Table 26. Integrated Classification of Roads

DFMP_Tables.xls
Table 72

Road Class	Description
I	Permanent, year-round access to a working area for 20 years+.
II	Permanent year-round access. A branch road serving as a collector or as a main winter haul road. Duration of use: 10 years+.
III	Permanent access available during dry or frozen periods – provides access to cutblocks. Duration of use: 2 to 20 years.
IV	Temporary access during dry or frozen periods between and within cutblocks. Duration of use: 2 – 5 years, or duration of operations.
V	Temporary access during frozen periods between and within cutblocks. Duration of use: 2 years or less.

Source: *Resource Road Planning Guidelines* (AENR 1989) –Table 1

11.2 Road Construction Standards

Roads are constructed in accordance with the *Resource Road Planning Guidelines* (AENR 1989). Table 15 provides the construction standards for each road class.

11.3 Log Haul

Most of the logs required by Canfor's mill are hauled in winter. The majority of the log haul utilizes off-highway roads constructed by Canfor and other forest resource users. Public roads are also utilized, particularly to haul logs from forest management units G2C and G8C. For example, approximately 17% of the wood hauled from the FMA area by Canfor's contractors in the 2000-2001 season was hauled on those roads. Log purchases from Alberta Newsprint Company and from the Commercial Timber Permit sales are also hauled on public roads. Road use is subject to the statutes and regulations promulgated by the Alberta Government.

Alberta Transportation must approve all log haul routes. Canfor consults with, and obtains approval from, the respective County and Municipal councils prior to applying to Alberta Transportation. Logging trucks must have approved log haul route maps for the roads being utilized.

11.3.1 Log Haul Distance

Haul distances vary depending on the location of harvesting activities. Currently Canfor's average haul distance from the FMA area ranges from 75 km to 200 km, with a weighted average distance of approximately 150 km. Cycle time varies according to road conditions, weather and other factors. The current cycle times range from 4 - 8 hours per trip.

11.3.2 Log Haul Weight Limits

When log trucks are hauling on the highways, the axle configurations (Figure 76), as well as the season, govern the load weights. Alberta Transportation administers a Winter Weight Log Haul Program[17] that allows increased weights during the winter months when the roads are frozen. The Forest Engineering Research Institute of Canada (FERIC) recently completed a study titled, "*Dynamic Stability Analysis of Logging Trucks Used on Alberta Highways*" (FERIC 2000). In this study, the legal weight for a 7-axle Tandem Jeep Logger truck during the summer is 56,500 kg while, in the winter, this same truck can haul 65,000 kg. The study, which is being used by Alberta Transportation as a benchmark for the Winter Log Haul Program, also lists the summer and winter weights for other truck configurations. The study indicates design changes that have to be incorporated into log trucks and trailer designs.

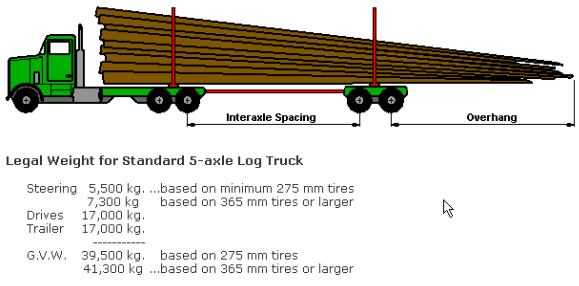


Figure 76. Standard Log Truck Configuration

Canfor's log haul contractors utilize a variety of truck configurations, which meet specifications established by Alberta Utilities and Transportation, to deliver logs to the mill.

Source: http://www.tu.gov.ab.ca/Content/doctype276/production/teg020.htm

Canfor, in consultation with the log haul contractors, has implemented a *Log Truck Hazard Assessment* (AFPA 1998). The assessment covers the following:

- Log Truck Weight Monitoring – the maximum weight on Canfor's off-highway road system is 66,000 kg. The log haul contractor has an overweight monitoring system in place that tracks the weights of all log trucks and penalizes those trucks that are over the maximum weight. In addition, Canfor ensures compliance with the policy through sampling;
- Speed control and monitoring – the road patrol contractor monitors speeds on the roads used for hauling. Violation by commercial users of the posted speeds is subject to progressive disciplinary action, which culminates in a suspension from driving on Canfor's roads;
- Signage – Canfor ensures that all signs are well maintained;
- Route control and communication – due to the amount of diverse traffic on Canfor's roads, the road patrol contractor holds safety meetings with the various groups using the Company's roads. The roads are radio controlled and other users may be diverted to alternate routes to avoid congestion;
- Truck driver management – the load and haul contractor maintains an extensive database on truck drivers. The information includes driver abstracts, mill yard orientations, safety meetings, safety training, monitoring of driver performance, etc.; and

[17] http://www.tu.gov.ab.ca/content/doctype276/production/teg020.htm

- Log truck and trailer maintenance – the load and haul contractor requires that truck drivers complete pre- and post-trip inspections as well as scheduling regular maintenance on the trucks. In addition, Canfor utilizes a qualified third party to randomly inspect log trucks for roadworthiness. Any trucks found with major deficiencies are suspended from the log haul until proof of repair is shown. Trucks with minor deficiencies may continue to haul, but must show proof of repair within a specified timeframe.

12 Protection of Forest Lands

Canfor and other timber users have the right to grow, harvest and manage the timber resources for which they hold rights. Other users, such as the energy sector, also have rights to resources within the FMA area. (Figure 77) As more land is withdrawn for other uses, less is available for the growing of forests. Maintenance of forests on the landscape is very important to the environmental health of the forest.

Figure 77. Land Withdrawals
The impact of land withdrawals on forest management is direct. As more land is withdrawn for other uses, less is available for forests.

12.1 Minimization of Canfor's Permanent Roads on the Landbase

An objective has been established to have less than 2% of productive area in Canfor's future permanent roads (LOC) (Section G "Critical Element 4c, Objective 1.1a.1"). Permanent roads are those roads that are managed through the License of Occupation (LOC) (refer to Section F 10.1).

Canfor has constructed or acquired 3 LOCs between 1999 and 2000 (equating to 16.2 ha) as follows:

- LOC 930682A (2.5 km) extension was constructed in the operational subunit DN-3;
- LOC 961570 (1.8 km) was acquired from an oil company in operational subunit SIM-3; and
- LOC 003218 (7.0 km) was constructed in operational subunit DN-5. (acquired from Burlington Resources Ltd.). Refer to Appendix 3 for additional information regarding operational units and subunits.

Canfor will monitor its performance in achieving the objective by tracking the actual and projected amount of Canfor's future permanent roads to be constructed. All newly constructed permanent roads and those permanent roads proposed in the Annual Operating Plan will be reported in the *Annual Performance Monitoring Report*.

Canfor will continue to monitor its performance in achieving the objective by tracking the actual and projected amount of road to be built.

12.2 Landbase Withdrawals

The FMA area contains a variety of resource values in addition to timber resources. The Government authorizes land withdrawals from the FMA area to accommodate these

values and uses. The FMA holder is consulted for consent on all applications including the following:

- Road construction;
- Wellsites;
- Processing plants;
- Pipelines;
- Recreation sites; and
- Gravel pits.

The majority of the land withdrawals from the FMA area result from the oil and gas sector, which is regulated and managed by the Crown (refer to Section F 12.3). Canfor has no control over the level of activity allowed or initiated during any given year. The amount of hectares withdrawn annually from the FMA area is tracked in a landuse database. Table 27 provides the data for the previous 7 years.

Table 27. Summary of Landbase Activity (1994-2000)

DFMP_Tables.xls
Table 12

Period Ending Dec. 31	Number of Dispositions	Area Withdrawn (no seismic) (ha)	Area of Seismic (number of programs) (ha)	Total Area (ha)
1994	178	689	223 (15)	912
1995	173	501	676 (34)	1,177
1996	230	588	212 (55)	800
1997	246	649	227 (32)	876
1998	205	689	242 (26)	931
1999	151	337	170 (21)	507
2000	221	619	96 (25)	715

Source: Canfor compiled data

Canfor will be monitoring the data listed in Table 27. If the area withdrawn (excluding seismic lines) exceeds 10% of the highest value in the previous 5 years, then concern will be expressed to Alberta Sustainable Resource Development.

A description of how land withdrawals are addressed in the *Resource and Timber Supply Analysis* is contained in Appendix 3.

12.3 Timber Damage Assessment

Whenever the activities of other land users such as seismic, wellsites, pipelines, roads, gravel pits, etc. impact the forest resources within the FMA area, Canfor receives compensation as per the *Forests Act* - paragraph 16(2):

"*Except as against the Crown and subject to any agreement to the contrary, ownership of all Crown timber on land subject to a forest management agreement or forest management lease is, during the term of the agreement or lease, vested in the holder of the agreement or lease, who is entitled to reasonable compensation from any person who causes loss of or damage to any of the timber or any improvements created by the holder*."

The FMA agreement holder retains the right to review all plans for the purpose of granting consent prior to entry in accordance with the *Surface Rights Act* - paragraph 12:

"No operator has a right of entry in respect of the surface of any land…until the operator has obtained the consent of the owner and the occupant of the surface of the land or has become entitled to right of entry by reason of an order of the Board pursuant to this Act."

Since 1995, the forest industry, Government and the Canadian Association of Petroleum Producers (CAPP) have been participants of a joint management committee, which evaluates the timber damage assessment process on a yearly basis to ensure the compensation amount and process remains fair for all parties. The timber damage assessment tables are updated annually.

Forest product companies must utilize timber damage assessment funds according to very clear guidelines that have been established by the Government and ratified by the forestry and the energy sector. Timber damage assessment funds must be used to maintain the forested landbase by either:

- Replanting the lands that were withdrawn and are no longer in use;
- Buying private land with timber to harvest or to grow additional fiber to replace the lost volume as a result of the land withdrawals within the FMA area, (maintaining a forested landbase on an area other than the FMA area);
- Conducting enhanced silviculture on other areas of the FMA area to compensate as replacement volume from the withdrawals;
- Buying private wood as replacement fiber for the mill; or
- Updating the Alberta Vegetation Inventory (AVI) to account for withdrawals and seismic activities.

Background

Timber Damage Assessment (TDA)

- 1966-1979 – TDA compensation collected on 2 established FMAs as "occupants of the land".
- 1979 – Environmental Council of Alberta (ECA) recommends compensation of damaged timber in the Green Area. The Province adopted this policy and a provincial TDA table is created.
- 1980s – TDA compensation becomes controversial in the late 80s due to the following:
  - new FMAs are signed;
  - new species have value (aspen);
  - Stumpage increases dramatically; and
  - TDA compensation tables have not been updated since 1979.
- 1989 – discussions between the Government, forest industry and petroleum industry begin to resolve TDA issues.
- 1992 – on Jan. 15, an interim TDA rate table is agreed to. This table was used by all FMA holders and the Government.
- 1992-1995 – negotiations continue on the principles for compensation and how compensation is determined.
- 1995 – negotiations result in an agreement to a process for development of a new rate table, annually based on the standing timber value of wood derived from surveys. New principles are in place and a dispute resolution process is available.

Canfor utilizes enhanced silviculture methods to replace the "lost" timber. Specific impacted areas, that have the potential for enhanced growth, are planted at higher than normal densities in order to grow stands that can be pre-commercial and commercially thinned. This process increases fiber recovery from the impacted site and helps to compensate for the loss of volume due to land withdrawals.

In a typical year, approximately 500 ha are withdrawn from forest production within the FMA area as a result of oil and gas activity (excluding the area impacted by seismic). (Refer to Table 27). On average, seismic activity removes an additional 321 ha from the FMA area. Canfor collects approximately $800,000 in timber damages annually and spends these funds to replace the lost timber volume in the following manner:

- $500,000 is utilized to grow additional fiber on the same landbase using enhanced silviculture techniques;
- $100,000 is spent annually for the Tree Improvement Program (refer to Section F 14.11.12); and
- The remainder is used to offset planting costs of wellsites and the purchase of additional fiber for the mill.

It was reported in a 1998 KPMG survey that over $15 million in timber damages was collected by the forest industry, on a provincial basis, and over $48 million was expended for a combination of replacement wood, research, tree improvement and intensive forest management.

12.4 Returning Withdrawn Areas to Productive Status

From a forestry perspective, it is important to bring previously withdrawn lands that are no longer in use back into productive status. As a result, Canfor and Alberta Sustainable Resource Development (ASRD) are cooperating to assess well sites as candidates for reforestation.

Canfor has committed to tracking and reporting the status of those withdrawn areas brought back into productive status (Section G “Critical Element 4c, Objective 1.2a.1”).

12.5 Shared Access

The key to maximizing and promoting shared access by all resource users is to communicate with other users and to integrate their road and land use plans, where feasible. Canfor’s objectives are “to maximize and promote shared access by all resource users” (Section G “Critical Element 4c, Objective 1.3a.1”) and “to minimize loss of area by working with other parties” (Section G “Critical Element 3a, Objective 1.1b.1”).

Canfor advocates a common corridor approach to minimize road duplication and to decrease the loss of productive landbase. As Canfor learns of the plans of other resource users, efforts are made to ensure that common road corridors are used. For instance, the oil and gas sector may use the same access routes that Canfor uses to access cutblocks or vice versa. By way of example, in the winter season 2000-2001, Canfor and an oil company cooperated to construct a road that accessed timber and a well site. Such cooperation demonstrates that joint access development is feasible when information is shared and work schedules are provided in a timely fashion.

12.5.1 Communication Plan

The key means of minimizing loss of area are to communicate plans with other industries and integrate road and land use plans, where feasible. Consequently, each year since 1996, Canfor forwards an informational letter and access map (5 Year GDP map) to the main industry companies that operate within the FMA area.

Canfor believes that development of a formal communication plan is a necessity. To initiate the process, the strategy is to develop a framework to improve communication between companies then, in cooperation with the other stakeholders, use the framework to discuss the issues and develop an efficient communication plan. To be effective, the plan should be developed jointly with Land and Forest Division, Tolko Industries Ltd., Ainsworth Lumber Company, Grande Alberta Paper, Canadian Association of Petroleum Producers and the main oil and gas companies within the FMA area. Canfor will develop the communication framework, as stated above, and commence contact with other stakeholders by December 2001.

13 Woodlot Management

Regardless of where the forest resources are located, they are a valuable asset and should be managed and harvested in an environmentally sound and responsible manner. In recognition of this importance, Canfor is in the process of producing a pamphlet titled, *Sound Forestry Practices - Information for Forestry Operations on Private Lands* (Draft Canfor 2001k).

Sound Forestry Practices provides information to assist landowners to manage private lands and to conduct their forestry operations in an environmentally responsible manner. It also provides information on *Canfor's Purchase Wood Program* and outlines the forest management and log quality standards that must be met before the Company will purchase wood from private lands.

Two basic principles guide the program:

- Canfor will not knowingly purchase wood from lands that have not been managed and harvested in an environmentally responsible manner; and
- Canfor desires to assist private landowners that want to manage their land as a woodlot. The Company's staff can assist by providing information and offering practical advice.

More information regarding the wood supply for the Grande Prairie facilities can be found in Section B 4.

14 Utilization Standards

Alberta Sustainable Resource Development establishes *Timber Harvest Planning and Operating Ground Rules* that define the utilization standards for both species. The standards include 3 merchantability components:

- Merchantable stand (Figure 78);
- Merchantable tree (Figure 79); and
- Merchantable piece (Figure 80).

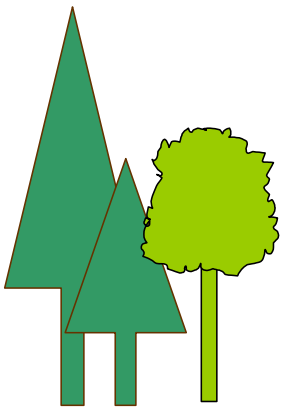


Figure 78. Merchantable Stand

A merchantable stand is defined as a stand:

- Having 50 m^3 or more of merchantable trees per ha.

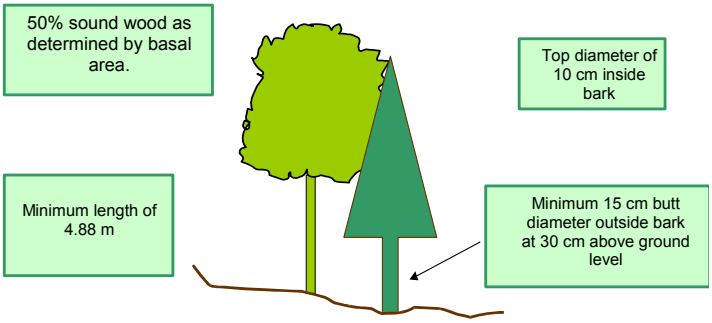


Figure 79. Merchantable Tree

A merchantable tree:

- Has a minimum 15 cm stump diameter, measured outside bark at 30 cm above ground level;
- Has a minimum 4.88 m usable to a top diameter measured inside bark of 10 cm; and
- Contains at least 50 % sound wood.

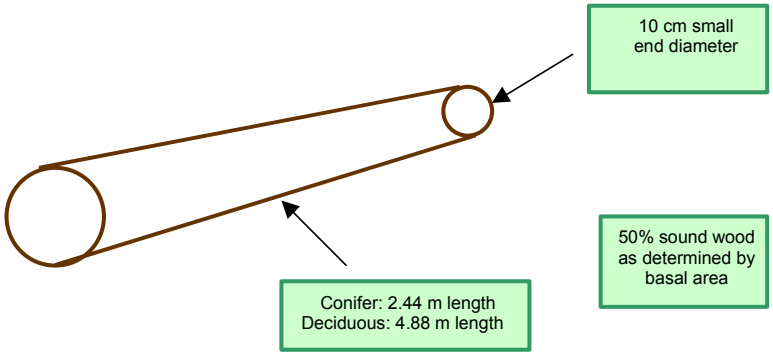


Figure 80. Merchantable Piece

A merchantable log or broken piece:

- Has at least 50 % sound wood;
- For coniferous, is 2.44 m in length plus trim allowance to a maximum length of 2.55 m to a 10 cm small end diameter inside bark; and
- For deciduous, is 4.88 m in length.

14.1 Timber Dues

The volume of logs harvested from the FMA area and other areas must be measured to ensure timber dues are paid to the Alberta Government. Timber dues are fees, payable by forest companies, to the Government for the timber resource. These fees are subject to the *Timber Management Regulations, Part 4 Crown Charges* (AR 102/2000). Each cubic meter delivered to the mill is multiplied by a rate monthly established by the Government, and that amount is then payable to the Government. The process for determining the volume of logs is called check scaling. The check scale determines the conversion factor of metric tonnes to cubic meters.

14.1.1 Scaling

Log trucks are weighed as they enter the mill yard to determine load weights. Manufacturers are required to sample a specific minimum number of samples for establishing a conversion factor from tonnes to cubic meters. The *Alberta Log Scale* method is used to meet these requirements. Certified sample scalers measure each log in the sample load in accordance with *Alberta Scaling Manual* (Alberta Environmental Protection 1992 revised). All scaling measurements are recorded in a data recorder and downloaded into a computer to calculate the conversion factors (m^3/tonne) for each species and product type within a load. The conversion factor is utilized to determine total volume hauled. This volume is then used as the basis for payment of timber dues and to establish periodic cut control volumes (refer to Appendix 3 for additional information regarding cut control).

14.2 Merchantable Waste

Waste minimization is an important objective because more of the tree is used and, consequently, less standing timber may have to be harvested. The objective is to leave less than 1% merchantable waste in the Company's cutblocks (Section G "Critical Element 4b, Objective 1.3a.1"). Merchantable waste is defined as the volume of merchantable timber left on the harvested area that should have been removed in accordance with the minimum utilization standards.

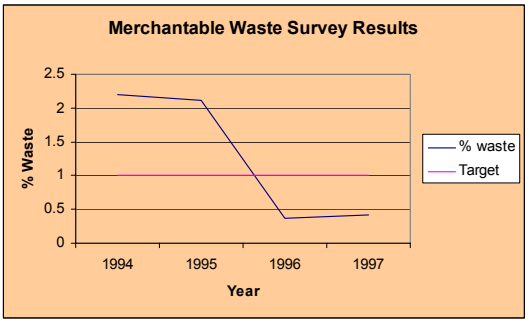


Figure 81. Merchantable Waste Surveys
Since 1994, the amount of merchantable waste on the harvested sites has declined dramatically.

The amount of coniferous merchantable wood waste varies depending on:

- Visual determination of cull; and
- Visual determination of top diameter.

The amount of deciduous merchantable wood waste varies depending on:

- Visual determination of cull;
- Visual determination of top diameter; and

- Markets for deciduous.

Waste surveys were conducted during the period 1994 – 1997 to determine the amount of coniferous merchantable waste left behind post-harvesting. The survey results for 1996 and 1997 show that Canfor did not exceed the 1% target by operating area or for the FMA area overall, and averaged 0.4% for each year. This is a significant improvement from the 1994 and 1995 survey results that showed an average of 2.2% and 2.1% waste, respectively (Figure 81). The surveys ceased after 2 years of excellent results because it was felt that waste minimization efforts were achieving the desired results. The need for surveys has recently been re-evaluated and the surveys will be re-initiated. Commencing in 2001, waste surveys will be conducted every 2 years. If the results show that merchantable waste exceeds the desired target in any single operating area, then logging practices will be evaluated and corrective actions implemented.

15 Silviculture

This section provides details regarding the governmental reports, various silvicultural programs, initiatives and activities undertaken for management of the forest resources within the FMA area.

15.1 Government Reporting

Forest companies comply with all statutes, regulations, policies, etc. relating to government reporting. The Company submits Annual Operating Plans, Vegetation Management Plans and Forest Protection Plans. The following section describes the government reporting with respect to silviculture and reforestation.

15.1.1 Reporting Silviculture Activities

Under subparagraph 143.2(2) of the Timber Management Regulations, "*A Timber disposition holder responsible for carrying out reforestation shall, by May 15 of each year, submit to the Minister a written report summarizing the proceeding year's reforestation program*." Canfor has intensified this reporting regime by reporting summaries of reforestation activities twice a year; May 1 (which is included with the submission of the Annual Operating Plan as required under paragraph 98 of the Timber Management Regulations, and November 30. The November 30 submission details all reforestation activities performed between May 1 and October 31.

Canfor anticipates that the Government's adoption of the new Alberta Reforestation Information System (ARIS) may change the timing for reporting reforestation activities. Canfor is currently developing its own reforestation reporting methodology using the *GENUS*® suite of resource management technology applications. This will enable Canfor to fully comply with any enhanced reporting requirements the ARIS system may require.

15.1.2 Silviculture Data Management

Canfor's internal forest management systems are updated after the completion of major activities. In addition, harvested areas are updated on a yearly basis using cutover update photography. This enables the geographic information system (GIS) to be

updated with any activities conducted within the FMA area, including any harvesting by other timber users.

Canfor is at the cutting edge in relation to utilizing state of the art GIS technologies. ***GENUS RMT*** (a wholly owned subsidiary of Canfor) has developed a suite of applications which allows Canfor to manage all forest resources entrusted to the Company's care. There are 4 modules currently in place: Cut Block Management System (CBMS), Forest Road Management System (FRMS), Operational Planning, and Logging Production (refer to Section E 5 for additional information). The fifth module, Silviculture, is currently in its final stage of development, and is being developed in parallel with the Government's Alberta Regeneration Information System (ARIS) system to ensure that Canfor will be able to fulfill its reporting requirements to the Government in full support of this Detailed Forest Management Plan.

15.2 Canfor's Approach to Reforestation

At Canfor, reforestation is more than "putting the trees back". The forest management practices are adaptive, and geared to continuous improvement. Not only are cutblocks satisfactorily restocked, but also they are reforested to their maximum ecological growth potential.

Canfor's program is based on 5 fundamental principles:

1. Clear and aggressive long-term management strategies and goals - to ensure a consistent and focused reforestation effort;
2. Detailed and accurate ecological data regarding sites proposed for harvest – to identify site potential;
3. Effective mitigation of factors that may limit reforestation performance;
4. Deployment of large and aggressive planting stock to ensure quick seedling establishment, and ensure desired yield groups are placed on a growth trajectory as soon as possible; and
5. Continuous monitoring to ensure reforestation goals and objectives are being achieved.

Reforestation Quick Facts

- Canfor plants between 4 and 5 million seedlings every year;
- The Company's planting program includes 3 main species and 5 different stock types;
- Canfor's contractors employ approximately 200 people for its reforestation program;
- Canfor has contracted with local Aboriginal people to conduct vegetation management activities; and
- Most silvicultural prescriptions are based on detailed, site specific ecological information.

Canfor has successfully reforested harvested areas since 1964. On average, Canfor's reforestation programs comprise 4,100 ha annually. Approximately 2,500 ha of this sum involve initial reforestation efforts on recently harvested cutblocks. Vegetation management comprises the other 1,600 ha.

The primary goal of Canfor's reforestation program is to satisfactorily regenerate harvested areas to at least provincial standards. Each cutblock is evaluated to determine the most efficient and cost effective way to attain satisfactory reforestation. A

summary of the reforestation activities undertaken by Canfor, for the period 1996–2000, is contained in Appendix 9.

As mentioned previously, prompt reforestation of harvested areas is key to silvicultural success. In order to achieve this, Canfor has made a commitment to reforest all harvested sites within 18 months of the end of the timber year (Section G "Critical Element 2b, Objective 1.1c.1"). This is an improvement on provincial regulations which state that, "*a timber licensee or holder of a forest management agreement shall, within 2 years of completing the cut in each area from which coniferous timber has been cut, carry out all treatment necessary to reforest each area to the level required*" (Timber Management Regulation Division 1, Section 123). In many of Canfor's operating areas, the 18 month timeline has been improved upon by reforesting sites the summer immediately following. This results in initial reforestation efforts being conducted within 3 months of the end of the timber year (Canfor 2000h), thereby improving on the provincial standard by 21 months. *The Alberta Timber Management Regulation, Part 6* – Reforestation – Division 2, paragraph 141.1 states, "*the holder of a timber disposition shall, within 2 years after the end of the year of cut of each area of public land cut, carry out such reforestation as, in the opinion of the Minister, will be needed to ensure that the reforestation standards will be met in respect of the area cut.*" However, all harvested sites will be monitored to ensure that site treatment occurs within 18 months from the end of the timber year in which the block was harvested.

15.3 Pre-Harvest Ecological Assessment

Effective reforestation is contingent upon detailed, site-specific ecological information. Canfor conducts pre-harvest ecological assessments to collect the required data (Figure 82). The most appropriate silviculture management decision can be made for selecting a reforestation tactic that recognizes both the limiting factors and performance opportunities a specific site possesses. For the past 5 years, Canfor's reforestation success has been in excess of 95%, after initial treatment, based on regeneration survey results. This is due to the use of detailed pre-harvest ecological information, effective, site-specific reforestation treatments, the use of well-planted, aggressive planting stock and performance monitoring.

Figure 82. Pre-Harvest Ecological Assessments
A detailed examination of soil conditions and lesser vegetation, as well as understorey and overstorey species present, provide data upon which to base accurate and cost-effective silvicultural prescriptions.

15.4 Ecosite Field Guides

Canfor uses a systematic approach to ecologically classify areas proposed for harvest. Using a systematic approach helps to organize current understanding about ecosystem functions.

The objectives of using a systematic approach to ecological classification are:

- To facilitate the application of ecological information to decisions on a wide variety of activities within the realm of forest resource management;

- To facilitate the collection and organization of information to expedite the development of resource management applications and decision support systems;
- To promote communication among resource managers and between managers and the public;
- To provide a common basis for integrated planning; and
- To reduce resource management costs by integrating ecological information into the decision-making process.

Figure 83. Ecosite Field Guides
Canfor retained Geographic Dynamics Corp. to provide further detail and enhancements to the existing ecosite field guides.

In order to appropriately evaluate the ecology of sites proposed for harvest, the *Field Guide to Ecosites of West-central Alberta* (Beckingham *et al* 1996a) and the *Field Guide to Ecosites of Northern Alberta* (Beckingham and Archibald 1996) are used. A Forest Resource Improvement Program (FRIP) project (Canfor 2000k) was completed in June 2000 that provided further detail and enhancements to the field guides, resulting in the publishing of the *Field Guide to Ecosites of the Boreal Mixedwood Region of Canfor's Grande Prairie FMA Area* (Canfor 2001d) and *Field Guide to Ecosites of the Foothills and Subalpine Region of Canfor's Grande Prairie FMA Area* (Canfor 2001e) (Figure 83). Each site is classified according to this methodology. This information is tracked spatially within the GENUS® silviculture system. Through spatial tracking, Canfor will be able to monitor reforestation success by comparing treatment success to pre-harvest ecosite information. This will further allow the Company to lend adaptive management strategies to its reforestation programs, and further increase success.

15.5 Silviculture Field Guide

The silviculture field guide was developed on past silvicultural successes and is a guide in assisting field staff in making silvicultural prescriptions (Canfor Undated). It is intended that the field guide will be applied with sound judgment based on practical experience and technical competence. It is recognized there may be exceptions or unusual conditions to which these standards cannot be strictly applied. Reasonable adjustments best suited to the requirements of each specific situation will be used.

15.6 Regeneration Strategy

The *Resource and Timber Supply Analysis* uses a regeneration strategy that is based on current practice, results from field surveys, Northern Interior Vegetation Management Association (NIVMA) plots, permanent sample plots (PSP), tree improvement programs and general observations. The implementation of this strategy within the *Resource and Timber Supply Analysis* consists of regenerated yield groups, years to breast height and tree improvement multipliers (Table 28). The 2000 pre-harvest ecological assessment, fundamental to the silviculture prescription program, is presently incorporating the regeneration strategy. The *2000 Silviculture Annual Operating Plan* incorporated the regeneration strategy for the 2000-2001 cutblocks.

The coniferous and deciduous strategies outlined in Table 29 must be followed in order to maintain both annual allowable cuts (AACs).

The following are the key assumptions for the regeneration strategy, all of which have been shown to be reasonably accurate in the past:

- Early crop establishment (within 18 months) will achieve projected breast height ages within the stated times;
- Silviculture treatment(s) successfully put the harvested stand on the growth and yield trajectory of the regenerated yield group;
- Allowances for plantation failures, regeneration delay, and understorey protection are accurate; and
- Tree improvement multipliers represent the actual improvement that will occur.

15.6.1 Growth and Yield Monitoring

The regeneration strategy will be compared to planned and actual silviculture activities to ensure compliance to the acceptable variance. If results are below the acceptable variance over a 5-year period, a review of the effects of such changes on the Detailed Forest Management Plan (DFMP) will be evaluated. This will be reported on an annual basis in the *Annual Performance Monitoring Report* and the *Five Year Forest Stewardship Report*. More information regarding monitoring of growth and yield is contained in Section J 1.1.

15.6.1.1 Maintaining Yield Groups on the Landscape

The objective is to maintain the yield groups on the landscape by regenerating 100% of the harvested area as per the regenerated yield group provided in Table 28 (Section G "Critical Element 2b, Objective 1.1a.1"). The acceptable variance is +/-10% of the area of regenerated yield groups and +/-5% of the AAC for C, CD, DC & D, provided that the overall AAC for both coniferous and deciduous are sustained (within – 5%). The ecological implications of implementing that objective is neutral, since the same relative proportions of yield groups will be maintained on the FMA area over time. Regeneration tactics will consider the goal of maintaining landscape diversity and maintaining representative yield groups over time.

The regeneration strategy, as defined below, will be compared to planned and actual silviculture activities to ensure compliance with the acceptable variance. If results are below the acceptable variance over a 5-year period, a review of the effects of such changes on this DFMP will be evaluated. This will be reported on an annual basis in the *Annual Performance Monitoring Report* and the *Five Year Forest Stewardship Report*.

Commencing with the 2000–2001 cutblocks, the 4 stocking standards (C, CD, DC, D), will be tracked by 5 year increments in accordance with *Forest Management Directive 2001-03*. The area for each stocking standard will be balanced to within ±5% when comparing regenerated to harvested areas. Only stocking standards that exceed 5% of the total harvested area will be tracked.

Both the coniferous and deciduous strategies outlined in Table 28 must be followed in order to maintain both annual allowable cuts (AACs).

Table 28. Regeneration Strategy

DFMP_Tables ver1.xls
Table 73a

Yield Group	Description	Natural Subregion	Regenerated Yield Group	Primary Species Years to Breast Height*	Secondary Species Years to Breast Height*	Tree Improvement Multiplier**
1	AW+(S)-AB	All	2	4	16	0.50
2	AW+(S)-CD	All	2	4	15	0.50
3	AWSW/PBSW/BWSW	CMW, DMW, LFH, PRP	3	8	10	1.00
3	AWSW/PBSW/BWSW	UFH, SAL	3	11	12	1.00
4	BW/BWAW+(S)	All	4	5	15	0.50
5	FB+OTH	CMW, DMW, PRP	16	8	10	1.00
5	FB+OTH	UFH, LFH, SAL	5	0	4	1.00
6	H+(S)/S	CMW, DMW, LFH, PRP	17	0	10	1.00
6	H+(S)/S	UFH, SAL	17	11	15	1.00
7	PB+(S)	All	7	4	10	0.50
8	PL/PLFB+(H)	CMW, DMW, LFH, PRP	8	6	10	1.07
8	PL/PLFB+(H)	UFH, SAL	8	9	12	1.00
9	PLAW/AWPL	CMW, DMW, LFH, PRP	9	6	10	1.07
9	PLAW/AWPL	UFH, SAL	8	9	12	1.00
10	PLSB+OTH	CMW, DMW, LFH, PRP	8	6	10	1.07
10	PLSB+OTH	UFH, SAL	8	9	12	1.00
11	PLSW/SWPL+(H)	CMW, DMW, LFH, PRP	11	7	10	1.07
11	PLSW/SWPL+(H)	UFH, SAL	8	9	12	1.00
12	SBLT/LTSB(G,M,F)	All	12	15	6	1.00
13	SBLT/LTSB(U)	All	13	23	9	1.00
14	SBPL/SBSW/SBFB	CMW, DMW, LFH, PRP	14	7	10	1.00
14	SBPL/SBSW/SBFB	UFH, SAL	14	10	12	1.00
15	SW/SWFB+(H)-AB	DMW, PRP	15	9	10	1.00
15	SW/SWFB+(H)-AB	CMW, LFH	16	9	10	1.00
15	SW/SWFB+(H)-AB	UFH, SAL	16	12	12	1.00
16	SW/SWFB+(H)-CD	CMW, DMW, LFH, PRP	16	9	10	1.00
16	SW/SWFB+(H)-CD	UFH, SAL	16	12	12	1.00
17	SWAW/SWAWPL	CMW, DMW, LFH, PRP	17	9	10	1.00
17	SWAW/SWAWPL	UFH, SAL	16	12	12	1.00

Notes on * and abbreviations:
* Includes an allowance for plantation failures; includes an allowance for regeneration delay; an entry of 0 indicates understorey protection.
** A value of less than 1.0 indicates a preference given to deciduous species; tree improvement multiplier indicates an allowance for non-treated areas.
Species: PL = Lodgepole pine; SW = White spruce; SB = Black spruce; FB = Balsam fir; LT = Tamarack larch; AW = White aspen (Aspen); BW = White birch; H = Generic for any deciduous species (aspen, birch); S = Generic for any coniferous species (pine, spruce, etc.) OTH = includes other unidentified species when FB or PLSB are identified as the main leading species.
Species descriptors: AB = refers to A and B stand densities (A being lower stems per ha than B); CD = refers to C and D stand densities (D being the highest stems per ha therefore the most dense type of stand); G,M,F = Timber productivity rating (site index) - "good, medium, fair"; U = timber productivity rating - uncommercial stand type.
Natural Subregions: CMW = Central Mixedwood; DMW = Dry Mixedwood; LFH = Lower Foothills; UFH = Upper Foothills; PRP = Peace River Parkland; SAL = Sub-Alpine

Source: ORM 2001a: Table 5

15.7 Regeneration Strategy – Implementation Guidelines

The regeneration strategy implementation guidelines to achieve the growth and yield objectives are provided in Table 29.

The primary silvicultural system used by deciduous companies is clearcut with partial retention. Aspen and poplar are both considered pioneer species and are dependent on some form of disturbance to regenerate. The majority of the canopy must be removed to initiate root suckering with both species. Suckering is promoted by altered hormonal levels in the roots after the canopy is removed (or killed in the case of fire) and the increased soil temperature that results after harvest or fire. The reforestation strategy is primarily "leave for natural" and, where necessary, site preparation and planting. Planting is only used where sufficient natural regeneration does not occur after harvest. This can occur as the result of:

- Soil compaction and/or root damage;
- Excessive debris left on the site which does not permit soils to warm sufficiently;
- An increase in water table following harvest resulting in anaerobic conditions and cold soil temperatures; and
- Competition from other plant species, notably marsh reedgrass (*Calamagrostis canadensis*).

Canfor will utilize leave for natural (LFN) as the main reforestation strategy for the following:

- Yield groups with understory protection;
- Deciduous yield groups 1, 2, 4 and 7;
- Coniferous (balsam fir) yield group 5 (UFH); and

Minor species such as balsam fir and larch spp.

Table 29. Regeneration Strategy – Implementation Guidelines

DFMP_Tables.xls
Table 45

Yield Group	Description	Regenerated Yield Group	Natural Subregions	Species To Plant	Reforestation Tactics
1 & 2	1 -AW+(S)-AB 2-AW+(S)-CD	1 & 2	All	SW	Suckering and natural seeding will be used for establishing deciduous regeneration. Maintaining the coniferous incidental volumes will be achieved by a combination of understory protection and/or planting 0 - 200 seedlings per ha. Depending on the condition of the conifer understory, 40 to 200 stems per ha will be required. No site preparation or vegetation management will be done unless there are voids in the deciduous regeneration.
3	AWSW/PBSW/BWSW	3	CMW, DMW, LFH, PRP	SW	Plant 1,100 per ha provided 512A container stock is used. Plant 1,500 per ha; 70% of area to be planted with stock from bulk seed collections from natural stands. Site preparation as necessary; vegetation management as necessary (see vegetation field guide).
3	AWSW/PBSW/BWSW	3	UFH, SAL	SW	Plant 1,100 per ha provided 512A container stock is used. If smaller stock is used, plant 1,500 per ha all stock will be from bulk seed collection from natural stands. Site preparation as necessary; vegetation management as necessary (see vegetation field guide).
4	BW/BWAW+(S)	4	All	SW	Suckering and natural seeding will be used for establishing deciduous regeneration. Maintaining the coniferous incidental volumes will be achieved by a combination of understory protection and/or planting 0 - 200 seedlings per ha. Depending on the condition of the conifer understory, 40 to 200 stems per ha will be required. No site preparation or vegetation management will be done unless there are voids in the deciduous regeneration.
5	FB+OTH	16	CMW, DMW, PRP	SW	Plant 1,800 per ha; 70% of the area to be planted with seed orchard seed stock, 30% of area to be planted with stock from bulk seed collections from natural stands. Site preparation as necessary. Vegetation management as necessary. See vegetation field guide; possibly PCT & CT.
5	FB+OTH	5	LFH, UFH, SAL	SW	Protect FB/SW understory; plant hole. All stock will be from bulk seed collections from natural stands. Site preparation as required; vegetation management as required. See vegetation field guide; possibly PCT.
6	H+(S)/S	17	CMW, DMW, LFH, PRP	SW	Protect conifer understory; fill in plant holes with seed orchard stock, (require 1,500 stems per ha). PCT if required. Vegetation management as required (see vegetation field guide).
7	PB+(S)	7	All	SW	Suckering and natural seeding will be used for establishing deciduous regeneration. Maintaining the coniferous incidental volumes will be achieved by a combination of understory protection and/or planting 0 - 200 seedlings per ha. Depending on the condition of the conifer understory, 40 to 200 stems per ha will be required. No site preparation or vegetation management will be done unless there are voids in the deciduous regeneration.
8	PL/PLFB+(H)	8	CMW, DMW, LFH, PRP	PL	Plant 2,000 per ha; 70% of the area to be planted with seed orchard stock, 30% of the area to be planted with stock from bulk seed collections from natural stands. Vegetation management as required. See vegetation field guide; possibly PCT & CT.
8	PL/PLFB+(H)	8	UFH, SA	PL	Plant 2,000 per ha; all stock will be from bulk collection seed from natural stands. Site preparation as required. Vegetation management to be done as per the vegetation field guide; PCT & CT.
9	PLAW/AWPL	9	CMW, DMW, LFH	PL	Plant 1,500 per ha; 70% of the area will be planted with seed orchard seed stock, 30% of the area to be plant with bulk collection seed from natural stands. Site preparation as required. Vegetation management to done as per the vegetation field guide.
9	PLAW/AWPL	8	UFH, SAL	PL	Plant 1,500 per ha; use bulk collection seed from natural stands for planting stock. Site preparation as required. Vegetation management to be done as per the vegetation field guide; PCT & CT.
10	PLSB+OTH	8	CMW, DMW, LFH	PL	Plant 2,000 per ha; 70% of the area will be planted with seed orchard seed stock, 30% of the area will be planted with stock from bulk seed collection from natural stands. Site preparation as required. Vegetation management to be done as per the vegetation field guide; PCT & CT.
10	PLSB+OTH	8	UFH, SAL	PL	Plant 2,000 per ha all stock will be from bulk collection seed from natural stands. Site prep as required. Vegetation management to be done as per the vegetation field guide; PCT & CT.

Source: Canfor *Silvicultural Field Guide* (Canfor Undated)

Table 29. Regeneration Strategy – Implementation Guidelines (cont.)

DFMP_Tables.xls
Table 45

Yield Group	Description	Regenerated Yield Group	Natural subregions	Species To Plant	Reforestation Tactics
11	PLSW/SWPL+(H)	11	CMW, DMW, LFH	PL & SW	Plant 2,000 per ha; 70% of the area will be planted with seed orchard seed stock, 30% of the area will be planted with stock from bulk seed collection from natural stands. Site preparation as required. Vegetation management to be done as per the vegetation field guide; PCT & CT.
11	PLSW/SWPL+(H)	8	UFH, SAL	PL	Plant 2,000 per ha; planting stock will come from bulk seed collections from natural stands. Site preparation as required. Vegetation management to be done as per the vegetation field guide; PCT & CT.
12	SBLT/LTSB(G,M,F)	12	All	SB	Plant 1,200 to 1,500 per ha; use seed from the SB seed production orchard if available, otherwise use bulk collection seed from natural stands.
13	SBLT/LTSB(U)	13	All	SB	Leave for natural or plant 1,200 per ha; use seed from the SB seed production orchard if available, otherwise use seed from bulk seed collection from natural stands.
14	SBPL/SBSW/SBFB	14	CMW, DMW, LFH	SB or SW	Plant 1,500 per ha; use seed from the SB seed production orchard if available, otherwise use seed from bulk seed collection from natural stands. Site Preparation as required.
14	SBPL/SBSW/SBFB	14	UFH, SAL	SB or SW	Plant 1,500 per ha; use seed from the SB seed production orchard if available, otherwise use seed from bulk seed collection from natural stands. Site Preparation as required.
15	SW/SWFB+(H)-AB	15	DMW, PRP	SW	Plant 1,000 per ha; use bulk collection seed from natural stands for planting stock. Scarify as required.
15	SW/SWFB+(H)-AB	16	CMW, LFH	SW	Plant 2,000 per ha; 70% of area to be planted with seed orchard seed, 30% of area to be planted with bulk seed from natural stands. Site preparation if required. Vegetation management as necessary. See vegetation field guide; possible PCT & CT.
15	SW/SWFB+(H)-AB	16	UFH, SAL	SW	Plant 2,000 per ha; all of the area to be planted with bulk seed from natural stands. Site preparation if required. Vegetation management as necessary. See vegetation field guide; possible PCT & CT.
16	SW/SWFB+(H)-CD	16	CMW, DMW, LFH, PRP	SW	Plant 2,000 per ha; 70% of area to be planted with seed orchard seed, 30% of area to be planted with bulk seed from natural stands. Site preparation if required. Vegetation management as necessary. See vegetation field guide; possible PCT & CT.
16	SW/SWFB+(H)-CD	16	UFH, SAL	SW	Plant 2,000 per ha; all of the area is to be planted with bulk seed collections from natural stands. Site preparation if required. Vegetation management as necessary. See vegetation field guide; possible PCT & CT.
17	SWAW/SWAWPL	17	CMW, DMW, LFH, PRP	SW	Plant 1,200 per ha provided 512A container stock is used. If smaller stock is used, plant 1,500 per ha; 70% of area to be planted with seed orchard seed, 30% of area to be planted with bulk seed collections from natural stands. Site preparation if necessary. Vegetation management as necessary (see vegetation field guide).
17	SWAW/SWAWPL	16	UFH, SAL	SW	Plant 2,000 per ha; all of the area is to be planted with bulk seed collections from natural stands. Site preparation if required. Vegetation management as necessary. See vegetation field guide; possible PCT & CT.

Notes on abbreviations:

Species: PL = Lodgepole pine; SW = White spruce; SB = Black spruce; FB = Balsam fir; LT = Tamarack larch; AW = White aspen (Aspen); BW = White birch; H = Generic for any deciduoud species (aspen, birch); S = Generic for any coniferous species (pine, spruce, etc.) OTH = includes other unidentified species when FB or PLSB are identified as the main leading species

Species descriptors: AB = refers to A and B stand densities (A being lower stems per ha than B); CD = refers to C and D stand densities (D being the highest stems per ha therefore the most dense type of stand); G,M,F = Timber productivity rating (site index) - "good, medium, fair"; U = timber productivity rating - uncommercial stand type

Natural Subregions: CMW = Central Mixedwood; DMW = Dry Mixedwood; LFH = Lower Foothills; UFH = Upper Foothills; PRP = Peace River Parkland; SAL = Sub-Alpine

Other: PCT = Pre-commercial Thin; CT = Commercial Thin

Source: Canfor *Silviculture Field Guide* (Canfor Undated)

Canfor is also committed to identifying management strategies and silvicultural tactics for retention, reestablishment and regeneration of terrestrial lichens in the Caribou Area.

The Company and ASRD will work cooperatively to review information, identify issues and determine the appropriate courses of action.

15.7.1 Site Preparation

Site preparation is defined as "*any action taken in conjunction with a reforestation effort (natural or artificial) to create an environment favorable for survival of suitable trees during the first growing season*". This environment can be created by altering the ground cover, soil, or microsite conditions, using biological, mechanical, or manual clearing, prescribed burns, herbicides, or a combination of methods (Dunster and Dunster 1996).

Canfor treated approximately 6,477 ha during the period 1996–2000. Table 30 provides a breakdown by method.

Table 30. Site Treatments (1996 – 2000)

DFMP_Tables.xls
Table 65

Year	Pile/Windrow Burning (ha)	Drag (ha)	Disk (ha)	Mound (ha)	Mulch (ha)	Ripper (ha)	Direct Seeding (ha)	LFH Planting (ha)	Total (ha)
1996	92	0	403	92	64	866	300	2,046	3,863
1997	0	67	98	166	23	796	45	1,528	2,723
1998	70	130	735	298	175	560	0	162	2,130
1999	0	0	60	381	70	300	0	1,334	2,145
2000	0	0	269	169	25	223	0	1,776	2,462
Total	**162**	**197**	**1,565**	**1,106**	**357**	**2,745**	**345**	**6,846**	**13,323**

Source: Canfor compiled data

Site preparation is chosen to achieve 1 of 2 objectives;

1. Reduce mitigating factors to reforestation performance; and
2. Provide an enhanced microsite to facilitate greater performance.

In certain cases, site preparation may meet both of these objectives. In selecting an appropriate site preparation method, 3 key questions are asked:

1. *What are the limiting factors of the site that may limit reforestation performance*? This involves an assessment of soils and vegetation that exists on the site prior to harvest;
2. *Which site preparation method would most effectively mitigate these limiting factors*? Each method has a specific application as indicated in Table 31; and
3. *Is access to the site limited to winter access only*? Access, as well as soil conditions at the time of proposed treatment, plays a role in selecting an appropriate site preparation strategy. Table 31 compares the various site preparation methods used by Canfor by objective, suitable sites, constraints and optimal treatment coverage parameters.

Table 31. Site Preparation Methods

DFMP_Tables.xls
Table 35

Site Preparation Method	Objective	Suitable Sites	Constraints	Coverage
Drag Scarification	To disturb the duff layer sufficiently to create a suitable seedbed for aerial seeding	- Sites with less than 15 cm duff - Slopes less than 25% - Sites that are prescribed for aerial seeding - Sites accessible in the summer with skidders	- Wet areas within a cutblock - A well-established grass mat - Slopes greater than 25% - Medium or greater slash loads	40 trails per 100 m measured at right angles to the scarification trails
Disk Trenching	To create either a raised microsite for planting or a suitable seedbed for aerial seeding	- Sites scheduled for aerial seeding, but are unsuitable for drag scarification - Sites with slopes less than 25% - Sites with light to medium slash loading - Sites that have duff depths between 15 and 30 cm - Sites planned for planting but do not have sufficient plantable spots - Sites that have either a mesic or drier sub-hygric moisture regime	- Areas that are wet sub-hygric or higher moisture regime. - Areas with a heavy slash load - Areas with slopes greater than 25%	Optimum coverage is 40 trails per 100 m measured at right angles to the scarification trails
Mulching	To create a suitable raised microsite for planting that mixes duff and mineral soil together in a raised mound of at least 20 cm	- Sites that have sub-hygric/ hygric and heavy clay soils - Sites with >15cm duff - Slopes greater than 25% - Sites with compacted soils	- Areas with high organic component - Areas for retreatment - Areas with a high threat of grass competition	Require 1,200 plantable mulch mounds per ha
Hoe Mounding (trackhoe or backhoe)	To create a suitable raised microsite for planting in a raised mound of at least 20 cm. If the mound is to control grass competition, the mound should have a 15 cm mineral soil cap	- Sites that are sub-hygric or wetter - Sites with high threat for grass competition - Sites with duff deeper than 30 cm - Preferred treatment on organic soils	- Areas with heavy slash loads - Areas with frost exceeding 15 – 20 cm in depth - Areas that are within 200 m of a small permanent or larger stream	Require 1,200 plantable mounds per ha
Dual Path Mounding	Same as for Hoe Mounding	- Sub-hygric where mounding has been prescribed - All deciduous harvested from site - Sites with light slash load	- Heavy slash loads - Residual aspen left on site - Areas wetter than subhygric - Frost greater than 15 cm - Areas that are within 200 m of a small permanent or larger stream	Require 1,200 plantable mounds per ha
Piling	To reduce slash loading to a level where the appropriate number of plantable spots may be obtained (1,450 per ha)	- Sites with heavy slash loading that cannot be dealt with effectively by other treatment methods - Sites with heavy balsam fir understorey	- Areas with slopes exceeding 30%	Ensure 1,450 plantable spots per ha while ensuring that a certain component of coarse woody debris remains on site
Ripper Plow	To create raised microsites for planting	- All sites that are prescribed for site preparation. but are not accessible in the summer - Sites with compacted soils - Sites with heavy slash loads that inhibit other site preparation methods	- This technique may only be used during winter months - Slopes must be less than 25%	Optimum coverage is 32 - 40 trails per 100 m measured at right angles to the scarification trails

Source: Canfor *Silviculture Field Guide* (Canfor Undated)

Through participation in various research initiatives, Canfor remains current with the latest developments in emerging technologies and more cost-effective scarification alternatives. A contingent of 4 general-purpose scarification contractors is maintained to ensure that the Company's reforestation goals are met on a timely basis.

Canfor treats harvested areas by a variety of methods depending on actual site conditions. Canfor's site preparation program involves 6 basic methods as indicated below. A description of broadcast burning, which is not currently used as a treatment, is included because of its historic use within the FMA area.

1. Drag Scarification;
2. Disk Trenching;
3. Mulching;
4. Mounding (trackhoe, backhoe, Dual Path Mounder);
5. Piling (windrow burning);
6. Ripper Plow; and
7. Broadcast Burns.

15.7.1.1 Drag Scarification

Large chains are dragged behind a prime mover to expose mineral soil, as well as a mixed layer of duff and soil to provide a suitable seed bed for aerial seeding activities (Figure 84).

Figure 84. Drag Scarification
Drag scarification exposes mineral soil to provide a suitable seed bed for aerial seeding.

15.7.1.2 Disc Trenching

As shown in Figure 85, disk trenching is a technique whereby hydraulic-powered disks are attached to a skidder. The disks are pressed into the forest floor and dragged by the skidder resulting in furrows. This provides an elevated microsite for planting operations.

Figure 85. Disc Trencher
Each pass of the disc trencher provides 2 rows of planting sites where the organic matter and mineral soil are mixed, creating an excellent site for seedling establishment and growth.

15.7.1.3 Mulching

Similar to mounding (below), mulching provides an elevated microsite. The 2 techniques differ, in that mulched mounds are composed of a mixture of mineral soil and organic materials. The result is a mound with nutrients mixed throughout.

15.7.1.4 Mounding

Cold wet soils and competition from grasses are the most serious factors limiting the establishment and growth of white spruce in northwestern Alberta. Mounding can be an effective operational practice for overcoming these constraints. A mound is a raised planting spot suitable for planting one tree. It is useful in the more poorly drained humic areas where it results in increased soil temperatures, particularly in the spring (Figure 86). Furthermore, in areas that are waterlogged for a considerable portion of the growing season, mounding allows for more suitable growing conditions. Mounding provides the seedlings with approximately 2 growing seasons to become established before grass competition, dominantly marsh reedgrass, becomes well established (Macyk 2000).

Several types of equipment including backhoe, trackhoe and the Dual Path Mounder (Figure 87) can be used to prepare mounds.

Figure 86. Mounding
The black spruce site in this photograph was mounded by a backhoe to prepare planting sites for seedlings. Approximately 1,200 mounds are created per ha.

Figure 87. Dual Path Mounder
The Dual Path Mounder, developed by Canfor Hines Creek and other partners, uses hydraulically activated "scoops" to create 2 rows of mounds. Cost efficiency can be improved by using a skidder as the prime mover.

15.7.1.5 Piling (Windrow Burning)

Piling is a technique whereby slash is piled within a cutblock by a 'cat' in order to provide additional plantable spots for reforestation. This technique is used where logging slash disposal operations have not been effective in providing sufficient plantable spots to permit effective reforestation.

15.7.1.6 Ripper Plow

Shear plows are pulled behind D-9 'cats' to provide deep furrows; the result is an elevated microsite (Figure 88). This technique is used only in areas where site preparation cannot be conducted during summer months due to difficult access.

Figure 88. Ripper Plow
Sites that have difficult access may be scarified using a ripper plow, which has the ability to penetrate frozen soils.

Figure 89. Broadcast Burns
In the past, Canfor conducted broadcast burns to research its use in removal of heavy accumulations of slash on over mature and decadent balsam fir/ spruce stands in preparation for reforestation.

15.7.1.7 Broadcast Burns (1984 – 1987)

From 1984 to 1987, Canfor initiated 6 broadcast burns covering 169 ha (Table 32). Broadcast burning was discontinued in 1988 mainly because the burn "windows" were too narrow, making it difficult to schedule and implement the burns when needed. Secondly, "mop up" costs were significant. An example of Canfor's broadcast burn is depicted in (Figure 89).

Table 32. Broadcast Burns (1984 – 1987)

DFMP_Tables ver1.xls
Table 62

Year	Number	Broadcast Burns (ha)
1984	1	5
1985	1	36
1986	2	42
1987	2	86
Total	**6**	**169**

Source: Canfor compiled data

15.7.2 Planting

Canfor has reforested more than 14,000 ha and planted approximately 21.9 million seedlings since 1996 (Figure 90). By planting in the season immediately following harvest, it is possible to take full advantage of the competition-free window. This is particularly important in the Lower Foothills and Central Mixedwood subregions where reedgrass competition is medium too severe. According to Forest Renewal B.C. (1999):

"*The longer reedgrass is on the site prior to crop establishment, the lower the success of reforestation effort.*"

Over 50% of the planting that Canfor utilizes within the FMA area involve a technique called "LFH", or duff planting. (Table 30) This is a technique whereby seedlings are planted directly into the upper-most, unmodified organic soil layer, referred to as the LFH layer. These unbroken fibric and humified organics provide a ready supply of nutrients and moisture to the growing seedling. This technique is used when there are no mitigating factors that may limit seedling performance.

Figure 90. Planting
Canfor has reforested more than 14,000 ha and planted approximately 21.9 million seedlings since 1996. Approximately 98% of planting is successful after the first treatment.

15.7.2.1 Planting Windows

Based on phytogram research trials conducted by Pelton Reforestation Ltd., it has been found the most effective planting window for spruce in the FMA area is the month of July. Seedlings planted during this time have excellent root egress (as much as 4 cm in 10 days) and are in biological sequence with the natural trees. Consequently, the seedlings are well adapted for local weather conditions (i.e. they can withstand an early frost) and are physiologically prepared for the winter season. In general, seedlings planted outside of this window are not in biological sequence and are ill-equipped to withstand an early fall frost. Pine has a longer planting window than spruce and can be planted as early as June 15 (Table 33). The results of spring planting have been mixed, therefore, the spring planting program is limited to approximately 350,000 bareroot seedlings.

Table 33. Planting Windows

DFMP_Tables.xls
Table 46

Species and Age	Container Size	May 5 to 25	June 15 to 30	July 1 to 31
PL 1+0	410B		X	X
PL 1+0	415B			X
PL 2+0	412A			X
PL .5X1.5	PBR	X		
SW 1+0	415B			X
SW 1+0	412A			X
SW 2+0	415B			X
SW 2+0	415D			X
SW 2+0	512A			X
SW 2+0	615A			X
SW .5x1.5	PBR	X		
SB 1+0	410B			X
SB 2+0	415B			X
Note: PL = Lodgepole pine; SW = White spruce; SB = Black spruce				

Source: Canfor compiled data

15.7.2.2 Planting Stock

The type of planting stock utilized in Canfor's reforestation program and their specifications are indicated in Table 34. The most consistent stock type is the 2+0 summer planted container stock. Commercial forest seedling nurseries provide planting stock for the Company's reforestation program.

It has been identified through the Northern Interior Vegetation Management Association (NIVMA) plots that, in order to meet the height requirement identified in this Detailed Forest Management Plan (DFMP) (Table 28), 415B container stock or larger must be used for spruce. Hence, 1+0 white spruce stock is only used if insufficient volumes of 2+0 stock are available to meet Canfor's planting requirements. On reedgrass complexes, large 415D or larger stock is used. On these sites, 2+0 stock is superior to 1+0 stock because it has a much larger root collar diameter (RCD) which gives it the ability to resist vegetation press from competing grass species (Table 35) seedling deployment).

Table 34. Seedling Specifications

DFMP_Tables.xls
Table 74

Species and Age	Container	Copper Treated	Caliper		Height		
			Target	Minimum	Target	Minimum	Maximum
PL 1+0	410B	Yes	3.2	2.5	14	9	20
PL 2+0	412A	Yes	5.5	3.3	25	15	35
PL 1+0	415B	Yes	4.7	3.0	22	14	30
PL .5X1.5	PBR	No	4.2	3.0	17	10	30
SB 1+0	410B	No	2.5	3.2	20	12	30
SB 2+0	415B	No	5.5	4.0	25	15	35
SW 1+0	412A	No	4.5	3.5	25	15	35
SW 1+0	415B	No	3.5	2.8	22	14	30
SW 2+0	415B	No	5.5	4.0	25	15	35
SW 2+0	415D	No	6.0	4.5	30	18	45
SW 2+0	512A	No	6.5	5.0	30	18	45
SW 2+0	615A	No	8.0	5.5	40	20	50
SW .5X1.5	PBR	No	4.0	5.0	27	17	37
Note: PL = Lodgepole Pine; SW = White Spruce; SB = Black Spruce							
Note: Canfor may use additional stock types in the future as seedling technology advances							

Source: Canfor compiled data

Table 35. Seedling Deployment

DFMP_Tables.xls
Table 47

Species & Age	Container Size	Vegetation Competition Index			
		Light	Medium	Heavy	Severe
PL 1+0	410B	X			
PL 1+0	415B	X	X		
PL 2+0	412A		X	X	X
PL .5X1.5	PBR		X	X	X
SW 1+0	415B	X			
SW 1+0	415D	X			
SW 2+0	415B	X			
SW 2+0	415D	X	X	X	
SW 2+0	512A		X	X	X
SW 2+0	615A			X	X
SW .5x1.5	PBR		X	X	X
SB 1+0	410B	X			
SB 2+0	415B		X	X	X
Note: PL = Lodgepole pine; SW = White spruce; SB = Black spruce					

Source: Canfor compiled data

15.7.2.3 Planting Microsite Selection

Based on Canfor's participation in various research initiatives, it was decided that the optimal planting spot is the highest one possible, with a certain amount of debris surrounding planted seedlings to protect from frost damage
(Figure 91). Screefing is no longer used because it does not effectively mitigate competition, and it prevents re-radiation of thermal energy from surrounding material to the seedling. It is this re-radiation that has been observed to extend the daily growing period of seedlings. This additional growing period goes a long way to assist seedlings establish effective rooting networks, thus contributing to overall reforestation success.

Figure 91. Planting Microsite
Canfor plants large and aggressive planting stock in a favorable microsite, such as the mound shown in the photograph, to ensure maximum survivability and growth.

15.7.3 Aerial Seeding

Canfor's first aerial seeding program was conducted on 110 ha in 1972. From 1979 to 1985, virtually all harvested areas were scarified and aerial seeded.

In 1986, with the availability of improved planting stock, Canfor increased its planting program. By 1990, only pine-dominant areas in the Upper Foothills and the higher elevations of the Lower Foothills were aerial seeded. Aerial seeding continued until 1995 and ceased when site classification was used on the entire FMA area and it became evident that only small portions within the blocks were being classified as optimal for aerial seeding. Aerial seeding these small areas is problematic. Canfor will continue to evaluate harvested areas to determine the most effective reforestation method.

15.8 Regeneration Surveys

According to subparagraph 132(1) of the Timber Management Regulations, companies are required to meet performance standards for a cutblock by year 14 after harvest. In accordance with *2000 Regeneration Standards* (Alberta Environment 2000), each cutblock is to be declared to one of the 4 stocking standards - C (coniferous); CD (coniferous/deciduous mixedwood); DC (deciduous/coniferous mixedwood), D (deciduous). Each of these stocking standards has different regeneration expectations, and thus requires different stocking percents and height performance by Natural subregion.

The *Regeneration Standards 2000* utilize 2 independent surveys with timelines for delivery as follows:

An Establishment Survey completed 4 to 8 years after harvesting in C, CD and DC cutblocks; and 3 to 5 years after harvesting in D cutblocks; and

A Performance Survey completed 8 to 14 years after harvesting in C, CD and DC cutblocks, and 10 to 14 years after harvesting in conditionally stocked D cutblocks.

In addition to the required establishment and performance surveys, Canfor conducts an assessment survey 2 years after planting to ensure the plantation has successfully established.

The Establishment Survey will show stocking amount (percent), density (stems/ha) and early growth (height and diameter) of regenerated trees, as well as the approximate locations of satisfactorily restocked (SR) and/or not satisfactorily restocked (NSR) areas larger than 4 ha.

The Performance Survey will measure the same variables as the Establishment Survey, however, to different standards. In addition, it will identify coniferous crop trees deemed to be free-to-grow or else in need of stand cleaning (Alberta Environment 2000).

Cutblocks harvested between 1991 and 1999 have been re-classified to 1 of the 4 stocking standards. Reforestation success of these blocks will be verified through performance surveys conducted in accordance with the protocols described in the *Regeneration Standards 2000*. From 2000, all harvested blocks will require an establishment and performance survey as per the *Regeneration Standards 2000*.

There is no performance survey required for areas satisfactorily restocked in the deciduous establishment survey. Conditionally stocked areas are subject to a performance survey.

In 2000, Canfor conducted regeneration surveys on 334 cutblocks using the *Regeneration Standards 2000*. The surveys were conducted in the spring (3,225 ha)

and the fall (2,423 ha). The 10 cutblocks that did not meet the establishment standards in the spring were planted in July 2000. The 8 fall cutblocks that did not meet the establishment standard will be planted in the spring of 2001 with 0.5 x 1.5 plug bareroot stock. It is Canfor's policy to replant all cutblocks not meeting the standards as soon as possible using the largest stock available to ensure that these areas are put back on the appropriate growth trajectory as soon as possible. A summary of the Company's 2000 regeneration survey results is shown in Table 36.

Table 36. Results of Regeneration Surveys Conducted in 2000

DFMP_Tables.xls
Table 44

Number of Cutblocks Surveyed	Area (ha) Surveyed	Number of Cutblocks Satisfactorily Restocked (SR) (establishment standard)	Area (ha) SR	Percent Successful
334	5,648	316	5,514	97.6%

Source: Canfor compiled data

15.9 Vegetation Management

Canfor uses a variety of methods to control competition and treat harvested areas. The *Vegetation Management Handbook* (Canfor 2000l) was developed to assist in determining the type of treatment to utilize.

15.9.1 Vegetation Management Handbook

In 1996, Canfor presented its *Vegetation Management Plan* to the Forest Management Advisory Committee (FMAC). The Committee asked Canfor to base its practices on science. In order to meet the Committee's request Canfor developed a forest *Vegetation Management Handbook* (Canfor 2000l).

The Handbook provides silviculture staff an autecology based approach to vegetation management for forest renewal. Autecological characteristics of selected crop (white spruce, lodgepole pine) and competing species (aspen, bracted honeysuckle, raspberry, and reedgrass) are reviewed. The autecological interaction of crop and competing species is reviewed. Crop tolerance to competition and impact of competing species on availability of light, moisture regime and nutrients are discussed in detail. Physical injury and indirect effects of competing species are also discussed within the Handbook.

Competition management techniques such as clipping, motor manual tending, girdling, grazing, basal bark herbicide application, stem injection herbicide use, and foliar application of herbicides are reviewed objectively. Techniques are compared (using current scientific understanding) based on their safety to users and the environment, effectiveness in controlling competition, safety to crop seedlings, and cost.

The *Handbook* provides silviculture staff sufficient information to prescribe treatments appropriate to competitive interaction, site constraints, and competing species

autecology. A model for developing prescriptions based on competition thresholds and treatment appropriateness and a set of standard operating procedures to be used in developing and implementing vegetation management plans is included in the handbook.

15.9.2 Selection of Vegetation Management Technique

The *Vegetation Management Handbook* (Canfor 2000l) is used in conjunction with treatment selection flowcharts (Figures 93, 94 and 95) to assist managers to select the appropriate treatment prescription. The flowcharts were approved by Alberta Sustainable Resource Development (ASRD).

15.9.3 Vegetation Management Treatments

Since 1993, Canfor has conducted vegetation management on approximately 13,000 ha as indicated in Table 37. A brief description of each method follows.

Table 37. Vegetation Management Within Canfor's FMA Area

DMP_Tables.xls
Table 30

Year	Weeding (ha)	Thinning (ha)	Girdling (ha)	Area Treated by Herbicide (ha)					Total Treated
				Hack & Squirt	Basal Bark	Backpack Foilar	Aerial Spray	Total	
1993	1,050							0	**1,050**
1994	1,739	128	43					0	**1,910**
1995	1,440			78				78	**1,518**
1996	726				295			295	**1,021**
1997	872				362			362	**1,234**
1998	403				623	115	441	1,179	**1,582**
1999	327				663	282	1,044	1,988	**2,316**
2000	12	288				73	2,014	2,087	**2,386**
Total	**6,568**	**416**	**43**	**78**	**1,943**	**470**	**3,499**	**5,990**	**13,016**

Source: Canfor compiled data

15.9.3.1 Manual Treatments

In 1993 Canfor embarked on a manual stand tending program using weeding, thinning and girdling. The following sections provide a description of the program.

15.9.3.1.1 Weeding

Weeding is the removal of deciduous competition from 2 m of coniferous crop trees using brushsaws. This treatment is prescribed on vigorously growing pine plantations and some pre-1991 spruce blocks where the deciduous competition is less than 8,000 stems per ha. (Figure 92).

Figure 92. Weeding
Weeding is the removal of deciduous species to allow the coniferous crop trees to survive and increase growth.

Figure 93. C Strata Flow Chart

The reforestation objective for C strata is to have less than 200 deciduous trees evenly spaced per hectare. At age 10, Coniferous trees must maintain a height/root collar diameter (HT/RCD) ratio of <60:1 for SW and <50:1 for PL.

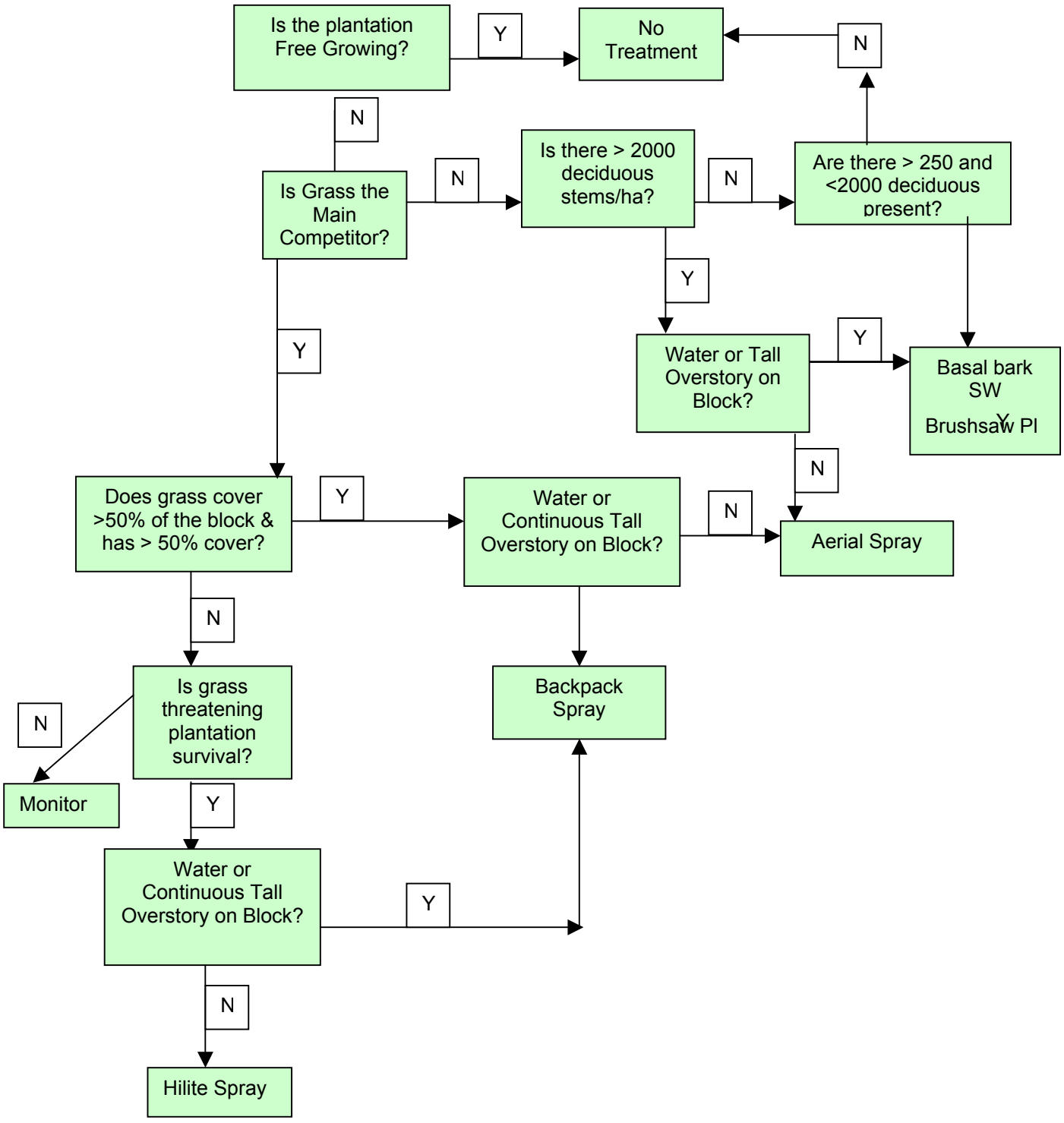


Figure 94. CD Strata Flow Chart

The reforestation objective for CD stands is to have a crop ratio of 2/3 coniferous to 1/3 deciduous and the coniferous trees must maintain a height/root collar diameter (HT/RCD) ratio of <60:1 for spruce and <50:1 for pine. At age 10, between 300 to 700 well spaced deciduous stems per ha and >1200 coniferous stems per ha will be evident.

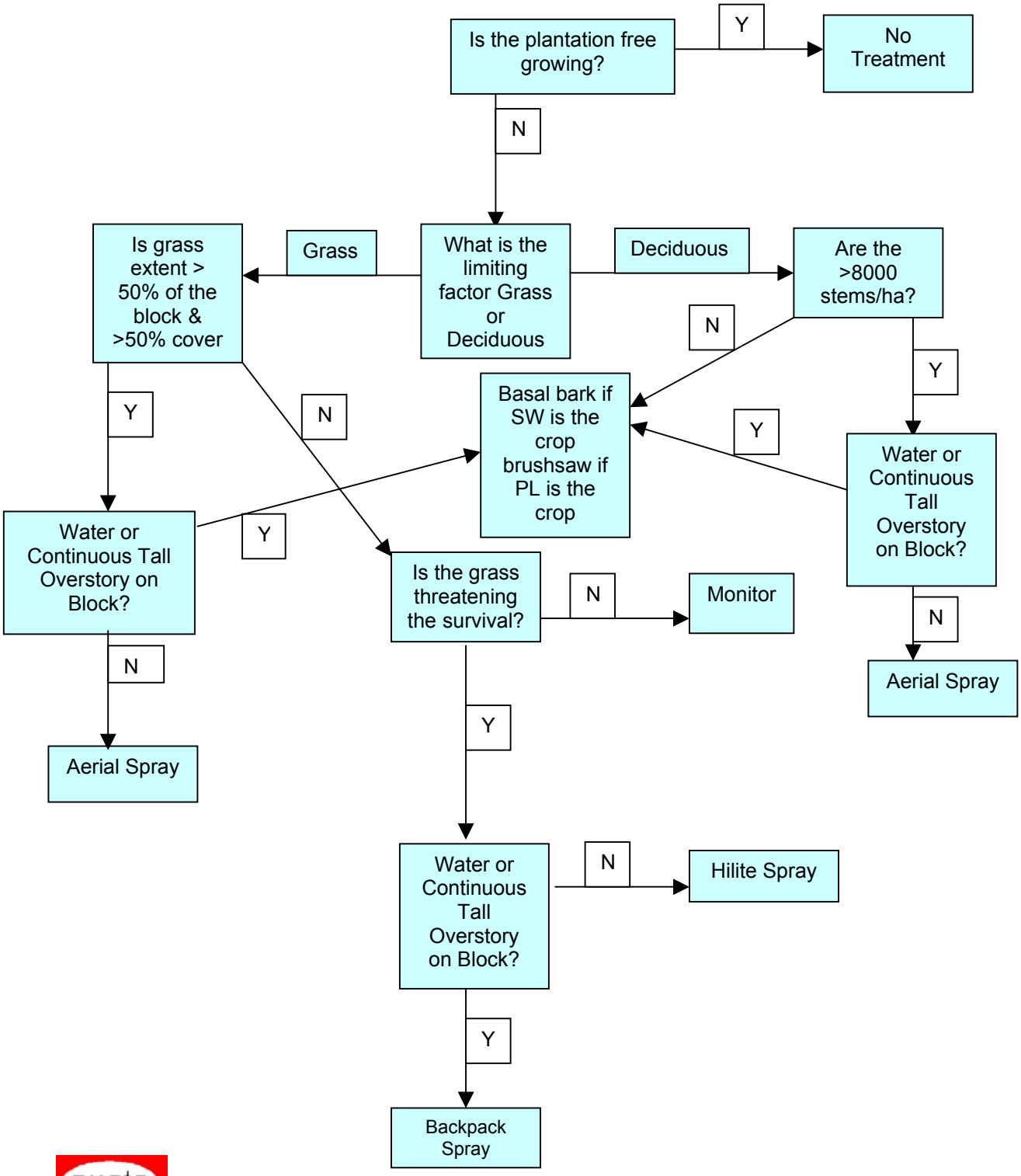
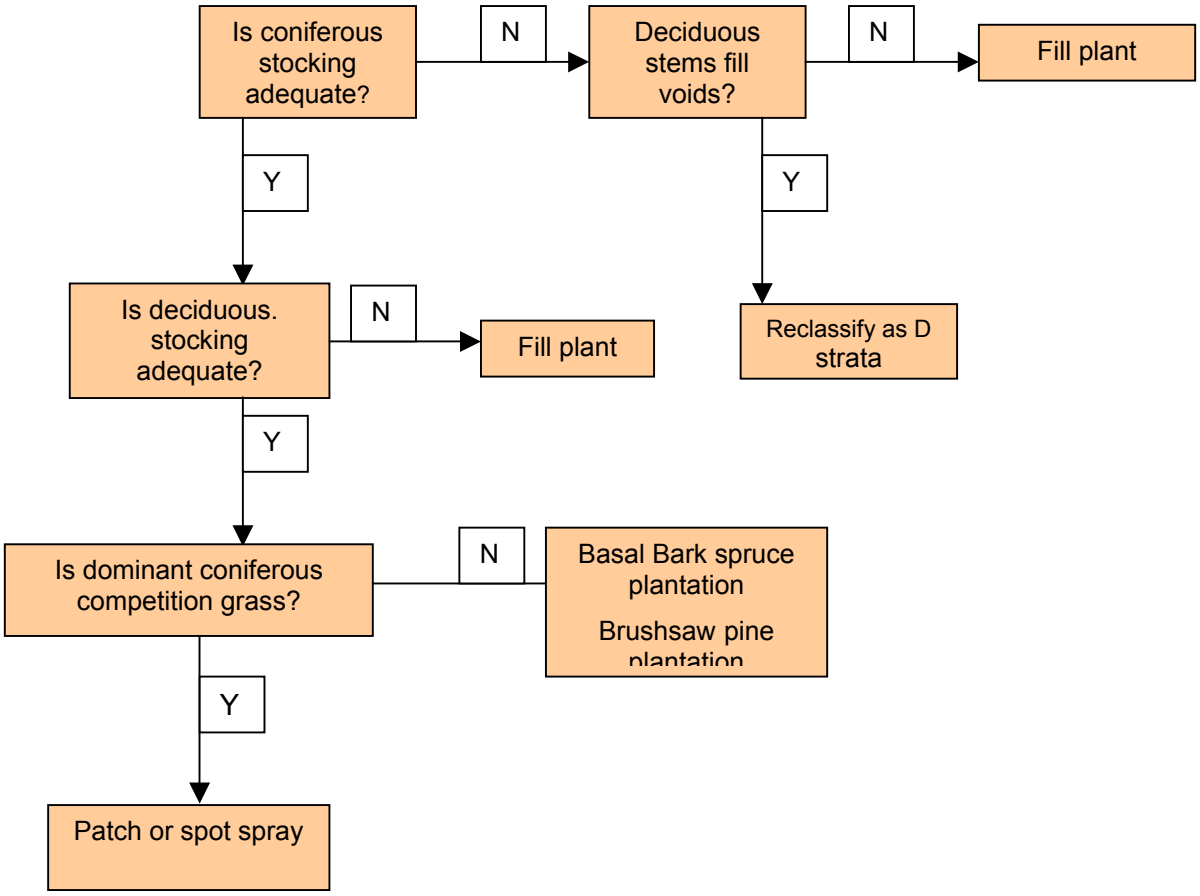


Figure 95. DC Strata Flow Chart

The reforestation objective is to have a 50:50 mixture of coniferous and deciduous (500 – 1200 stems per ha of each). The same height/root collar diameter (HT/RCD) ratios as the other strata for spruce and pine also apply. Basal bark treatment will be used on spruce plantations and brushsaw on pine plantations.

Aerial spraying or backpack spray can only be used if there are grass patches that are devoid of deciduous stems which would create regeneration voids in the block or used for site preparation for planting deciduous or failed areas.



15.9.3.1.2 Thinning

Thinning is the spacing of overstocked young coniferous plantations to 2,000 stems per ha. All thinning to date has been done in overstocked pine stands.

15.9.3.1.3 Girdling

Girdling uses specialized cutters to cut through the bark of woody competing species. Cuts are made through the cambium, leaving the sapwood uncut. Treated trees die slowly without loss of apical dominance; thus suckering or basal sprouting is less likely to occur.

15.9.3.2 Herbicide Application

There are 2 primary regulations that deal with herbicides in Alberta, and they fall under the pesticide regulations in the *Alberta Environment Protection and Enhancement Act* (Alberta Environmental Protection 1992):

1. *Pesticide (Ministerial) Regulation* (AR 43/97); and
2. *Pesticide Sales, Handling, Use and Application Regulation* (AR 24/97).

Canfor embarked on the "go-slow" herbicide experience building program in 1995 with a stem injection herbicide (Vision®) project of approximately 80 ha in area. This was followed with 250 ha of single-stem stand tending using basal bark application of Release® silviculture herbicide to woody competition in a defined radius around coniferous crop trees in 1996. In 1997, approximately 450 ha were treated, again using basal bark application to treat defined radii around crop trees.

Since meeting operational experience requirements in 1997, Canfor has a herbicide stand tending program based on treatment needs. In 1998, Canfor began using a wider array of herbicide treatments based on competition species, density, and crop tree status. In 1998, 1,150 ha were treated followed by 1,987 ha in 1999.

Canfor follows legislated protocols outlined in Articles 43/97 and 24/97 within the *Alberta Environment Protection and Enhancement Act*. Canfor also adheres to recommendations outlined in the *Guidelines for the Use of Herbicides for Silvicultural in Alberta* (Alberta Environmental Protection 1998) to:

- Minimize herbicide use;
- Protect wildlife;
- Maintain block diversity;
- Maintain habitat diversity;
- Avoid watercourses;
- Properly apply specific herbicides;
- Involve and notify the public; and
- Monitor the short-term and long-term effects of herbicide use.
- Two herbicides are currently used: Vision®

Figure 96. Grass Competition
Grasses compete vigorously with coniferous seedlings on some sites. The growth of the seedling in the photograph will be greatly impaired.

(forestry equivalent of Roundup®) and Release®.

- Vision® is used in 3 situations:

1. Control of grass competition (Figure 96 on previous page);
2. Brush control when the deciduous density is too high for basal bark treatment; and
3. Hack and squirt treatment.

Release® is used for basal bark treatments.

15.9.3.2.1 Public Awareness

As outlined in Section 11(5) of the *Environmental Code of Practice for Pesticides* (Alberta Environmental Protection 1997), the public is notified of herbicide programs by open house and newspaper advertisements. Advertisements are placed in local newspapers 2 weeks in advance of the open house, which has been held in February for the past 3 years. Newspaper advertisements are placed again a minimum of 72 hours prior to commencement of a project. All trappers are met individually to discuss the *Vegetation Management Plan* as it pertains to their individual traplines.

Signs are posted at the entrance to cutblocks at the time of spraying and left for 48 hours as required by the *Forest Management Pesticide Reference Manual* (Figure 97).

Figure 97. Public Awareness
Canfor erects signs at the entrance to cutblocks to advise the public that herbicide spraying is in progress.

In November 2000, Canfor and 11 industrial partners convened a herbicide information session in Valleyview, Alberta. The objective of that project was to provide a forum whereby a panel of experts made presentations on relevant herbicide topics and provided an opportunity for the forest industry and the public to obtain information and provide input. Such venues assist companies and the public to work more efficiently together to find solutions that recognize the needs and concerns of all parties.

Five experts from a variety of disciplines made presentations at the information sessions:

- Toxicologist: Dr. Frank Dost, Extension Toxicologist *emeritus* Oregon State;
- Ecologist: Dr. R.A. Lautenschlager, Ontario Forest Research Institute;
- Wildlife Biologist: Dr. Tom Sullivan, Applied Mammal Research Institute;
- Alberta Regulations: Jock McIntosh, Alberta Environment; Pesticide Management Branch; and
- Forest Herbicide Consultant: Milo Mihajlovich, Incremental Forest Technologies Ltd.

Approximately 70 people attended the evening session. Attendees included representatives from the government, forest industry, Canfor's Forest Management

Advisory Committee (FMAC), political representatives, environmental representatives and trappers. A lively discussion ensued on several topics.

15.9.3.2.2 Types of Application

There are 4 basic types of herbicide application being used. They are discussed briefly in the following sections.

15.9.3.2.2.1 Aerial Application

Aerial application is the most efficient means of treating large, contiguous areas with herbicide (Figure 98). It is used primarily where marsh reedgrass *(Calamagrostis canadensis)* is the main competitor to coniferous crop trees. Marsh reedgrass is the most pernicious competitor present on sub-hygric rich sites. It competes with coniferous seedlings for nutrients, forms a dense thatch that lowers soil temperatures below critical levels for coniferous root growth, and in combination with snow, presses seedlings to the soil surface – termed "vegetation press." This phenomenon often eliminates any potential crop tree value associated with the seedling.

Figure 98. Aerial Herbicide Application
Aerial application is the most common type of forest herbicide used in Canada. It is also the most highly regulated application method due to its inherently broad scale nature.

Targeted aerial application (termed "hilite" treatment) is used only when parts of the block have a problem due to vegetative competition. The highlight treatment is a broadcast herbicide treatment used in portions of blocks that have a total area greater than 1.5 ha. These portions must have full conifer stocking, and have in excess of 8,000 stems per ha of aspen.

The only herbicide currently available to provide adequate control of marsh reedgrass is glyphosate (Vision® or Forza®), that requires area-based treatment for success. The reasons for this are:

- Glyphosate translocates only moderately well, thus the bulk of the grass infestation must be treated to ensure rhizome kill; and
- Glyphosate has no soil activity, thus the grass must be killed well back from coniferous trees to ensure a growth opportunity of sufficient length to ensure coniferous seedling survival and performance objectives are met.

Used appropriately, it has less likelihood of causing an adverse environmental impact than ground broadcast application, as there is no need to move heavy equipment across the treated area. Aerial application may pose a risk of off-target application or movement (drift.) These risks are carefully managed. Off-target application is prevented by marking obscure block boundaries and sensitive areas with bag lines (lines of large plastic garbage bags hung on saplings or in other prominent places) to make no-treatment areas easily noticed and avoided. Furthermore, these sensitive areas are pointed out to the pilot on the pre-treatment reconnaissance flight (which is mandatory).

The risk of drift (or off-target movement) is managed by using only low-drift application equipment (AccuFlow® nozzles) and strict application weather parameters, measured in the treatment block by the ground monitor. Weather parameters monitored are wind speed (through the entire vertical drop zone), temperature and humidity. For more information on the herbicide monitoring program refer to Section F 15.9.3.2.3.

15.9.3.2.2.2 Basal Bark Application

Basal bark herbicide applications spray an oil soluble herbicide mixed with mineral oil on the lower bark of woody competitive species (Figure 99). The herbicide is translocated upward moving to sites of active growth, thereby killing the plant. Limited to woody species, this method gives good control of root suckering and basal sprout species and crop trees are protected from injury by selective application. As with any herbicide, use is highly regulated. Release® is the only herbicide approved for forestry basal bark application in Alberta.

Figure 99. Basal Bark Application
Basal bark treatment is primarily used for mixedwood management.

15.9.3.2.2.3 Hack and Squirt Application

Hack and squirt relies on cutting the bark of woody competitors to the cambium then placing a 50% solution of water and Vision® in the cuts. The solution translocates to sites of active growth and kills the targeted plant. One cut per 10 cm diameter breast height (DBH) is made and 10 ml of solution is applied to each cut.

15.9.3.2.2.4 Backpack Foliar Application

Backpack foliar is a broadcast spray applied manually using backpack sprayers. All the weather parameters used for aerial application apply to backpack. This method is used on sites that cannot be aerial sprayed, e.g. cutblocks that are too narrow for the width of the helicopter. The main target species with this application is marsh reedgrass.

15.9.3.2.3 Monitoring

Canfor's herbicide monitoring program has 2 primary components:

- monitoring during operations; and
- follow-up monitoring.

15.9.3.2.3.1 Monitoring During Operations

During basal bark and backpack foliar applications, the Canfor designated on-site supervisor monitors and records application details: areas, product use, and times. The supervisor also monitors and records weather information: wind (speed and direction), temperature, and relative humidity.

For aerial applications, Canfor's on-site supervisor monitors and conducts all reconnaissance flights with the pilots, supervises the block monitors, and reports any excursions or other incidents to the Land and Forest Service. Most importantly, the supervisor works with pilots and monitors to ensure Canfor standard operating procedures are followed and risk of off-target application is minimized. The block monitors (either Canfor employees or independent contractor employees) assess and record weather conditions. They relay this information to the site supervisor and the pilot and participate in spray, no-spray decisions. The monitors record loads and times for blocks they monitor. Finally, they give the pilot feedback on spray pattern behavior.

Pilots work with the site supervisor and the monitors to make spray no-spray decisions. The pilot is ultimately in charge of ensuring safe, accurate application. If an incident or excursion occurs, and the pilot is aware of it, he is responsible for reporting to the site supervisor. The pilot maintains a set of load and treatment records.

On the aerial application program, a new system of block control will be used. On the reconnaissance flight, the Canfor supervisor confirms the cutblock location with the pilot and geographic positioning system (GPS) coordinates are taken to ensure return to the same cutblock. Cutblocks will not be sprayed without a monitor present in the block. When the monitor is positioned, the Canfor supervisor confirms the location. If there is any disagreement between the monitor and pilot as to block location, no spraying will occur until the Canfor supervisor resolves the location concern.

The mixers ensure loads are mixed correctly and record where loads were used and what area was treated. When the pilot and the mixer records cannot be reconciled, the monitor records act as a check and balance.

15.9.3.2.3.2 Follow-up Monitoring

Follow-up monitoring includes an evaluation of treatment effectiveness, excursions, and operational herbicide monitoring plots.

Internal monitoring mechanisms will ensure stand tending treatments are achieving their goals and not jeopardizing coniferous or deciduous fibre supply. If this is not the case, treatment threshold and intervention options will be adjusted to better achieve the goals of the Detailed Forest Management Plan (DFMP).

15.9.3.2.3.2.1 Excursions

An objective to have zero excursions of herbicides in water has been developed (Section G "Critical Element 3c, Objective 1.1d.1"). Herbicide application and monitoring procedures have been developed in the *Vegetation Management Plan* (Canfor 2000l) to achieve this objective.

An excursion occurs when any vegetation outside the target zone is affected by herbicide. Excursions known to have occurred at the time of treatment are reported immediately to Alberta Sustainable Resource Development, Land and Forest Division (LFD) using the Herbicide Excursion Reporting Form found in the *Forest Management Herbicide Reference Manual* (Alberta Environmental Protection 1999b). Canfor conducts an excursion assessment flight in the spring after treatment. All blocks where excursions are suspected to have occurred are flown. Twenty-five percent of the total

area treated with herbicides is also flown on a random check basis. If excursions are found, they are evaluated and sampling intensity may be increased as a result.

Canfor had 1 slight excursion in 1998 (understorey vegetation damage only) and 1 excursion in 1999 (aerial spraying occurred in an incorrect block). Neither of these excursions impacted watercourses.

15.9.3.2.3.2.2 Monitoring Plots

Monitoring plot establishment is part of Canfor's commitment for using herbicides. Presently the Company has 3 monitoring installations. Each installation consists of untreated and treated plots. The plots have 2 subsets: 1 for monitoring vegetation change and 1 for measuring crop tree response. The existing plots will be utilized until they expire in 5 years. Monitoring plots are being replaced with replicated research. Canfor will participate in funding the various research projects though the Herbicide Task Force.

15.10 Reforestation of Wildfires

Productive forested areas that have been burned need to be returned to productive status. This ensures that the forested landbase does not suffer from sustained deforestation. An objective has been developed to track burned areas to ensure they have regenerated (with preference to natural regeneration) (Section G "Critical Element 4c, Objective 1.2a.2"). To achieve this objective, sites will be monitored to ensure they regenerate, and the level of stand management required to bring the stand into productive status will be determined. Protocols have been established to address when reforestation of burned areas are required, i.e. whenever a fire is in a harvested area or an adequate seed source is not available. Burns greater than 4 ha on productive sites will be reforested. Burned areas greater than 4 ha that are included in harvested or planned cut units will continue to be tracked in the silviculture database. A separate non-liability tracking system utilizing Microsoft Access® has been established to track the reforestation of burns, wellsites and their associated roads.

15.11 Genetic Diversity

Canfor's goal is to conserve genetic diversity of tree species (Section G "Critical Element 1c, Goal 1.1"). To achieve this goal a tree improvement program has been developed based on 3 primary objectives as discussed in the following section.

Efforts to conserve genetic diversity are based on the reforestation program, which uses seed from authorized seed zones and tree improvement programs. Natural ingress also plays a role in genetic diversity when seedlings establish from cones left on site after harvest, from seed originating from neighboring stands, and from advanced growth and seedlings remaining on site after harvest.

15.11.1 Objectives for Conserving Genetic Diversity of Tree Species

1. To maintain between 300-600 genotypes in breeding program to safeguard long-term diversity (Section G "Critical Element 1c, Objective 1.1a.1").

A genotype is the genetic constitution of an organism. In order to maintain genetic variability, there has to be an effective number of unrelated genotypes in the breeding program. This will ensure there is sufficient variability in the gene pool so trees can adapt to environmental stresses and change. The linkage between diversity and adaptation is well recognized in conservation biology and tree improvement, as genetic diversity is the raw material from which adaptations are derived thorough natural selection and other evolutionary forces (Edwards *et al* 2000a). The main assumption is that 300 to 600 genotypes in the breeding program for each tree species is sufficient to safeguard long-term genetic diversity. Preliminary analyses indicate that this range of genotypes is sufficient to capture the natural genetic diversity in the FMA area. Including more genotypes would yield relatively little additional protection. As an additional safeguard, ingress and unharvested ecosystems will provide additional genetic variability.

Another key objective is to maintain flexibility for future breeding cycles to accommodate unforeseen economic, industrial, political, climatic, or biological changes. Participants in the breeding programs are continually looking for superior trees to add to the programs. These trees come from within the breeding region, which ensures that they are adapted to the climate, soils, diseases, and pests within the Grande Prairie biogeoclimatic zone (Figure 100).

The Region B1 lodgepole pine breeding program has achieved the objective of having between 300 and 600 genotypes in the breeding program with 459 genotypes currently in the program (Edwards *et al* 2000a). In 1998-1999, 100 trees were added to increase the geographic coverage of the parents and the overall genetic variability in the program.

In the G1 white spruce breeding program, 218 parent trees have been intensively grafted into clone banks at Smoky Lake (Edwards *et al* 2000b). A further 140 non-intensive selections are planned to improve the geographic coverage and broaden the genetic base; these will be made when a good cone crop occurs. This will bring the total number of genotypes in the white spruce program to 358.

In August 1999, FMU G2C and the northern portion of FMU G5C had a sufficient cone crop for white spruce to enable collection of 30 additional trees. When the southern portions of FMU G5C have a sufficient cone crop, 40 additional trees will be collected. Weyerhaeuser is required to collect 70 trees. All trees selected are registered with Alberta Sustainable Resource Development, as they are collected.

2. To maintain sufficiently large orchard populations of unrelated trees (20–60 genotypes) to safeguard diversity in a given seed orchard (Section G “Critical Element 1c, Objective 1.1b.1”).

   Canfor will maintain seed orchard(s) of sufficient size to produce registered seed crops as per the proposed *Management and Conservation Standards for Forest Tree Genetic Resources in Alberta.*

   Effective number is a measure of the relative contribution of each genotype to a given seedlot, as well as of the number of genotypes. An increased number of ramets (or seedlings) per genotype (or family) compensate for any imbalance in genotypic representation. Both programs currently have at least 89 genotypes represented.

Progeny tests of all parents will be conducted within the tree breeding programs. This will provide a population for intensive selection of parents of the next generation seed orchard. Subsequent interbreeding and selection will provide continued progress and the expansion of the current breeding population currently underway will ensure long-term maintenance of genetic diversity (Edwards *et al* 2000a).

It is important to balance genetic gains (generally measured in yield) with genetic variability. Selecting superior parents from geographically dispersed areas within the

breeding region will increase the likelihood of having relatively high genetic diversity within the breeding program.

3. To include cones of at least 400–750 mother trees for the bulk seed collections for lodgepole pine and white spruce, and 50–150 mother trees for black spruce over a 10 year period (Section G "Critical Element 1c, Objective 1.1d.1").

   Seed from white spruce is collected from approved seed zones (Figure 100), which possess relatively homogeneous biological, climatic, and geological conditions. Seed for lodgepole pine and black spruce is collected from within 80 km and 150 m in elevation of the planting site. The seedlings grown from the seed taken from a specific seed zone or area are planted in the same seed zone or area to which it has adapted, thereby ensuring they will survive and prosper.

   Canfor maintains a variety of records regarding seed collections but does not currently track the number of mother trees. Canfor estimates, however, that seed has been collected from 10,379 mother trees of lodgepole pine, 742 of white spruce, and 40 of black spruce. These estimates are based on Canfor's supply of seed at the Alberta Tree Improvement and Seed Centre (as of September 1, 1999) (Table 40).

When a sufficient seed crop occurs, collections will be made to increase the number of mother trees for black spruce. Collections of seed for the remaining species will be made as dictated by seed supplies. A mother tree tracking system, to record the mother trees of each species represented in the bulk seed collection and the location and seed zone from which the seed was collected, will be developed when additional cones are collected.

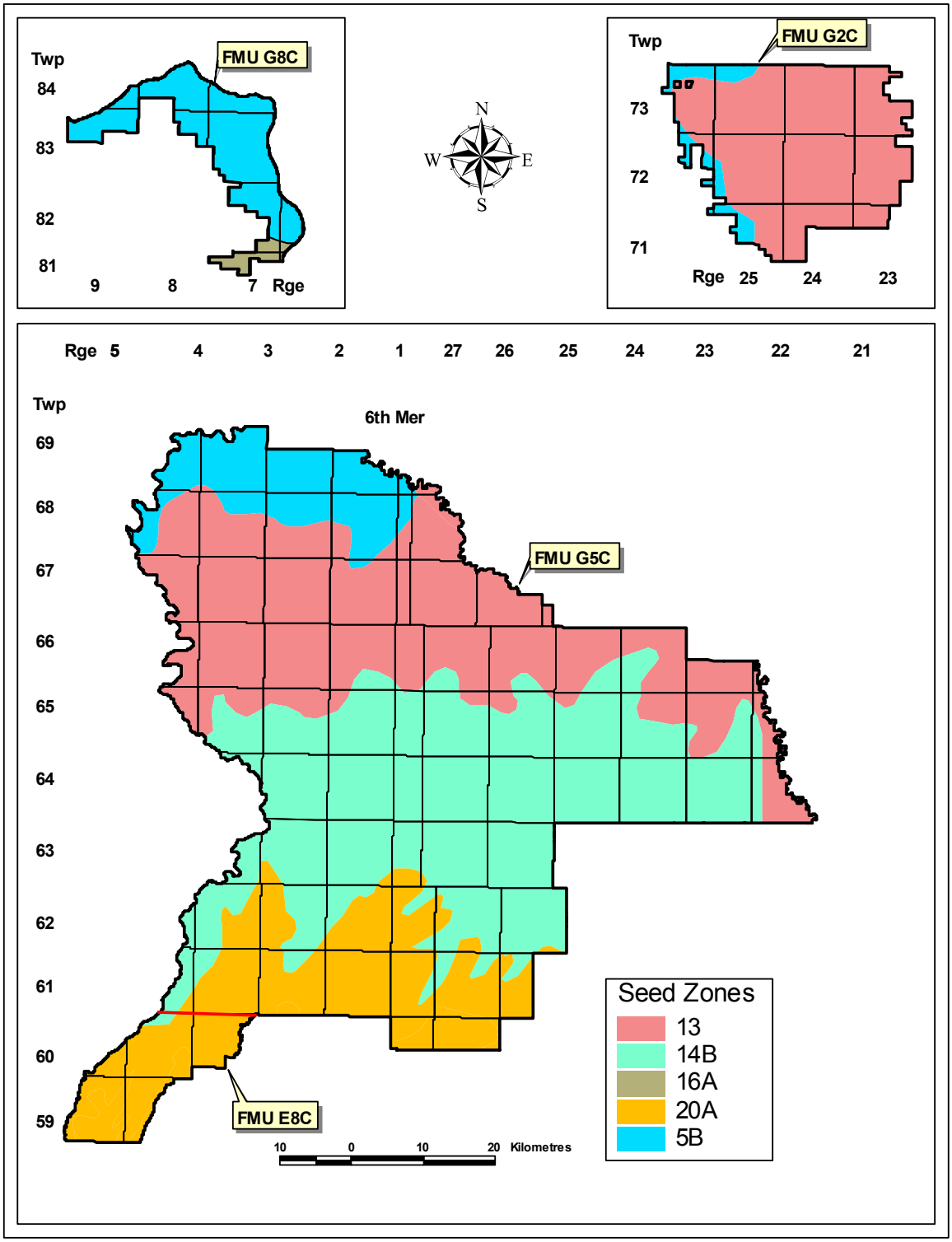


Figure 100. Seed Collection Zones Within the FMA Area

15.11.2 Tree Improvement

Canfor has been involved in tree improvement programs since 1977. The Company participates in the B1 low elevation lodgepole (800 to 1,200 m) breeding program in partnership with Weyerhaeuser, Alberta Newsprint Company Ltd., and Alberta Sustainable Resource Development, Land and Forest Division (LFD). Canfor also participates in the G1 low elevation white spruce (650 to 1,050 m) breeding program in association with Weyerhaeuser and LFD.

The goal for both programs is to provide a secure source of seed and propagation material to produce trees with fast growth, good general health, good form, and undiminished wood quality. The primary objectives of the programs are to (Edwards *et al* 2000a and 2000b):

- Provide genetically improved material for reforestation;
- Achieve optimum economic gain per unit of time;
- Predict, obtain, and verify genetic gains as quickly as possible; and
- Maintain genetic diversity and long-term adaptive capability through a sufficiently large mainline breeding population, an elite production population, and genetic archives (clone bank).

The work plans developed for each of the tree improvement species identify the activities and timelines of the breeding programs (Edwards *et al* 2000a and 2000b). Precise records are maintained for all components of the programs. All trees (clones) selected for the programs are also registered with Alberta Sustainable Resource Development.

The Region B1 project is the most advanced of the 2 tree improvement projects, in that plans are now underway to start a second generation orchard. Progeny testing for the B1 program is done at 4 sites; Canfor is responsible for 1 of these sites. Nineteen-year measurements were made in 1998 and analyses for genetic rouging were completed. The orchard was subsequently rogued in the fall of 1999. Fifty-eight forward selections were made in the progeny tests. Scion material was collected and grafted from these 58 selections. This is the beginning of the Phase 2 orchard.

Canfor and Weyerhaeuser are the industry partners in Region G1 tree improvement project. One hundred and ten selections and 3 more progeny sites must be established to complete testing for the first generation orchard.

Canfor, Weyerhaeuser, Weldwood, Millar Western and Alberta Newsprint manage the Huallen Seed Orchard Company (HASOC). The consortium maintains a half-section agricultural site located near Beaverlodge, Alberta, for seed production. HASOC was formed in January 1995 in order to facilitate cost sharing, improve efficiency and realize economies of scale among companies within shared breeding regions.

To date, Canfor has harvested approximately 96 kg of pine seed from B1 and 3 kg of white spruce seed from G1. The seed is shipped to Smoky Lake Tree Improvement Centre for storage.

Possessing the genetically variable seed is only one component of the Company's efforts to conserve genetic diversity. The other relates to how genetically improved seed is deployed within the FMA area.

15.11.3 Deployment of Improved Seed

Canfor's objective is to plant 30% of the FMA area cutblocks with the bulk seed collection and 70% with seed orchard stock within the following Natural subregions: Central Mixedwood, Dry Mixedwood, and Lower Foothills (Section G "Critical Element 1c, Objective 1.1c.1"). The acceptable variance is to plant not more than 70% of the harvested area with seed orchard seed on a 5-year average. Table 38 shows the deployment strategy. It should be noted that genetically superior trees can only be planted from 800 to 1200 m in elevation.

The B1 lodgepole pine program trees in the seed orchard have been rouged and crown management has commenced. It will be 3 years before the orchard is in full seed production. Consequently, only a small amount of seed will be available each year for growing pine planting stock.

Seed production from the G1 white spruce program has just commenced and it is anticipated that full production will be realized within the next 3 to 5 years. Until the production of seed from the seed orchard is available, harvested areas will be planted with seedlings grown from seed from bulk collections.

The bulk seed collection activities must continue to provide adequate seed for reforestation purposes. Individual seed collection and seed deployment must occur within a specific seed zone unless approved by the Land and Forest Division.

The distribution of the seed resource for production of seedlings and planting will be implemented, within 3 years for pine and 3 to 5 years for spruce, as seed orchard seed becomes available.

Canfor recognizes there are draft standards for deployment of improved seed within the *Management and Conservation Standards for Forest Tree Genetic Resources in Alberta* and the Company is committed to adhering to these standards when they are finalized.

Table 38. Improved Seed Deployment Strategy

DFMP_Tables.xls
Table 48

Yield Group	Yield Group Descriptor (Species)	Subregion for Deployment
8	PL/PLFB+(H)	CMW, DMW, LFH
9	PLAW/AWPL	CMW, DMW, LFH
10	PLSB+OTH	CMW, DMW, LFH
11	PLSW/SWPL+(H)	CMW, DMW, LFH

Notes on Abbreviations:

Species: PL = Lodgepole pine; SW = White spruce; SB = Black spruce; FB = Balsam fir; AW = White aspen (Aspen); H = Generic for any deciduous species (aspen, birch); OTH = includes other unidentified species when FB or PLSB are identified as the main leading species

Natural Subregions: CMW = Central Mixedwood; DMW = Dry Mixedwood; LFH = Lower Foothills

Source: Canfor compiled data

Spruce orchard seed will be used as per Table 39.

Table 39. Deployment of Seed Orchard Seed

DFMP_Tables.xls
Table 49

Yield Group	Group Descriptor	Subregion for Deployment
11	PLSW/SWPL+(H)	CMW, DMW, LFH
16	SW/SWFB+(H)-CD	CMW, DMW, LFH
17	SWAW/SWAWPL	CMW, DMW, LFH

Notes on Abbreviations:

Species: PL = Lodgepole pine; SW = White spruce; FB = Balsam fir; AW = White aspen (Aspen); H = Generic for any deciduous species (aspen, birch)

Species descriptors: CD = refers to C and D stand densities (D being the highest stems per ha therefore the most dense type of stand)

Natural Subregions: CMW = Central Mixedwood; DMW = Dry Mixedwood; LFH = Lower Foothills

Source: Canfor compiled data

Of the above yield groups/subregions, 70% of the area will be planted with seed orchard seed; 30% of the area will be planted bulk seed collections from natural stands. All other yield groups, except black spruce, will be planted with bulk seed collections from natural stands. Black spruce seed will come from a seed production orchard. Canfor plants approximately 130,000 black spruce annually.

15.11.4 Seed Collection

Seed for Canfor's reforestation program is collected from 4 seed zones within the FMA area (Figure 100). Pine seed has been traditionally handpicked from logging slash from various cutblocks within the Company's FMA area. Spruce has been collected from areas within the FMA area during "good" cone crop years. In 1997, 2 helicopter collections were made instead of handpicking (Figure 101). All future white spruce collections will be helicopter-picked. Black spruce will continue to be handpicked from logging slash. Table 40 indicates the volumes of seed currently available.

Figure 101. Cone Collection
A helicopter is used to collect spruce cones when there is sufficient volumes.

Canfor, Weyerhaeuser (Grande Prairie) and Alberta Sustainable Resource Development participate in the Region L2 Black Spruce program (Edwards *et al* 2000). The goal is to secure a source of high quality seed and propagation material for black spruce between 800 and 1,200 m elevation. Parent selection, and seed and scion collections, were completed between 1993-2000. Sixty-two parents have been selected based on better than average growth and size, and good form and branching characteristics. A small clonal seed orchard was established in 1997 and occupies .58 ha at the Huallen Seed Orchard.

Table 40. Available Seed

DFMP_Tables.xls
Table 63

Seed Zone	Natural subregion	Number of Seedlots	Species	Amount (kg)
5B	DMW	1	PL	0.9
		2	SW	11.4
13	CMW	0	PL	0.0
		1	SW	335.6
14B	LFH	8	PL	1,231.4
		1	SB	3.8
		2	SW	73.7
20A	UFH, SAL [1]	3	PL	144.4
		2	SW	55.8
	Total	20		**1,857.0**
Tree Improved Seed	Under 1,200 m elevation		PL	2.4
			SW	0.9

Notes on abbreviations.
Species: PL = Lodgepole pine; SW = White spruce SB = Black spruce
Natural subregions: DMW = Dry Mixedwood; CMW = Central Mixedwood; LFH = Lower Foothills; UFH = Upper Foothills; SAL = Sub-Alpine
Note 1: Commencing in 2003, when seed is collected from the Subalpine Natural subregion (SAL) it will be identified separately, by seed zone, from seed collected in the Upper Foothills Natural subregion (UFH)

Source: Canfor compiled data

Additional collections will be made when a white spruce cone crop of sufficient size becomes available in Seed Zones 13 and 14B. This is also true for black spruce collections in Seed Zones 13 and 20A. The white spruce cones will be helicopter-picked and the black spruce will be handpicked from logging slash. Sufficient quantities of pine seed are available and no further collections are planned. Figure 102 depicts where cones are temporarily stored prior to seed extraction.

Pine reforestation in Seed Zone 13 will use tree-improved seed as there is only a very small component of pine in this zone. At the present time, no harvest is scheduled in Zone 5B for the next 5 years or more.

Figure 102. Cone Storage
Canfor collects cones, which are temporarily stored at Alberta Tree Improvement and Seed Centre awaiting seed extraction.

16 Research Initiatives

Canfor participates in research initiatives to:

- Assist in meeting DFMP objectives;
- Validate assumptions and test new theories;
- Improve its knowledge and understanding of forest ecosystems; and
- Obtain information for strategic, tactical and operational planning.

The primary research initiatives undertaken by Canfor and the corresponding DFMP objective(s) that has, or will, be achieved using data or information from the initiative are contained in Appendix 15. Also refer to Appendix 15 for more information regarding the linkages between CSA and research.

Canfor will report on how the research results are being applied as a component of the *Five Year Stewardship Report* submitted to ASRD.

Research assists the Company to achieve the objective, "to validate Canfor's assumptions and test new theories to improve its knowledge of forest ecosystems by conducting on-going research" (Section G "Critical Element 6f, Objective 1.1a.2").

16.1 Forest Resources Improvement Program (FRIP)

Canfor conducts many research projects independently or through partnerships under the Forest Resource Improvement Program (FRIP). A list of the projects is included in Table 41 and some of the projects are discussed in the following sections.

16.1.1 Grizzly Bear

Figure 103. Grizzly Bear

Canfor provides funding for a 5 year Grizzly Bear research program being conducted in the Hinton area.

Source: Gorden Stenhouse

Grizzly bear numbers have remained relatively stable outside the national parks since 1980 (www.gov.ab.ca/env/fw/status/index.html).

It is widely recognized that the grizzly bear (Figure 103) is an important indicator species of the ecological health of a natural system. It is also recognized that maintenance of conditions favorable for this species will result in conditions beneficial to a wide range of other wildlife (NESERC 2000). To gather more information on which to improve grizzly bear management, Canfor provides funding to support a 5-year research program being conducted in the Hinton area by the Foothills Model Forest. The program has recently concluded its second year.

The long-term program objectives are, *"to provide resource managers with the necessary knowledge and planning tools to ensure the long-term conservation of grizzly bears in the Yellowhead Ecosystem".* The program focuses on collecting various biological data that will help to address important management decisions in support of current and ongoing wildlife management programs in the region. An element of this research involves the capture and collaring of grizzly bears.

The project will provide information to support the *Strategic Framework for Achieving Integrated Grizzly Bear Conservation in the Alberta Yellowhead Ecosystem* developed by Alberta Sustainable Resource Development and others (NESERC 2000). This strategy is a management approach that will provide resource managers with planning and management tools.

Table 41. Research Conducted Under the FRIP Program

DFMP_Tables.xls
Table 67

Project	Expenditures ($)
GRANDE PRAIRIE	
Fisheries Phase I	$45,000
Fisheries Phase II	$54,907
Fisheries Phase III	$48,581
Stand Tending Phase I	$1,015,291
Stand Tending Phase II	$338,940
Stand Tending Phase III	$549,870
Stand Tending Phase IV	$494,345
Stand Tending Phase V	$895,448
Soil Compaction Phase I-III	$45,000
Soil Compaction Phase IV & V	$15,843
Regenerated Yield Standard Initiative (RYSI)	$17,325
Swan Lake Aeration Project	$29,340
Hydrography, DEM & Watershed Data Sets	$23,658
Mill By-Product	$23,572
Ecosystem Classification Phase I	$1,094,109
Ecosystem Classification Phase II	$104,685
Air Photo Indexing	$5,550
Public Participation	$15,435
Forest Protection (1998)	$56,550
Forest Protection (1999 - 2001)	$189,378
Genetic Diversity	$30,255
Constraints on Crown Closure	$21,000
Biological Productivity	$52,106
Forest Educator	$133,298
Caribou Phase I	$214,321
Caribou Phase II	$272,265
Canadian Environmental Assessment	$3,133
AEP Regeneration Standards	$35,438
Ecosite Field Guide	$56,396
Silviculture Field Guide	$68,000
Grizzly Bear	$119,280
Small Mammals	$19,950
Foothills Growth and Yield (Sub-Proj 1)	$20,000
Foothills Growth and Yield (Sub-Proj 2)	$645,000
WESBOGY	$369,884
NIVMA	$153,594
Softcopy Photogrammetry	$42,945
Herbicide Information Session	$16,000
Total	**$7,335,689**
HINES CREEK	
Growth and Yield Phase I Regenerated Yield	$45,000
Dual Path Mounder	$54,907
AVI (Enhancement Phase III IN P11)	$97,163
Mill By-Product	$1,015,291
EMEND (1997 - 1999)	$338,940
Ecological Classification	$549,870
EMEND (2000 - 2001)	$988,691
Evaluation of Yield Groups	$1,790,897
Forest Resource Educator	$45,000
White Spruce Establishment	$31,686
Site Specific Regen Standards	$17,325
Total	**$4,974,769**

Source Canfor compiled data

16.1.2 Cooperative Fisheries Inventory

During the period 1994 – 1996 Canfor, in partnership with other forest industry companies, participated in the Cooperative Fisheries Inventory Program (CFIP) conducted in northwestern Alberta, including Canfor's FMA area (Figure 104). The inventory was sponsored by the Alberta Sustainable Resource Development, Alberta Conservation Association (formerly the Buck for Wildlife Fund), Weyerhaeuser, Ainsworth Lumber Company Ltd., Manning Diversified Forest Products Ltd., Daishowa Marubeni International Ltd., and the Department of Fisheries and Oceans (DFO).

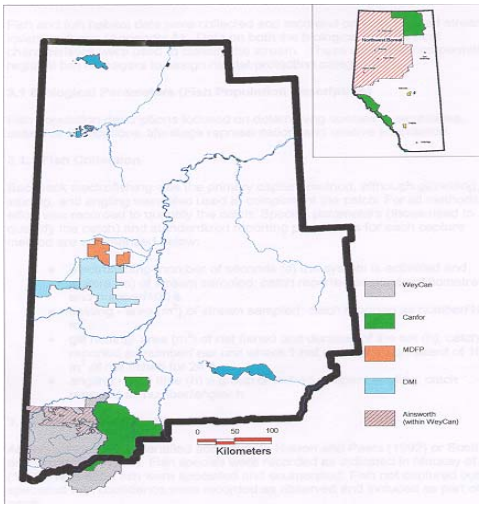


Figure 104. Cooperative Fisheries Inventory Program
This program, conducted in part within Canfor's FMA area, provided much-needed fisheries data for its many sponsors.
Source: ACA 1998

Canfor's primary objective in participating in that project was to improve the quality and quantity of fisheries inventory data within the FMA area and in turn, improve long-term and short-term timber harvest planning. The project provided much-needed fisheries data and expanded the Company's fisheries inventory data by determining the:

- Quantified densities (by life stage) of fish species;
- Seasonal distribution of species;
- Relationship (importance) of tributary and mainstream headwaters with the remainder of the systems i.e. the correlation (if any) between stream order and species life stage utilization;
- Seasonal migration patterns of fish species; and
- Preferred habitat types of fish species and life history stages, including the identification of critical (limited) habitats.

16.1.3 Soil Compaction

Canfor and 5 partners (Weyerhaeuser, Weldwood of Canada Hinton Division, Sundance Forest Industries Ltd., Sunpine Forest Products Ltd. and Alberta Newsprint Company Ltd.) funded a study titled, *Modelling Soil Compaction, Decompaction and Tree Growth on Alberta Soils Following Forest Harvesting* (McNabb and Startsev 1994). The project has 5 phases covering the period 1994–2002.

The objective of the Soil Compaction Project is to model:

- The changes in soil physical properties resulting from summer logging on moist soil at 4 levels of skidding activity;
- The natural rate that compacted forest soils recover as a function of severity of compaction, soil type and climate; and

- The effect of soil compaction on seedling growth, including the effect on seedlings growing adjacent to areas of contrasting amounts of compacted soil, i.e. seedlings planted in undisturbed soil adjacent to severely compacted skid trails.

16.1.4 Ecological Management Emulating Natural Disturbance (EMEND)

Canfor and Daishowa-Marubeni International Ltd (DMI) have invested approximately $3 million in support of this ecologically based research. In the widest sense, the EMEND project integrates the efforts of some biologists, economists, sociologists, and modellers to determine how harvest and regeneration of upland, mixedwood forest can best approximate natural disturbance regimes in north western Alberta (Spence 1997). The project is designed to test predictions about benefits of alternative approaches to forest management (Figure 105). Participants in the project will study the ecological and production implications of harvest patterns that leave various amounts of residual structure after harvest (0% [clear-cut], 10% residual, 20% residual, 50% residual and 75% residual) across 4 "original forest cover" types (>70% deciduous, mixedwood forest, aspen with significant understorey of white spruce, and >70% coniferous forest). The project currently has 70 researchers conducting 43 projects, some of which are silviculture projects:

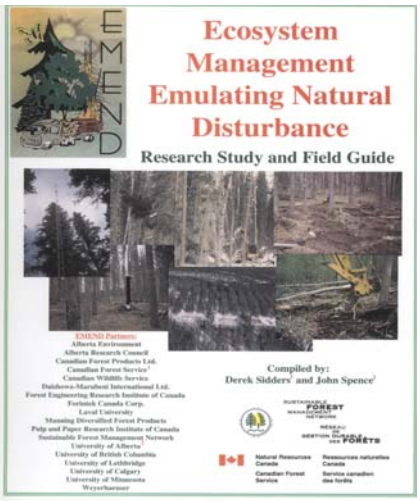


Figure 105. EMEND
The EMEND (ecosystem management by emulating natural disturbance) project studies how harvest and regeneration of upland, mixedwood forest can best approximate natural regimes.

- Greenway, K., Ivor Edwards and Amar Varma. *Deciduous Regeneration Study*. Objective: to assess the effect of different levels of partial harvest on aspen and balsam poplar;
- Sidders, D. *Regeneration on Prepared and Natural Seedbeds (clearcut, 50% and 75% retention)*. Objective: to establish and monitor response of artificial and natural seedlings;
- Stewart, J., Rick Hurdle, Derek Sidders, Rob Taylor, Travis Jones and Jessica Roberts. *Regenerating White Spruce in Partial Cut Mixedwood*. Objective: to quantify the influence of overstorey retention and site preparation on the microenvironment and relate this to physiology and growth of softwood seedlings;
- Stewart, J., Dan Gilmore, Kathy Haiby, Jessica Roberts and Travis Jones. *Partial Harvest on White Spruce Cone Production and Seed Rain.* Objective: to quantify the relationships among cone production, residual stand density (degree of exposure), tree condition (pre-harvest crown class), and seed rain following partial harvest;
- Gilmore, D. *Modelling Early Regeneration Processes in Mixed-Species Boreal Forest of Alberta.* Objective: to initiate a long-term record of natural regeneration

processes; to assemble a database that can be used for modelling aspects of forest regeneration for mixed species of boreal forest of Alberta;

- Hillman, G. and Jim Stewart. *Effects of Timber Harvesting, Snow Accumulation and Melt, on Seedling Survival and Growth*. Objective: to determine patterns of snow accumulation and melt under different levels of timber harvest; to relate seedling survival and growth to snow cover, soil temperature and soil water content;
- MacDonald, E. *Causes and Rates of Mortality for Understorey White Spruce, Aspen and Balsam Fir in a Boreal Mixedwood Forest*. Objective: to characterize the seedling mortality of important tree species across the boreal forest; and
- Sidders, D. *Seedbed Microsite Classification and Receptiveness to White Spruce Establishment and Growth*. Objective: to classify and quantify the various microsites resulting from partial harvesting; to categorize the seedbed receptiveness of the various microsites to natural softwood seedling establishment.

16.1.5 Constraints on Crown Development

Five forest industry companies, including Canfor, have provided funding for a project to improve Canfor's understanding of tree crown and forest canopy development entitled, *Constraints on Crown Development in Boreal Conifers* (Lieffers and Silins 1997). The project includes a number of related studies. The studies will extend the Company's knowledge of crown growth potential and vulnerability of stands to wind damage as regulated by stand characteristics such as inherent wood strength, height, diameter, stem taper, crown length, and foliage density. Understanding these mechanisms will help foresters develop stand-specific thinning strategies and reduce reliance on costly silvicultural trials for which growth information may not become available for many years or decades. This understanding will help improve the forest resource by allowing foresters to increase the growth and merchantability of slow-growing, overly dense stands without undue risk of severe wind damage. The objectives for the project include extending the knowledge base concerning crown water relations and wind effects on forest growth and developing management applications for this knowledge. Information from the project will be important in developing stand-specific intensive silvicultural practices.

16.1.6 Biological Productivity Project

Todd Little, M.Sc. candidate, has undertaken a project titled, *Post-Fire Forest Floor Development Along Toposequences of White Spruce - Aspen (Picea glauca – Populus tremuloides*) *Mixedwood Communities in West-Central Alberta* (Little *et al* 1997*).* The data from the project will improve management of the forest resource by providing information to identify the more productive mixedwood lands. The project will also provide a means of assessing and monitoring soil quality. Understanding the relationship between soil properties and uneven-aged forest productivity will provide a model for monitoring and assessing silvicultural practices. The overall objectives of the project are to discern soil properties over a topographic sequence influential to boreal mixedwood forest productivity in west central Alberta, and to develop a model for determination of nitrogen-phosphorous-potassium using quantitative soil indicators.

15.1.7 Tree Improvement on Genetic Diversity

The project, *Effects of Forest Management and Tree Improvement on Genetic Diversity of Lodgepole Pine and White Spruce* (Thomas *et al* 1998), was funded by 5 Alberta forest Industry companies including Canfor. Dr. R. Hodgetts, Dr. Ellen Macdonald and Dr. Barbara Thomas, all of the University of Alberta, have been examining the impact of forest management on genetic diversity of lodgepole pine in west central Alberta for 3 years (1996-1999). This project has 3 phases:

- Phase I, molecular markers (RAPDs-randomly amplified polymorphic DNA) were utilized to study the effects of artificial regeneration (planting) following clearcut harvesting on genetic diversity. The researchers also developed microsatellite markers for lodgepole pine, which they feel are much superior for use as genetic markers and have employed these in subsequent phases;
- Phase II involves development of comprehensive baseline data on stand and landscape-level patterns of genetic diversity in natural populations of lodgepole pine and white spruce. The impact of alternative silvicultural practices on genetic diversity, with specific consideration of stands which are pre- and post-self thinning, will also be examined further; and
- Phase III will develop microsatellite markers for white spruce.

The data from the project will provide an understanding of patterns of genetic diversity in lodgepole pine and white spruce, and of the impact of silvicultural practices and tree breeding regimes upon it. The project will address the questions of utmost interest and importance to the forest industry and further the Company's understanding and ability to sustain Alberta's boreal forest.

15.1.8 Northern Interior Vegetation Management (NIVMA)

The Northern Interior Vegetation Management Association (NIVMA) is a forest industry cooperative which has been building a database for assessing plantation performance since 1989.

The primary objectives of the Association are to:

- Compile a common database and generate valuable information for silviculture decision-making;
- Monitor attributes such as biodiversity and long-term site productivity;
- Monitor years to breast height for timber supply planning purposes;
- Monitor years to free growing;
- Monitor tree performance in relation to competing vegetation;
- Monitor years to breast height in the context of site disturbance;
- Monitor years to green-up height;
- Monitor tree performance from various silviculture regimes to assist in identifying trends;
- Describe changes in plant species communities; and
- Monitor forest health in managed stands.

Twelve forest companies, 2 Government agencies and 1 educational institution are currently participating in the Association as voting members as indicated in Table 42. Canfor has been an active member of the Association since 1994.

Table 42. NIVMA Members (2000)

DFMP_Tables ver 1.xls
Table 53

NIVMA Members (2000)
Alberta Newsprint Company Ltd., Alberta
Alberta Plywood Ltd., Alberta
British Columbia Ministry of Forests, Caribou Forest Region
British Columbia Ministry of Forests, Prince George Forest Region
British Columbia Ministry of Forests, Prince Rupert Forest Region
Canadian Forest Products Ltd., Alberta
Canadian Forest Products Ltd., British Columbia
Daishowa-Marubeni International Ltd., Alberta
Donohue Forest Products Inc., Mackenzie Region, British Columbia
Dunkley Lumber Ltd., British Columbia
Millar Western Forest Products Ltd., Alberta
Natural Resources Canada, Canadian Forest Service, Northern Foresty Centre
Slocan Forest Products Ltd., Mackenzie Operation
The Pas Lumber Company Ltd.
Tolko Forest Industries, High Level Lumber Division
UBC Alex Frazer Research Forest
Weldwood of Canada Ltd., Alberta
Weldwood of Canada Ltd., Canim Lake Sawmills Division
West Frazer Mills Ltd., British Columbia
Weyerhaeuser

Source: Canfor FRIP proposal

The information obtained from being involved in the Association will enhance the management of forest resources within the FMA area by providing a continually improved, scientific, quantitative, and credible basis for:

- Evaluating and selecting silvicultural regimes and crop plans for the management of targeted species;
- Evaluating if the growth performance of the various yield groups is met; and
- Promotion of cooperation, partnership, and shared responsibility among forest managers, researchers and the public.

16.3 Silviculture Research

Canfor is committed to validating management assumptions and testing new theories in relation to forest management. Following is a brief description of some of the silvicultural research activities in which Canfor is currently participating.

One such partnership with Pelton Reforestation and Pacific Regeneration Technologies (PRT) was aimed at continuously improving the Company's direct planting program. Through this research, Canfor has opted for minimal disturbance, "LFH style" planting. "LFH" planting refers to a technique whereby the litter layer surrounding a planting microsite is left undisturbed. This provides thermal protection for the seedling, as well as additional nutrients, as this duff layer decomposes. This approach fosters quick seedling establishment, and puts plantations on a growth trajectory in the desired yield class as soon as possible (Refer also to Table 28).

16.2.1 Operational Planting Trial

In cooperation with Pacific Regeneration Technologies Inc. (PRT), the Company has established a seedling trial. Each stock type from various nurseries is graded into the top third, middle third and bottom third. Each group was planted into 3 rows chosen randomly. Thirty seedlings were planted in each row. The plots were replicated 3 times for each pine and spruce. The trial contains approximately 8,500 seedlings (Figure 106). The objective is to find the stock types that perform the best and to determine if there is any difference in performance of the different grades within each stock type. If, for instance, the bottom third does not perform well, it may be culled at the nursery stage. This trial was planted in May and July 2000; with monitoring planned for 10 years.

Figure 106. Operational Planting Trial
The objective of the trial is to find the stock types that perform the best. The seedling in the photo is in the top third of the 0.5 x 1.5 plug bareroot stock type.

16.2.2 Non-Native Conifer Plantations

In the past, Canfor attempted to establish non-native species to evaluate how they would perform within the FMA area. The species included siberian larch, chinese larch, grand fir, interior douglas fir and red pine. Only the 2 larch species performed well. Both of the fir species died out. The red pine proved overly susceptible to snow press and became very twisted and was weeded out when thinning the natural pine. Canfor will not be establishing any additional non-native plantations at this time, and will not be using non-native species in its reforestation program.

16.3 Program to Enhance the Management Activities and the Level of Understanding of the Forest Resources

In accordance with subparagraph 32(3) of Forest Management Agreement 9900037, the Company maintains a fund to enhance the management activities and level of understanding of the forest resources and forest products within the forest management area. A minimum of $0.25 per cubic meter, based on all coniferous timber cut by or for the Company from the FMA area, is contributed to the fund annually.

17 Mixedwood Management

The primary challenge of mixedwood management is to maintain, over time, a spatial distribution of mixedwood patches at various seral stages that will meet wood fiber and ecological objectives. Silvicultural approaches and better understanding of successional pathways will be key to the successful regrowth of mixedwood stands and maintaining the current distribution in the landscape. The mixedwood forest (Figure 107) supplies a significant portion of the current deciduous annual allowable cut (AAC) therefore it is very important for maintenance of the deciduous volume. All forest companies operating within the FMA area agree that a variety of options with regard to management of mixedwood stands should be explored, including the following:

- Partial removal of deciduous overstorey in stands with an established coniferous understorey;
- Under-planting coniferous trees in mature and immature mixedwood and deciduous stands;
- Fill-in planting prior to harvest in stands containing a low density of coniferous understorey;
- Allowing a deciduous component to develop in specific coniferous stands; and
- Gaining an understanding of how harvesting differs from fire with regard to spruce recruitment after disturbance.

Figure 107. Mixedwood Forest Type
The mixedwood forest supplies a significant portion of the current deciduous AAC.

18 Coniferous Understories

An understorey consists of trees and other woody species growing under the canopies of larger adjacent trees and other woody growth (Dunster and Dunster 1996). Coniferous understories are very important to Canfor because they provide growing stock for future forests. Identification of deciduous priority stands with coniferous understorey is very important due to its substantial contribution to the coniferous annual allowable cut.

The FMA agreement Appendix B: 3(1) defines how stands will be managed:

"Pure coniferous and mixedwood stands (C, CD, and DC) and pure deciduous stands with established coniferous understorey identified on timber type maps produced under paragraph 1 of this Appendix and which form part of the coniferous cut in the detailed forest management plan approved on December 3, 1991 or, when approved, in the detailed forest management plan referred to in paragraph 10(3), shall be managed for coniferous production. The detailed forest management plan shall provide for the sustainability of the volume of deciduous timber harvested from those stands managed for coniferous production."

Refer to Appendix 3 for additional information regarding the identification of coniferous understories and their role in the *Resource and Timber Supply Analysis*.

18.1 Coniferous Understorey Protection

Protection of coniferous understories during harvest operations is important given its role in the calculation of the coniferous annual allowable cut (AAC). Protection of coniferous understories is provided for under paragraph 7(9) of the FMA agreement:

"The Minister may allow the Deciduous Company to harvest merchantable deciduous trees from stands designated in the approved Annual Operating Plan even if they contain a coniferous understorey, provided that damage to the coniferous understorey is minimized through current harvesting techniques. Where the Minister, after consulting with the Company, determines that appreciable damage is being done to the coniferous understorey, the Minister shall order the cessation of timber harvesting operations being carried out by the Deciduous Company in those stands."

For coniferous priority blocks, Canfor targets spruce, pine and balsam fir for understorey protection since they are the primary commercial coniferous species of interest. Balsam fir understorey is protected on north facing slopes. Figure 108 depicts a stand with coniferous understorey (pre- and post-harvesting) to demonstrate understorey protection in deciduous priority block.

Figure 108. Coniferous Understories
It is important to protect coniferous understories because they are growing stock for future forests and play an important role in the calculation of the AAC. The photographs above show a mixedwood stand prior to harvest (top) and after harvest (bottom).

19 Forest Health

It is Canfor's goal to conserve forest health. According to the CSA, forest ecosystem condition and productivity are conserved if the health, vitality, and rates of biological production are maintained. The following sections provide the details.

19.1 Fire

It is Canfor's goal to conserve forest health (Section G "Critical Element 2a, Goal 1.1"). To achieve that goal, the Company endeavors to limit the number of occurrences and amount of area impacted by fire and catastrophic events of insects, disease, windfall, etc. (Section G "Critical Element 2a, Objective 1.1a.1").

19.2 Insect and Disease

The only insect epidemics that have occurred in the FMA area have been associated with the forest tent caterpillar and large aspen tortrix, both species that impact deciduous trees. Insect infestations of coniferous tree species remain at endemic levels, as they have for many years. Diseases of both conifer and deciduous tree species have only occurred at endemic levels within the FMA area.

Canfor is a participant in the North West Boreal Integrated Pest Management Working Group, which has developed an insect and disease monitoring system. Members funded a pilot project to test and improve the monitoring system and have finalized protocols for monitoring. Members of the Working Group and ASRD are working co-operatively to develop a sampling program to determine the extent of insect and disease within operating areas. The objective of the program is to locate infestations before they reach epidemic levels, and implement control activities to prevent their spread. As per paragraph 28(4) of FMA Agreement 9900037, the Company will, in co-operation with ASRD, develop a strategy to suppress any insect and disease outbreak of epidemic proportion within the FMA area.

Canfor is a participant in the North West Boreal Integrated Pest Management Working Group, which has developed an insect and disease monitoring system. Members have funded a pilot project to test and improve the monitoring system before it becomes operational in 2002.

Neither the Government nor Canfor have used insecticides or biological agents within the FMA area, as there have not been any insect or disease outbreaks.

19.3 Catastrophic Windfall

A certain amount of windfall is endemic in all forested areas. This usually involves relatively small areas and impacts only minor timber volumes. Of a greater concern is the occurrence of a catastrophic windfall. In general, catastrophic windfall refers to a windfall event that reduces the aggregated growth of the forest to such an extent that it triggers a recalculation of the Annual Allowable Cut.

Figure 109. Endemic Windfall
A certain amount of windfall is endemic in all forested areas. Areas prone to windfall will be identified using softcopy photogrammetry and salvage plans formulated on a site-specific basis.

Windfall has a potential impact on a number of resources. Endemic windfall serves a useful purpose as coarse woody debris, which supplies nutrients for plant growth and habitat for wildlife (Figure 109). However, it also affects some wildlife species by blocking travel routes. Water resources may also be impacted when watercourse buffers are blown down, resulting in increased stream temperatures and sedimentation. Catastrophic windfall events, resulting from a number of natural and human-related causes, can produce localized conditions that are

favorable for increased population levels of insects. Therefore, from a management perspective, it is important to identify those areas that are prone to catastrophic windfall. Canfor has established a system to identify windfall-prone areas.

Canfor will also assist ASRD to develop long-term plans to mitigate catastrophic wildfire events.

19.3.1 Windfall Assessments

Prior to 1997, no windfall assessment surveys were conducted within the FMA area, however, windfall was addressed operationally as found. In 1997, a windfall assessment survey was conducted for the FMA area. As a result, a number of patches (130 ha) in FMU G5C (operational subunit Sim-4) were identified as catastrophic windfall. These patches were harvested in the 1998 - 1999 season, salvaging approximately 32,000 m^3. Based on a reconnaissance survey in FMU G2C (operational subunit Pusk-3), approximately 231 ha were harvested in 1999 in a catastrophic windfall area, salvaging approximately 39,500 m^3.

New technology (softcopy photogrammetry) has evolved to the point that digital photographs can now be used to identify large areas of windfall (refer to Section E 4.5 for additional Information. By fall 2001, the FMA area will be reviewed using this technology. Areas prone to windfall will be identified and field verified.

Since dry wood is a very important issue for the sawmill, the age of the windfall must be determined. If the wood is older than 2 years, it will be too badly checked to make into boards. Those areas that have blown down within the past 2 years will be targeted for more intensive scrutiny. These areas will require an economic and environmental analysis to evaluate such factors as access, roads, harvesting systems, and the environmental impacts of either harvesting or not harvesting. When all of these factors have been considered, a decision will be made on whether or not to harvest the area. Such plans require the approval of Alberta Sustainable Resource Development (ASRD) prior to implementation. There will be no attempt to salvage minor amounts of windfall.

In addition to the above strategy, there are numerous opportunities for recently harvested areas to be inspected for windfall. Helicopter flights for final clearances, silviculture or other uses will also be used to monitor the status of windfall in areas. As information is obtained, plans will be made to salvage those areas where it is economically and environmentally feasible.

Projecting into the future, it is envisioned that new aerial photographs will be flown every 5 years. New areas of windfall will be identified and the above process repeated. Over time, as knowledge increases, Canfor will be able to identify windfall-prone areas. In addition to “high tech”, Canfor and ASRD personnel make numerous post-harvest inspections of cutblocks. As windfall is identified, an assessment will be made as to whether or not a salvage plan will be prepared. In these areas, management strategies will be employed to minimize the effect of wind on cutblock boundaries. These strategies may include:

- Altering the direction of the cutblock boundaries so that the prevailing winds do not directly impact the boundary;
- Where windfall is continuous, the size of the cutblock may be expanded to a windfirm boundary; and

- Operational practices such as "feathering" cutblock boundaries by leaving a percentage of trees adjacent to the boundary. The percentage and type of trees that are left will be subject to site-specific conditions.

20 Forest Protection

As per subparagraph 28(1) of the FMA agreement, forest protection is primarily the responsibility of ASRD. Current forest protection practices fall under provincial pre-suppression and wildfire suppression programs, as well as insect and disease monitoring and control programs. In accordance with subparagraph 28(2) of the FMA agreement, Canfor is required to work with ASRD to assist in the delivery of these programs. Canfor will also assist ASRD to develop long-term planning to mitigate catastrophic wildfire events (i.e., fire landscape planning and fire smart planning).

20.1 Canfor's Role in Fire Protection and Control

Canfor's role in fire prevention and control is as follows:

- Assist with fire suppression by providing manpower and equipment when required;
- Assist Land and Forest Division (LFD) when required to suppress all fires at the initial stages, preferably at the "spot stage";
- Provide initial attack on all fires encountered and notify LFD immediately to determine if backup is required;
- Keep in daily contact with LFD regarding fire hazard ratings; and
- Provide road patrols when the hazard warrants.

20.2 Fire Prevention and Control Initiatives

To limit the occurrences of fire, Canfor has implemented the following activities:

- Development of a *Forest Protection Plan* (Canfor 2000e);
- Providing funds to supplement deployment of fire protection resources[18]; and
- Research into silviculture applications emulating fires is currently being undertaken by the EMEND Project, which is in part funded by Canfor (Canadian Forest Service 2000) (refer also to Section F 16).

[18] Since 1994 Canfor has participated in a 3 way forest protection initiative with Lands and Forest Division (LFD) and Sturgeon Lake Cree Nation. Under this program, Canfor hires Sturgeon Lake personnel for stand tending, the LFD provide suppression equipment and, when the fire hazard warrants it, Sturgeon Lake Resource Crew personnel becomes a stand-by crew for fire suppression. Canfor then "tops up" the fire wages so that the Sturgeon Lake Resource crew earns the same salary as if they were stand tending.

20.3 Forest Protection Plan

Canfor prepares a *Forest Protection Plan* (Canfor 2000e) for the use of Company and Lands and Forest Division (LFD) personnel in fulfillment of the *Forest and Prairie Protection Act*, *Forest Management Agreement 9900037* (subparagraphs 30(8) and (9) and *Fire Control Agreement* with the Province of Alberta. In addition to fire control and prevention, the plan also makes provisions for reporting insect, disease, and restricted and noxious weeds (refer to Section F 19).

The plan is for use by all supervisory personnel concerned with the forest protection objectives of detection, communication, prevention, pre-suppression, and suppression of fires for the fire season (April 1 to October 31). Since the majority of Canfor's operations are in the Smoky River Forest Area, all communications are with the Fire Liaison Officer, Grande Prairie Fire Centre or the Smoky River Forest Area (Figure 111). Copies of this plan are distributed to all woodlands staff personnel, all logging and forestry contractors that the Company uses during the fire season, and all main oil and gas companies operating within the FMA area.

Figure 110. Fire Equipment Trailers
In accordance with regulations, Canfor maintains equipment, such as the fire equipment trailers shown in the photograph, and trained personnel to assist in fire prevention and control.

Canfor maintains 5 equipment trailers and 5 water trailers (Figure 110). A set of these trailers is located at each of the active summer operating areas.

Canfor's woodlands staff has various levels of fire training. They are assigned, on a rotating basis, as fire duty officers each weekend during the fire season to act as the first contact for the ASRD.

20.4 Fire History

Fire control and prevention programs have limited the number and area of fires within the FMA area. For more information on the fire history of the FMA area refer to Section C 2.5.1.

20.5 Holding and Protection Charges

Canfor pays holding and protection charges to the Government as per paragraph 31 of the FMA agreement. A portion of the money paid to the Government is for the right to harvest timber from the FMA area; one may consider it rent for the use of the land. The rest of the money is for protection purposes (wildfires).

21 CO_2 / NO_x

CO_2 is carbon dioxide, which is a greenhouse gas of major concern in the study of global warming. It is estimated that the amount in the air is increasing by 0.4% annually.

Anthropogenic (man-caused) carbon dioxide is emitted mainly through the burning of fossil fuels and deforestation (i.e. conversion of forested landbase to farmland or grazing pastures on a long-term basis).

NO_x is a generic term for nitrogen oxides (such as nitric oxide (NO) or nitrogen dioxide (NO_2); both of which are corrosive and hazardous to health). Nitrogen oxides are a major pollutant in the atmosphere, being a precursor to acid rain, photochemical smog and ozone accumulation.

CO_2 / NO_x

Activities to Undertake

- Identify all equipment and technologies in the woodlands operation that are potential sources of CO_2 and NO_x emissions;
- Identify alternative sources of equipment and technologies that can be used to reduce CO_2 and NO_x and emissions; and
- Design programs that will promote the use of new CO_2 and NO_x reduction equipment and technologies.

One of the critical elements identified for the Sustainable Forest Management Plan (SFMP) was to minimize the disturbances that negatively impact carbon cycles responsible for recycling of water, carbon, nitrogen and other life-sustaining elements. A goal was established by the Forest Management Advisory Committee to minimize disturbances that negatively impact carbon cycles (Section G "Critical Element 4a, Goal 1.1"). The objective is to promote the use of equipment and technology that minimizes CO_2 and NO_x emissions (Section G "Critical Element 4a, Objective 1.1c"). To achieve this objective, Canfor is working on identifying the source of these emissions within the woodland area and evaluating alternate equipment with lower emissions. Once the information is compiled, it will be reviewed and promoted to the contractors.

Figure 111. Fire Management Districts Have Been Established by the Alberta Government