

SERM - SASKPOWER  
FOREST-BASED CARBON OFFSET AGREEMENT

Project Document

Submitted to

Greenhouse Gas Emission Reduction Trading Pilot

25 August, 1999

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## Executive Summary

This project is a trade-matched agreement between Saskatchewan Environment and Resource Management (SERM), and Saskatchewan Power Corporation (SaskPower). This agreement is made up of two components: (1) direct carbon sequestration through the establishment of white spruce plantations in east-central Saskatchewan; and (2) forest protection in the form of Forest Carbon Reserves established by the government of Saskatchewan, in which trees formerly available for harvest are now protected. The total amount of carbon emissions offset as a result of this agreement is 6 million tonnes carbon or 22 million tonnes CO<sub>2</sub> equivalent.

The tree planting component will provide for the planting of approximately 5 million seedlings in areas designated Not Sufficiently Restocked (NSR) in east-central Saskatchewan. These areas were subject to timber harvest in the past but have not been replanted. This agreement calls for 5 million seedlings to be planted at an average planting density of 1500 stems per hectare, resulting in a total of 3300 ha. of plantations. Planting will be carried out over the first four years of the agreement. Based on our provincial growth models, we estimate that at maturity (i.e., 90 years), approximately 210,000 tonnes of carbon will have been sequestered on the 3300 ha. Over the 50 year life of the agreement, approximately 85,000 tonnes will have been sequestered. We will measure actual carbon sequestration on these sites annually by destructively sampling individual trees, drying and weighing them to determine dry-weight biomass. Assuming biomass is 50% carbon, these measurements will indicate how much carbon is being fixed annually. We propose that credits will be available at the beginning of the agreement based on the amount of carbon sequestered over the entire rotation period (90 years).

The Forest Carbon Reserves will be established across the province as part of the provincial Representatives Areas Network program. These areas were formerly part of the annual allowable cut of various Forest Management Agreement Areas, but have been withdrawn from harvesting, thereby reducing carbon emissions. Credit will be based on the amount of volume that would have been harvested in the absence of this agreement. From existing forest inventory data we have estimated that approximately 178,000 ha of FCRs will be required in order to deliver the balance of the 6 million tonnes of emission reductions called for in this agreement. Given the uncertainty inherent in traditional forest inventory data, we will undertake a detailed biomass inventory of these sites. Fixed-area measurement plots 10 m x 10 m will be established at a density of one plot per 500 ha, on which tree height and diameter will be measured on all trees of merchantable size. Species-specific biomass equations will be used to determine total aboveground merchantable biomass on each plot; these values will be used to estimate total standing carbon stocks across all the FCRs. These measurements will be repeated every five years to track changes in carbon stocks over time. The province has recently established a new fire suppression system and an aggressive budworm control program. We feel this will allow us to keep carbon loss due to leakage to a minimal

## INTRODUCTION

Forests play an important role in the functioning of the global climate. Forests take carbon dioxide (CO<sub>2</sub>) out of the atmosphere on an annual basis, and also store carbon over long time periods due to their long life span. Because of these factors, forest management can have important impacts on mitigating the effects of increasing levels of CO<sub>2</sub> in the atmosphere. International agreements, in particular the Kyoto Protocol to the United Nations Framework Convention on Climate Change, recognize the value of forests and forest land use activities as carbon sinks for the purpose of granting credit to CO<sub>2</sub> emitters that can be used to offset their emissions.

Saskatchewan Environment and Resource Management (SERM) has entered into such an agreement with Saskatchewan Power Corporation (SaskPower). The agreement stipulates that SERM will provide emission credits for 6,000,000 tonnes of carbon through a combination of the establishment of Forest Carbon Reserves and reforestation. The purpose of this project description is to present the methods that will be used to determine the amount of carbon sequestered as a result of these activities.

## PROJECT ELIGIBILITY

### Location of Emission Reduction

Emission reductions will be based on forest protection and reforestation activities undertaken across north-central Saskatchewan. Figure 1 indicates the location of these activities.

### Participants:

**Seller:** Saskatchewan Environment and Resource Management (SERM), the natural resource management agency of the Saskatchewan Government. SERM will adjust its greenhouse gas emission reports to reflect the transfer of ownership of the emission reductions to SaskPower.

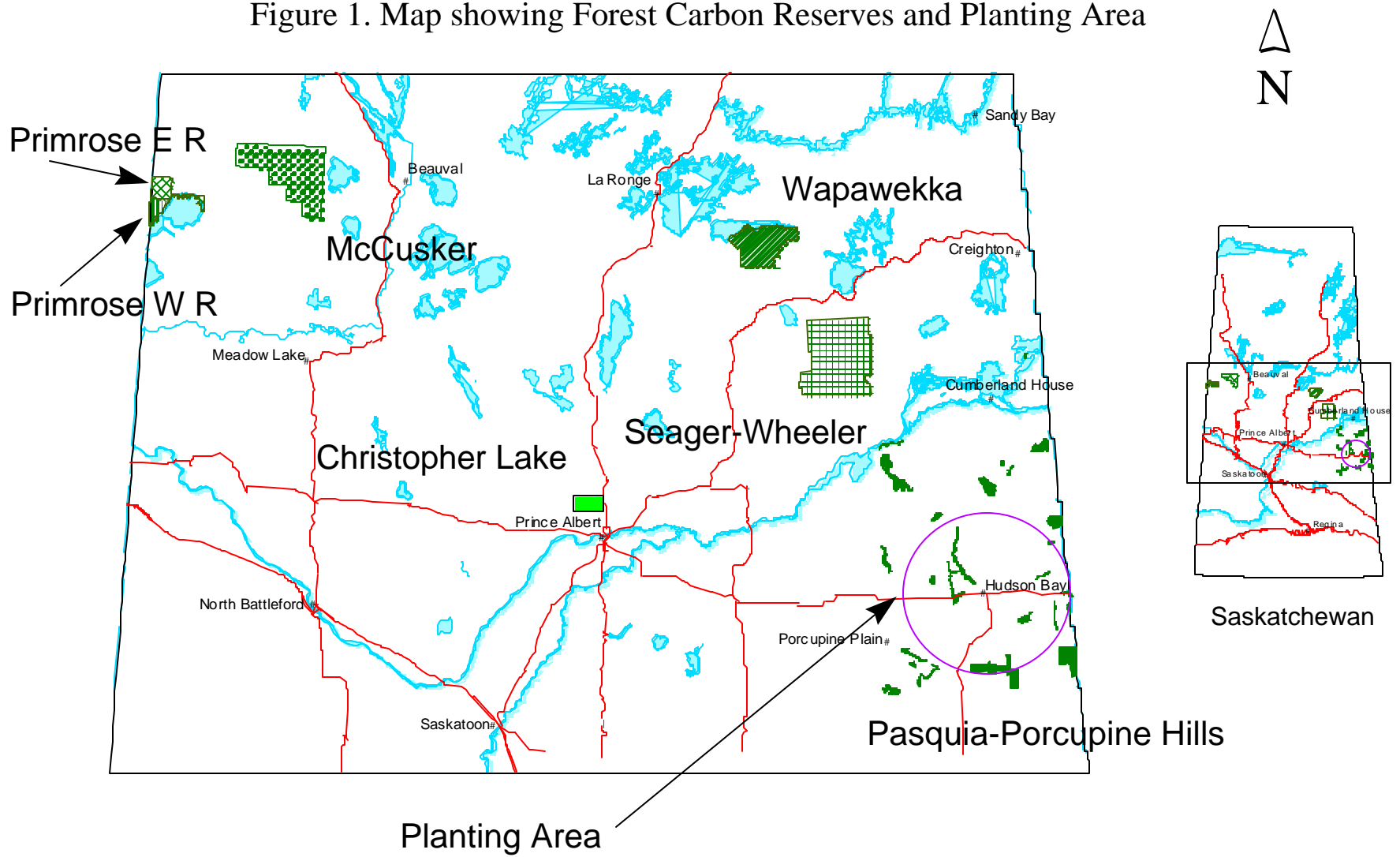
**Buyer:** Saskatchewan Power Corporation (SaskPower), the provincial electrical utility. SaskPower will report the emission reduction in Canada through the Voluntary Challenge Registry.

Evidence of VCR membership - STILL NEEDS TO BE DONE

### Start Date of Reductions

Carbon sequestration arising from tree planting will commence when planting begins in the summer of 2000. Carbon emissions avoided as a result of forest protection began when each of the representative areas was declared, beginning in February 1998.

Figure 1. Map showing Forest Carbon Reserves and Planting Area



## MANDATORY REVIEW CRITERIA

### Real emission reductions.

The emission offsets contained in this agreement are based on two forest-based land-use activities. One is carbon sequestration arising from tree planting; the other is avoidance of carbon emissions through forest protection. In this agreement, forest protection means prevention of forest harvesting and protection of forest stands from fire within the area of the provincial Representative Areas Network (RAN). Potential sources of leakage from these projects are primarily losses in biomass or tree growth due to fire and insects, which would reduce the amount of carbon sequestered or emissions avoided. The provincial government has recently undertaken a major restructuring and upgrade of its fire-fighting capabilities. A recent review of the new system indicates that there has been a significant increase in the province's ability to limit fire's impacts to forests in Saskatchewan. Henderson and Smith and MacAuley (1999) suggest that the new fire suppression system has reduced area burned by about 50% since its implementation. In addition, we are currently implementing a new spruce budworm control program. The spruce budworm is the most important insect pest that attacks white spruce, which is the tree species that will be used for the tree planting in this agreement. We conclude that the probability of controlling leakage due to fires and insects is high.

### Measurable emission reductions

#### Units of measurement

Emission reductions will be expressed in tonnes of CO<sub>2</sub>. However, carbon sequestration in biomass is measured in terms of tonnes of carbon, since this unit is basic to calculations involving biomass and its carbon content. To convert carbon to CO<sub>2</sub> equivalent, we used the conversion factor 1 tonne carbon = 3.67 tonnes CO<sub>2</sub>.

#### Reference Case

The reference case refers to the emissions by SaskPower in the absence of the offset agreement described herein. We have chosen to use a historical reference case as shown in Table 1.

Table 1. Annual CO<sub>2</sub> emissions by SaskPower, 1996-1998.

Year	Emissions (million tonnes CO <sub>2</sub> [Mt])
1998	14.5
1997	14.1
1996	13.5
Average	14.0

Emissions data are those reported to provincial regulators and available in SaskPower's annual *Environmental Review* (SaskPower 1996, 1997, 1998).

#### Emissions Reduction Case

The Emissions Reduction Case was calculated by subtracting the carbon dioxide offset, based on credits purchased from SERM, from the Historical Reference Case. We assumed the three-year average emission of 14.0 Mt (see Table 1) as the projected annual emissions over the next four years. The offset credits will be delivered to SaskPower between 1999 and 2002. Table 2 shows the delivery of credits and the resulting reduced emissions:

Table 2. Schedule of emission credit delivery and resulting reduced emissions

Date	Offset Credit (Mt CO <sub>2</sub> )	Reduced Emissions (Mt CO <sub>2</sub> )
15 October, 1999	3.67	10.33
1 April, 2000	7.34	6.66
1 April, 2001	7.34	6.66
1 April, 2002	3.67	10.33

While the credits will be delivered over a four year period, the life of the agreement is 50 years.

#### Monitoring and Measurement

The basis for the emission reductions shown above is carbon sequestered in forest biomass managed by SERM. The following section provides the details of how the carbon in biomass will be monitored and measured, and also outlines areas of risk and uncertainty. The project is

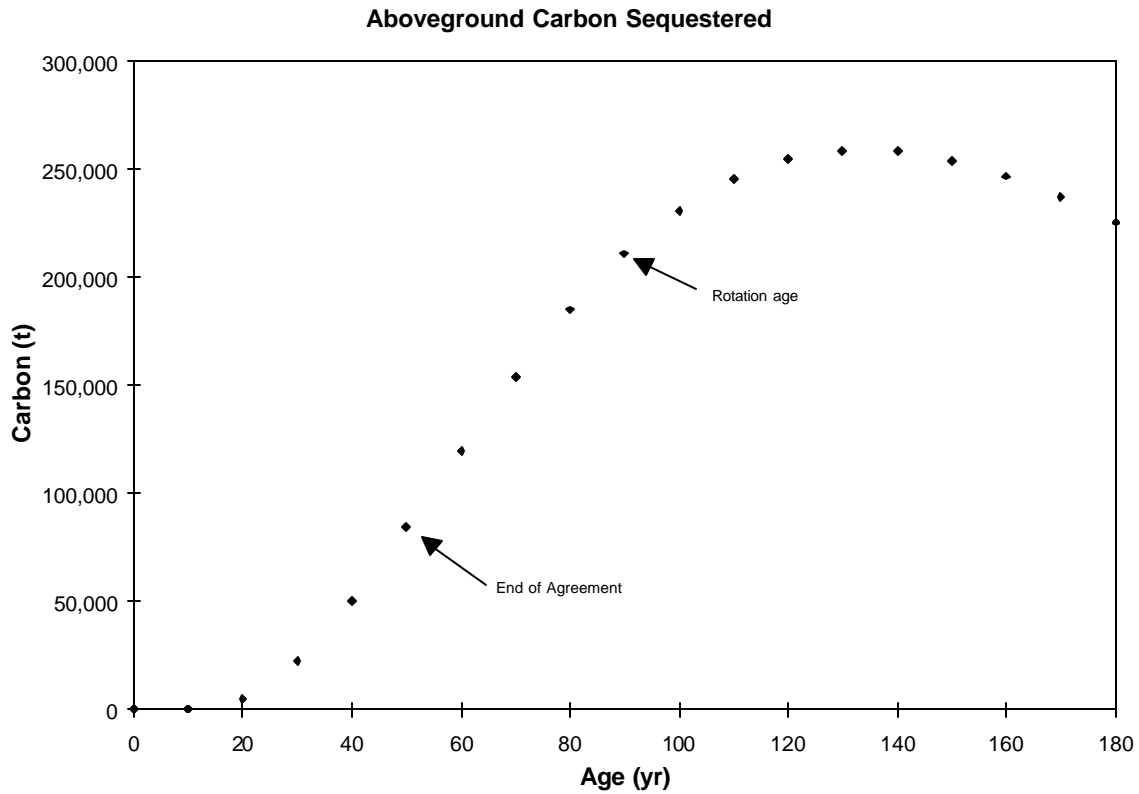
based on carbon sequestered in forest biomass that arises from two sets of land use activities. The first is the establishment of forest plantations in east-central Saskatchewan, and the second is the protection of forest biomass in the provincial Representative Areas Network.

### Plantations

The province has a backlog of some 300,000 ha of not-sufficiently-restocked (NSR) land, resulting from areas that were harvested in the past but not successfully regenerated. These areas are ideal candidates for carbon offset projects based on reforestation. The area we have targeted for plantation development in this agreement lies in the vicinity of Hudson Bay, SK, approximately 250 km east of Prince Albert (see Fig. 1). The bulk of the funds transferred in this agreement will be used to establish white spruce plantations in the Hudson Bay area. White spruce is the most appropriate species in this area for planting because of its economic value and the fact that natural regeneration for white spruce is unreliable because of its variable seed production. White spruce plantations can be established in this area for approximately \$1 per seedling, which includes the costs of growing the seedling, transport to the planting area, putting the seedling in the ground, and subsequent stand tending if required. At a planting rate of 1500 seedlings per hectare (a standard planting density for this species), our agreement will result in the reforestation of approximately 3300 ha.

The projected carbon sequestration resulting from reforestation was estimated from volume accumulation using SERM's natural stand yield curves for pure white spruce stands. This estimate is likely to be conservative as plantations will generally yield greater growth rates and volume accumulation than natural stands due to genetically improved stock and density control. At the end of the agreement (i.e., 50 years), approximately 85,000 tonnes of carbon will have been sequestered, while at rotation (i.e., 90 years) approximately 210,000 tonnes will have been sequestered (Fig. 2)

Figure 2. Aboveground carbon accumulation for white spruce in Saskatchewan on a 3300 ha plantation.



Conversion of volume to carbon content was calculated as:

$$B = V * 0.386$$

$$C = B * 0.50$$

$$C_t = C * 3300$$

where  $B$  is biomass (t/ha),  $V$  is volume (m<sup>3</sup>/ha),  $C$  is carbon (t/ha) and  $C_t$  is total carbon sequestered over the entire planted area (t). Conversion factors were taken from Alemdag 1983 for white spruce.

Uncertainty related to plantation establishment includes that associated with the yield curves; survival of seedlings once planted; losses of plantations due to fire and insects/diseases. The

yield curves used in the projections above are based on several hundred permanent sample plots established in the Hudson Bay area, and thus represent growth in the area that will be planted. However, projections from the yield curves are only an approximation of actual growth, so SERM will carry out an annual monitoring program to document carbon sequestration in the plantations. We will accomplish this by destructively sampling individual trees, drying and weighing them to determine dry-weight biomass. Assuming biomass is 50% carbon, these measurements will indicate how much carbon is being fixed annually. We will sample approximately 100 trees per year, selected randomly from across the areas planted. In addition, regeneration surveys are normally conducted at year five, and plantations are surveyed at about year 10 to determine whether they have met SERM's free-to-grow standards (to be implemented in 2000). These operational surveys will also assist in determining the health and survival of the plantations.

Losses due to fire and insects and disease are potential sources of carbon leakage. As indicated above, Saskatchewan has recently implemented an aggressive initial attack fire suppression system and a budworm spray program. Because of their economic value, plantations are accorded the highest priority for protection under both of these programs, and should keep carbon leakage to a minimum.

#### Forest Carbon Reserves

The second component of the offset agreement is the maintenance of sequestered carbon through forest protection. Beginning in 1998, the province established a number of protected areas across Saskatchewan through the Representative Areas Network program. The Representative Areas in the forested portion of the province will be designated Forest Carbon Reserves (FCRs). These areas were originally part of the Forest Management Agreement License areas of various forestry companies in the province, but have been removed from their operating areas and are no longer included in the company's annual allowable cut. Therefore the carbon that would have been harvested will now remain in the forest. The result is that only carbon sequestered in merchantable volume is available for credit. Table 3 shows the FCRs established to date and the carbon contained in each.

Table 3. Merchantable volume, biomass and carbon in FCRs in Saskatchewan. Locations shown in Fig. 1.

FCR Name	Volume (m <sup>3</sup> )	Biomass (t)	Carbon (t)	Area (ha)
Christopher Lake	7,888	3,641	1,821	77
McCusker River	8,244,500	3,590,331	1,795,166	60,886
Pasqua-Porcupine Hills	5,461,836	2,405,054	1,202,527	41,031

Primrose Ecological Reserve	666,235	292,170	146,085	4,772
Primrose Wildlife Refuge	573,382	248,957	124,479	4,170
Seager-Wheeler	830,857	347,332	173,666	14,587
Wapawekka Hills	4,212,877	1,791,822	895,911	43,979
Totals	19,997,575	8,679,308	4,339,654	169,502

Volumes were taken from SERM's volume tables for the stands located within the boundaries of the FCRs. Biomass and carbon content were calculated from volume using the following conversion factors:

$$B_h = V_h * 0.463$$

$$B_s = V_s * 0.413$$

$$C_{h,s} = B_{h,s} * 0.50$$

where  $B_h$  and  $B_s$  are merchantable biomass for hardwood and softwood species, respectively;  $V_h$  and  $V_s$  are merchantable volumes for hardwood and softwood species, respectively; and  $C_h$  and  $C_s$  are merchantable carbon for hardwood and softwood species, respectively. The constants 0.463 and 0.413 are average wood densities for hardwood species (aspen and white birch) and softwood species (jack pine, black spruce and white spruce), respectively and were taken from Alemdag (1983, 1984). We assume carbon content of biomass is 50%.

The total carbon sequestered in merchantable biomass is approximately 4.3 million tonnes. This amount plus the 210,000 tonnes accumulated in the plantations totals approximately 4.5 million tonnes, some 1.5 million tonnes short of the target in the agreement. The additional carbon will become available as new FCRs are established in the next year.

Existing inventory data do not verify the amount of carbon in the FCRs. In the first year of implementing the agreement, sample plots will be established in the FCRs in order to document the amount of carbon stored. Data will be collected on 10 x 10 m plots, in which the height and diameter at breast height (dbh) for each tree > 5 cm dbh will be measured. Plots will be established at a density of 1 plot per 500 hectares. Carbon storage will be determined using biomass equations developed for the major tree species in the prairie provinces (Singh 1982). In addition, understory vegetation will be sampled for carbon content by clipping on 0.5 x 0.5 m plots and determining over-dry biomass. These plots will be remeasured every five years to monitor changes in carbon storage. We will also investigate the use of remote sensing data as a method to monitor changes in biomass in these stands.

Soil carbon is an addition C sink in cases where forests are re-established on abandoned agricultural land or other areas where significant C loss has occurred. However, in this project trees are being established on areas that have been declared NSR but still have some vegetative cover (grasses, shrubs, non-commercial trees, etc.). We are assuming that little additional soil carbon will be added to the soil as a result of reforestation and that the additional C sink is in the trees being planted. Further, we also assume that soil carbon in the FCRs will change little and will represent neither a source nor a sink.

### Sole Ownership

Ownership of the carbon credits is established in the formal agreement between SERM and SaskPower; see copy attached.

### Project Additionality

Additionality refers to the principle that carbon sequestration occurring as a result of this agreement would not have occurred in the absence of the agreement. Additionality in our agreement arises from two actions. The first is the establishment of plantations, in which additional carbon is sequestered as a result of photosynthesis by the newly planted trees. The second is avoidance of emissions that would have occurred had the trees in the FCRs been harvested.

### Environmental and Socio-economic Impacts

Reforestation of NSR areas will have several benefits. This land will be returned to productive forest land and will contribute to the maintenance of economic development in eastern Saskatchewan. In particular, land undergoing reforestation will contribute to the development of a new wood processing facility in Hudson Bay. These areas would not have been reforested without the funding made available through this agreement. In addition, there are environmental benefits in re-establishing forest on these NSR areas, including soil stabilization, wildlife habitat and amenity values.

FCRs will be part of the provincial network of Representative Areas which are to be set aside for recreation, traditional land uses and scientific study. They will also be used as benchmark sites for Saskatchewan's provincial ecosystem health monitoring program currently under development.

This agreement also has significant social value as a learning tool concerning carbon credit arrangements. For example, there is very high interest in Saskatchewan in the possibility for

agricultural land owners to obtain credit for low disturbance agricultural practices that result in increased soil carbon sequestration. Our agreement will provide the opportunity for others interested in carbon emissions trading to learn more about how it can work.

#### Representatives

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#### Other Emissions Trading Options in the Forestry Sector

The current agreement is based on forest protection and tree planting. However, there are other opportunities for emissions trading in the forestry sector that Saskatchewan is interested in pursuing, and we would welcome feedback from GERT on these ideas.

##### *Fire Suppression*

Forest fires are common in Saskatchewan's forests. Fires release large amounts of CO<sub>2</sub> and reduce the forest's carbon storage capacity over large areas. It takes many decades to return the carbon storage potential of the forest, so protection from fire is an important component of a forest-based carbon sequestering strategy. Offset potential exists in granting credit for fire suppression activities that are additional to that which government would normally undertake.

This could take the form of direct fire suppression activities such as those often carried out by forest industries, or through the purchase of major pieces of fire-fighting equipment such as fire tanker aircraft. We compared area burned in the portion of the province under aggressive fire protection (the intensive protection zone) with that in the area in which fires are only attacked if human life or property is threatened (the extensive protection zone). We found that fires burn an average of 1% of the land area in the extensive zone annually but only about 0.5% in the intensive protection zone. Assuming that most of this difference was due to rapid initial attack with air tankers, we calculated that each air tanker prevents fire on approximately 7,500 ha annually. Fires in the boreal forest release on average approximately 20 t/ha of carbon (Zoltai et al. 1998), so that each air tanker is responsible for preventing the release of about 150,000 t C annually. This amount of carbon could be available for generating a tradable carbon credit.

#### *Reforestation/Afforestation on Marginal Agricultural Land*

Saskatchewan has large areas along the southern fringe of the provincial forest that would benefit from the establishment or re-establishment of forest cover. In addition to increasing the carbon sequestration, these activities would help to protect the soil from erosion, maintain soil organic matter, enhance water quality and increase biodiversity values. In these areas, the financial return from tree plantations is often much better than that from non-subsidized agricultural crops. A recent study indicates that there are approximately 2.2 million ha available for planting in Saskatchewan, and that this area could sequester approximately 0.5 Mt C annually through an aggressive program that included plantations of fast-growing hybrid poplars and white spruce, and an expanded farm shelterbelt program (Peterson et al. 1999). Depending on ownership and financial issues, carbon sequestered as a result of these activities could generate carbon credits.

#### *Insect and Disease Control*

As with the case for fire protection, carbon credits could be generated through protecting the forest from insects and disease. For example, the Canadian Pulp and Paper Association recently estimated that control of forest insects through the application of biological agents could result in the sequestering of an additional 6 million tonnes of carbon nationally (CPPA 1998). Saskatchewan is in the early stages of a spruce budworm outbreak and has recently implemented an aggressive budworm control program. Credits could be generated as a result of the carbon emissions prevented from such a control program. We currently do not have data on how much emissions have been reduced through budworm control, but will have these data by the end of 1999.

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