred; for some SPSPs, this will be as early as 2006. Plots will be reestablished as PPSPs following harvest (next Section).

3.3.2 Plantation Permanent Sample Plots (PPSPs)

New PPSPs will be placed wherever an unsampled grid point falls on a managed stand within the managed landbase. In addition, as SPSPs are harvested, they will be reestablished as PPSPs. A minimum of 10 SPSPs will be targeted for harvest over the 2007-2016 planning period, although this number is reliant on the spatial harvest sequence. Based on timber supply analysis, a total of 0[7] SPSPs will be harvested and converted to PPSPs over the next 20 years.

Table 11. Number of PPSPs based on current grid conditions and planned harvest of SPSPs over the next 20 years.

FMU	DFMP Yield Stratum	Existing PPSPs	Planned PPSPs[1]	Harvested SPSPs[2,3]	Total PPSPs
W11	AW_AB		1		1
	AW_CD		6		6
	BW				0
	APAS_ABCD		1		1
	PASA_ABCD		1		1
	LT				0
	PL_AB				0
	PL_CD		2		2
	SB				0
	SW_AB				0
	SW_CD		1		1
	Herb. Forb				0
	Herb. Grass				0
	Closed Shrub				0
	Open Shrub		1		1
W11 Total		0	13	0	13
W13	AW	7	12		19
	BW				0
	AP				0
	AS		1		1
	PA		1		1
	SA	2	1		3
	LT				0
	PL	6	11		17
	SB				0
	SW	1	3		4
	Herb. Forb				0
	Herb. Grass				0
	Closed Shrub		1		1
	Open Shrub				0
W13 Total		16	30	0	46
Grand Total		16	43	0	59

[1] Grid-based PSPs to be established on existing cutblocks.

[2] Grid-based SPSPs scheduled for harvest within the next 20 years.

[3] To be completed once results from timber supply analysis are available.

[7] Number of SPSPs to be harvested will be incorporated into the February 2008 resubmission, following approval of the DFMP.

3.3.3 Non-Productive Permanent Sample Plots (NPSPs)

Additional NPSPs will be established where an unsampled grid point falls on a natural stand within the unmanaged landbase. Note that the number of NPSPs to be established in non-productive areas has been capped; as such, not all grid points will have a PSP established at their locale. In order to cap NPSPs, potential plot locations were assigned to one of five categories: non-productive black spruce, larch, grass, shrub, and non-productive TPR (TPR U). Within each FMU, a maximum of five NPSPs from each category were selected. In certain cases, more than five NPSPs have already been established and will be maintained. Capping will have the greatest effect on the number of non-productive black spruce and larch stands. For more information on capping procedures, please refer to Millar Western (2005b).

3.3.4 Enhanced Forest Management Permanent Sample Plots (EFMPSPs)

Existing thinned areas and associated numbers of EFMPSPs within the FMA area are presented in Table 12. There are no thinned areas or EFMPSPs in FMU W11. No new commercial or salvage thinning is planned for the upcoming 2007-2016 DFMP; as such, no additional EFMPSPs are planned at this time.

Table 12. Current thinned areas and associated number of EFMPSPs by DFMP yield stratum, FMU W13.

DFMP Yield Stratum	Thinned Area (ha)	Number of EFMPSPs[1, 2]
AW	2.2	
BW	1.0	
AP	17.0	
AS	3.7	
PA	45.0	
SA	7.7	
PL	1,131.5	27
SB	74.5	6
SW	2.5	2
Total	1,285.0	35

[1] Number represents individual plots, rather than EFM installations

[2] Excludes Non-DFA EFMPSPs.

3.3.5 Number of Planned Permanent Sample Plots (Grid Only)

Based on data updated to the end of 2004, an additional 89 grid-based PSPS will be established in FMU W13 and an additional 129 grid-based PSPs will be established in FMU W11 (Table 13). Plots will be SPSPs, PPSPs, or NPSPs depending on where grid points fall. This table breaks down plots based on the current landbase assignment only[8]: plot classification is not static and will change as stand conditions change, or as landbase definitions change. For example, planned SPSPs may be harvested and converted to PPSPs, the definition of the unmanaged landbase may change and NPSPs may be redefined as SPSPs, or vice versa. Therefore, the tables presented here are based on a snapshot of the landbase rather than potential future conditions.

[8] Assignment of PSP attributes was based on version 6 of the landbase being produced for the 2007-2016 DFMP.

Table 13. Number of additional grid-based PSPs to be established by DFMP yield stratum and PSP type, based on current landbase conditions.

FMU	DFMP Yield Stratum	SPSPs	PPSPs	NPSPs	Total PSPs
W11	AW_AB	6	1		7
	AW_CD	30	6		36
	BW				0
	APAS_ABCD		1		1
	PASA_ABCD	7	1		8
	LT			5	5
	PL_AB	2			2
	PL_CD	8	2		10
	SB			5	5
	SW_AB	1			1
	SW_CD	1	1		2
	Herb. Forb			1	1
	Herb. Grass			5	5
	Closed Shrub			2	2
	Open Shrub		1	3	4
W11 Total		55	13	21	89
W13	AW	23	12		35
	BW				0
	AP				0
	AS	13	1		14
	PA	4	1		5
	SA	9	1		10
	LT				0
	PL	20	11		31
	SB	17			17
	SW	11	3		14
	Anth. Nonfor.			1	1
	Herb. Forb				0
	Herb. Grass		1	1	2
	Closed Shrub				0
	Open Shrub				0
W13 Total		97	30	2	129
Grand Total		152	43	23	218

Table 14 lists the anticipated number of PSPs by DFMP yield stratum and PSP type, when grid establishment is complete, based on current landbase conditions. Completion of initial grid-based PSP establishment is scheduled to be completed within the 2007-2016 planning period.

A total of 415 grid-based PSPs are expected based on current landbase designations. In the managed landbase, there will be 315 plots in natural stands (SPSPs) and 59 plots in managed stands (PPSPs); in the unmanaged landbase, there will be 41 plots in natural stands and/or nonforested areas (NPSPs). The number of SPSPs are expected to decrease as stands are harvested and the number of PPSPs will increase.

No additional EFMPSPs are planned at this time.

Table 14. Anticipated number of PSPs by DFMP yield stratum and PSP type, based on current landbase conditions.

FMU	DFMP Yield Stratum	SPSPs			PPSPs			NPSPs			EFMPSPs		Total PSPs
		Existing	Planned	Total	Existing	Planned	Total	Existing	Planned	Total	Existing[1]	Total	
W11	AW_AB	9	6	15		1	1			0		0	16
	AW_CD	16	30	46		6	6			0		0	52
	BW			0			0			0		0	0
	APAS_ABCD	2		2		1	1			0		0	3
	PASA_ABCD	4	7	11		1	1			0		0	12
	LT			0			0		5	5		0	5
	PL_AB	5	2	7			0			0		0	7
	PL_CD	1	8	9		2	2			0		0	11
	SB			0			0		5	5		0	5
	SW_AB		1	1			0			0		0	1
	SW_CD	3	1	4		1	1			0		0	5
	Herb. Forb			0			0		1	1		0	1
	Herb. Grass			0			0		5	5		0	5
	Closed Shrub			0			0		2	2		0	2
	Open Shrub			0		1	1		3	3		0	4
W11 Total		40	55	95	0	13	13	0	21	21	0	0	129
W13	AW	28	23	51	7	12	19			0		0	70
	BW			0			0	2		2		0	2
	AP	2		2			0			0		0	2
	AS	10	13	23		1	1			0		0	24
	PA	12	4	16		1	1			0		0	17
	SA	8	9	17	2	1	3			0		0	20
	LT			0			0	6		6		0	6
	PL	42	20	62	6	11	17			0	27	27	106
	SB	17	17	34			0	10		10	6	6	50
	SW	4	11	15	1	3	4			0	2	2	21
	Anth. Nonfor.			0			0		1	1		0	1
	Herb. Forb			0			0			0		0	0
	Herb. Grass			0		1	1		1	1		0	2
	Closed Shrub			0			0	1		1		0	1
	Open Shrub			0			0			0		0	0
W13 Total		123	97	220	16	30	46	19	2	21	35	35	322
NON-DFA											4		4
NON-DFA Total											4		4
Grand Total		163	152	315	16	43	59	19	23	42	39	39	455

[1] No thinning is planned for the upcoming 2007-2016 DFMP, therefore no EFMPSPs are planned.

3.3.6 Regenerating Stand Permanent Sample Plot Initiative

Millar Western will be establishing 100 additional plantation PSP's in regenerating stands to help bridge the data-gap which exists between years 0 and 30. These PSP's will be located using a stratified random sample design and will represent an addition to the existing PSP-grid. These PSP's will be established within the next five years in order to provide some data for the next DFMP. The sample design and data collection protocols will be developed in consultation with Alberta SRD and included in the February 2008 resubmission.

3.3.7 Remeasurement Scheduling and Eligibility for Harvest

Table 15 presents the PSP remeasurement schedule and information on eligibility for harvesting. Both remeasurement frequency and timing of eligibility for harvesting vary by type of plot and attributes being sampled.

All attributes within NPSPs are measured on a 10-year remeasurement interval. SPSPs, PPSPs and EFMPSPs are remeasured more frequently during the first few measurements after establishment, although certain types of data are collected only on a 10-year interval (*e.g.*, CWD and large snags).

SPSP plots are protected from harvesting until at least 3 measurements (2 remeasurements) have been obtained, after which they will be eligible for harvesting. PPSPs are eligible for harvesting 55 years after establishment, and EFMPSPs are eligible for harvesting 35 years after establishment. NPSPs are never eligible for harvesting, since they are within the unmanaged landbase.

Table 15. PSP remeasurement schedule and eligibility for harvesting.

PSP Type	Data Type	Years Following Plot Establishment (0 = Plot Establishment Year)																				
		0	+5	+10	+15	+20	+25	+30	+35	+40	+45	+50	+55	+60	+65	+70	+75	+80	+85	+90	+95	+100
Standard	Trees	■	■	■		■		■		■		■		■		■		■		■		■
	Vegetation	■		■		■		■		■	ELIGIBLE FOR					■		■		■		■
	CWD	■		■		■		■		■		HARVEST				■		■		■		■
	Large Snags	■		■		■		■		■		■		■		■		■		■		■
Plantation	Trees	■	■	■	■	■		■		■		■		■		■		■		■		■
	Vegetation	■	■	■	■	■		■		■		■		■	ELIGIBLE FOR					■		■
	CWD	■		■		■		■		■		■		■		HARVEST				■		■
	Large Snags	■		■		■		■		■		■		■		■		■		■		■
Non-Productive	Trees	■		■		■		■		■		■		■		■		■		■		■
	Vegetation	■		■		■		■		■		■		■		■		■		■		■
	CWD	■		■		■		■		■		■		■		■		■		■		■
	Large Snags	■		■		■		■		■		■		■		■		■		■		■
EFM	Trees	■	■	■	■	■	■	■		■		■		■		■		■		■		■
	Vegetation	■	■	■	■	■		■		■		■	ELIGIBLE FOR					■		■		■
	CWD	■		■		■		■		■		■		HARVEST				■		■		■
	Large Snags	■		■		■		■		■		■		■		■		■		■		■

■ Measurement Required

A detailed PSP establishment schedule is presented in Table 16. Plots established between 1996 and 2004 represent existing plots tabulated in this document. Plots between 2005 and 2016 represent plots to be established (not included as current plots in this document). Note that assignment is based on current landbase conditions (*i.e.*, not incorporating whether SPSPs are planned for harvest over the next 20 years – these stay as SPSPs in this table). Also note that regenerating stand PSPs are not included at this time; these tables will be updated in the February 2008 submission to include these PSPs.

Table 16. Detailed PSP establishment schedule to 2016, based on current landbase conditions.

Establishment	FMU W11				FMU W13				NON-DFA	
Year	SPSP	PPSP	NPSP	EFMPSP[1]	SPSP	PPSP	NPSP	EFMPSP[2]	EFMPSP[3]	Total
1996					20	1				21
1997					34	1	4		2	41
1998					26	2	6	13	2	49
1999					5	2	3	3		13
2000					21		3	11		35
2001					10	2	2	6		20
2002										0
2003					7	8	1	2		18
2004	40									40
Total Existing	40	0	0	0	123	16	19	35	4	237
2005	18	4	8		13	3				46
2006										0
2007	9	4	5		18	8				44
2008										0
2009	9	2	2		24	4				41
2010										0
2011	9		5		19	8	1			42
2012	10	3	1		23	7	1			45
2013										0
2014										0
2015										0
2016										0
Total Planned	55	13	21	0	97	30	2	0	0	218
Grand Total	95	13	21	0	220	46	21	35	4	455

[1] Includes new PPSPs to be established on existing cutblocks. PPSPs that will occur as a result of harvesting existing SPSPs are not included.

[2] No additional EFMPSPs are planned within FMU W13 at this time.

[3] No additional EFMPSPs will be established outside of the DFA area.

A detailed PSP remeasurement schedule is presented in Table 17. The number of remeasurements represent the expected number of remeasurements based on current plot assignment (stand type) and planned year of establishment.

Table 17. Detailed PSP remeasurement schedule to 2016, based on current landbase conditions.

Remeasurement	FMU W11				FMU W13				NON-DFA	
Year	SPSP	PPSP	NPSP	EFMPSP[1]	SPSP	PPSP	NPSP	EFMPSP	EFMPSP[1]	Total
1996										0
1997										0
1998										0
1999										0
2000										0
2001					20	1				21
2002										0
2003					60	2	10	15	4	91
2004										0
2005					23	3		8		34
2006					30	3		10		43
2007										0
2008					64	10		17	4	95
2009	40				1		3			44
2010	18	4			38	6	3	8		77
2011					30	3	2	8		43
2012	9	4	1		17	8		2		41
2013					67	10	11	17	4	109
2014	49	2			24	4				79
2015	18	4	8		36	6		8		80
2016	9				49	11	1	8		78
Total	143	14	9	0	459	67	30	101	12	835

3.3.8 Protection

A protective buffer is required to maintain the integrity of all permanent sample plots. Plots not only assess tree growth over time, but they also measure a variety of nontimber values. Large snags are assessed within a 30.90 m radius around plot center, and coarse woody debris is sampled in a series of linear transects that extend 30 m from plot center. As such, Millar Western requires a 60 m buffer (29.1 m from large snag plot boundary, 60 m from plot center) around the boundary of each PSP plot, not only to protect these areas from windfall, but also to create an area that adequately buffers against outside effects on biodiversity values. Industrial Sample Plot (ISP) reservations covering the PSP and associated buffer area are required for all PSPs. Applications will be made to ASRD on an annual basis.

3.4 Regeneration Surveys

3.4.1 Alberta Sustainable Resources Development (ASRD) Regeneration Surveys

ASRD regeneration surveys will continue at Establishment and Performance assessment ages. These surveys will follow the ASRD Regeneration Survey Manual (ASRD 2003) methods.

Consideration of additional measurements (*e.g.*, top height/Site Index, growth intercept) and revised minima for managed stands will occur during the development of Alternative Regeneration Standards. Once Alternative Regeneration Standards have been completed, the ASRD Regeneration Survey Manual will no longer be followed.

3.5 Mortality and Ingress

3.5.1 Mortality and Ingress (MI) Permanent Sample Plots

Twenty-four MI PSPs will be established each year (eight blocks with three plots per block). As previously described, four blocks each will be randomly selected from planted pine and planted white spruce blocks. Plots will be sampled at year of planting (year 0) and at years 2, 4, 6, 10 and 15.

Establishment will continue at this rate up to 2012 (ten years of plot establishment), which will result in a sample of 77 blocks (231 plots) with repeated measures. It is anticipated that at this time sufficient data will have been collected to allow for the development of reliable mortality curve. Following 2012, MI plots will continue to be established in order to keep the data set current, although the number of blocks sampled each year will be reduced. Establishment will be restricted to areas in the FMA, harvested by Millar Western.

3.6 Tree Improvement

3.6.1 Tree Improvement Program Approval

Millar Western will obtain approval of their program in compliance with Standards for Tree Improvement in Alberta (STIA) by February 2008.

3.6.2 Tree Improvement Progeny Trials

Millar Western will continue participation in the Tree Improvement Progeny Trials, including maintenance of the existing trial on their FMA area.

3.6.3 Regeneration Surveys

Millar Western will collect regeneration survey data within managed stands planted to improved stock. Data collection parameters will be determined during development of Alternative Regeneration Standards.

3.6.4 Permanent Sample Plots

There are currently no grid-based PSPs in tree improvement stands. Full deployment of improved stock is not expected until 2013. Millar Western will work with Alberta SRD to develop a protocol for PSP establishment in tree improved stands. The intent is to develop a paired plot design which will allow direct comparison between improved and "unimproved" stock. This protocol will be included in the February 2008 resubmission.

During the development of Alternative Regeneration Standards, the need for data to bridge the near-term data gap in the 0-30 year age range (in the form of permanent sample plots) will be addressed.

3.7 In-Block Roads

3.7.1 In-Block Road (IBR) Temporary Sample Plots

Data collection will continue over the 2006 and 2007 field seasons. Analysis of the 2005 results may result in use of a stratified sampling scheme in order to fill data gaps identified in the 2005 data, rather than sampling all blocks slated for Establishment surveys.

3.7.2 In-Block Road (IBR) Permanent Sample Plots

Fifteen IBR PSP plot pairs will be established over the next five years (2006-2010), as described in Section 2.8.2, with 3 plot pairs established per year on average. Establishment will be occur over this time period in order to achieve a temporal range in addition to a range of site conditions.

3.8 Other Data

Millar Western has created a database structure for storage of all PSP information which incorporates both spatial and aspatial data. Within the next five years, Millar Western will complete database and archiving protocols for cataloguing and storing all growth and yield information in a single locale. This will include a synthesis of metadata, sampling protocols, field manuals, data compilations, reports and storage of the data itself (including spatial data components).

The data archiving project will have a broad scope, including formal research and operational data collection as well as data from informal operational trials and other sources. Data sets, sampling designs,

analysis results, reports and any other products resulting from these programs will be archived within this system.

3.9 Summary of Planned Growth and Yield Activities

The core planned growth and yield activities are summarized in Table 18. Other growth and yield data collection or research activities may occur on an ad-hoc basis, but are not specifically referenced here.

Table 18. Summary of core growth and yield programs, and planned future development.

Program	Description
Forest Inventory	Inventory as required to meet Alberta Forest Management Planning Standards.
TSPs	Develop a volume sampling plan to assess whether new TSPs are required for yield curve development prior to the 2017-2026 DFMP.
Regeneration Surveys	Carry out ASRD regeneration surveys (Establishment and Performance) on each cutblock as required by ASRD, until Alternative Regeneration Standards are developed and approved.
Permanent Sample Plot Program	Establish remaining grid-based PSPs by the end of the 2007-2016 planning period; as Standard PSPs are harvested, replace with Plantation PSPs, with a minimum of 10 SPSPs harvested over the 2007-2016 planning period; establish 1 EFM PSP per 250 ha thinned.
Regenerating Stand PSP Initiative	Establish 100 Plantation PSPs in regenerating stands on a stratified basis over the next five years.
In-Block Roads	Collect additional IBR data during ASRD regeneration surveys until 2007; establish of 15 IBR PSP plot pairs over the next five years.
Tree Improvement	Obtain STIA (Standards for Tree Improvement in Alberta) program approval by February 2008; continue participation in progeny trial data collection and analysis; develop a protocol for PSP data collection for inclusion in the February 2008 G&Y plan resubmission.
Mortality and Ingress	Establish 24 new MI PSPs (8 blocks with 3 PSPs per block) every year until 2012 (10 year establishment period).
Data Archiving	Within the next five years, complete database and archiving protocols for cataloguing and storing all growth and yield information in a single locale.

4. Program Summary

4.1 Meeting Growth and Yield Needs

Growth and yield needs are met through existing and planned growth and yield data collection efforts. The primary growth and yield needs identified in Section 1.2 are reiterated here, along with a description of how each need is addressed:

1. A plan for inventory updates must be developed.

    - ✓ Commitment to providing inventory updates as required by the Alberta Forest Management Planning Standard.

2. Data are required for assessing managed stand Site Index.

    - ✓ Paired plot sampling programs (FGYA Paired Plot Sampling and 2000 DFMP Paired Plot Sampling) provide data from contemporaneous stands (harvested and unharvested portions of the same original polygon) at a single point in time.

    - ✓ Permanent sample plots (FGYA Regenerating Lodgepole Pine PSPs and Millar Western PPSPs and EFMPSPs) provide data from the same physical location both before and after harvesting.

3. Regeneration status and productivity on in-block roads must be assessed.

    - ✓ In-Block Road TSPs provide information on stocking status and species composition of in-block roads relative to cutblock areas at establishment age.

    - ✓ In-Block Road PSPs provide information on height growth on in-block roads relative to cutblocks over an extended time period (up to 30 years).

4. Data are needed to validate and improve yield curves.

    - ✓ Permanent Sample Plot, Temporary Sample Plot, and Special Area Temporary Sample Plot data provide volume estimates suitable for development and validation of empirical yield curves. These data may also be used to provide other metrics of interest (*e.g.*, density, height, basal area). These data, particularly PSP data, are suitable for calibration of other growth models if deemed of interest in the future.

5. Data are required to assess response to commercial thinning activities.

    - ✓ EFMPSPs established under the Millar Western PSP program provide data from both control and treated areas over time. The plot design provides data from thinned stands 1) both before and after thinning at a single locale and 2) simultaneously from treated and untreated plots within the same original stand type.

6. Data are needed to provide a linkage between juvenile stand performance and predicted yields for managed stands, to support the development of an Alternate Regeneration Standards (ARS) process.

    - ✓ A continuum of temporary sample plot data across a range of stand types and ages is available to create linkages between juvenile and mature stand types:

        i. Juvenile Harvested Stands: ASRD regeneration surveys provide baseline data describing the condition (height, age, density, stocking) of harvested regenerating stands at both establishment and performance ages.

        ii. Juvenile Fire Origin Stands: Virginia Hills and Roche Lake Burn surveys provide comparable data (height, age, density, stocking) from post-fire, naturally regenerating stands.

        iii. Juvenile to Mature (transition) Harvested Stands: Pre-91 Harvest Block regeneration surveys provide comparable data (height, age, density, stocking) from harvested stands that are past performance age (up to 30+ years of age).

        iv. Mature Fire Origin Stands: Temporary Sample Plot data provide comparable data (height, age, density) from mature stands (generally 30 years or older).

    - ✓ Mortality and Ingress plots provide information suitable for estimating mortality from 0 to 15 years post harvest, which is useful for describing changes in density over time in harvested regenerating stands.

    - ✓ Permanent Sample Plot data (Millar Western PSPs and FGYA Regenerating Lodgepole Pine PSPs) provide data from stand initiation through to maturation; these data will be invaluable for validation of ARS targets set using temporary sample plot data.

7. Expected yield increases due to tree improvement must be validated.

    - ✓ Data collected under Millar Western's Tree Improvement Progeny Trials will be used to validate assumptions regarding expected gains in volume.

- ✓ Grid-based PPSPs in stands planted to improved stock, paired with control PPSPs, will monitor growth and mortality of white spruce tree improvement stock relative to that of non-improved planted stock.

8. Data are needed to model forest stand dynamics and succession in both the managed and unmanaged landbase.

    - ✓ The Millar Western PSP program and FGYA Regenerating Lodgepole Pine PSPs will provide growth data suitable for calibrating models of forest succession, including stand development in unmanaged stand types.

    - ✓ Mortality and Ingress PSPs will provide data that can be used to model mortality of planted and natural conifer seedlings.

9. Information on mortality and ingress are needed to support both model calibration and validation, but also to support planting density targets for ARS development.

    - ✓ Mortality and Ingress PSPs will provide data that can be used to model mortality of planted and natural conifer seedlings, and provide a means of developing a relationship linking juvenile and mature stand densities.

    - ✓ Millar Western PSPs will track mortality and ingress across a range of stand types.

10. Data on nontimber attributes (*e.g.*, biodiversity, fire fuels, wildlife habitat) are required for planning for multiple values.

    - ✓ Biodiversity Assessment Project data collected under the Temporary Sample Plot Program and the Millar Western PSP program are suitable not only for characterizing nontimber attributes of interest, but are also suitable for input into various landscape-level modelling endeavors.

4.2 Growth and Yield Plan Updates

Growth and yield needs change as a function of changing priorities and increased understanding of forest systems. As such, changes to this Growth and Yield Plan are anticipated and this document will be updated as required to reflect these changes.

A Growth and Yield Plan was submitted in June 2006. This Growth and Yield Plan reflects changes to the 2006 submission, undertaken to address comments provided by Alberta Sustainable Resource Development (ARS). Following submission and approval of the Millar Western DFMP, a revised Growth and Yield Plan will be developed, and submitted for approval by February 2008.

The Growth and Yield Plan will be reevaluated and revised prior to subsequent DFMPs and/or as required during the 2007-2016 planning period. Any time major changes are made to the growth and yield program, the growth and yield plan will be resubmitted to ASRD for review and approval.

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