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A comparison of financial results of various logging plans on the Montmorency limits, Quebec.

Jobidan, Arthur

A COMPARISON ~~AND~~ of FINANCIAL RESULTS
OF VARIOUS LOGGING PLANS ON THE MONTMORENCY LIMITS, QUEBEC

University of Michigan
School of Forestry and Conservation
Ann Arbor, Michigan

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Reverend Arthur Jobidon

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A. J.

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INTRODUCTION

The owner of a forest property has always to face various and difficult problems to obtain the best value from his property and also to keep it in advantageous and economical conditions of productivity. One of these problems, which is also the headache of all the woods operators, is the logging job. All operators "realize that it is the most profitable one when the total cost of operations is kept at a minimum level, but the method of reaching this minimum level has never been agreed upon" (4). The owner is also perplexed to establish the value of his property or of his crop when he has not a complete knowledge of the logging costs.

This problem has compared the various logging plans which could be adopted for a small tract of the Montmorency Limits. The first chapters, for a better knowledge of the logging practices, have described the conditions of these limits and the tract to be logged. A more detailed study and comparison have been made between various logging plans for a destructive logging and an estimation of stumpage made on those plans. We have tried also, in Chapter V, to demonstrate what should be the value of this property and the costs of logging operations on a sustained yield basis. The last part has been devoted to the possibility of a management plan and the means of appraising the stumpage with more data available.

We hope that this work will show the necessity of adequate control of the factors that affect the costs of the new logging methods, and will contribute to bring some light in the means of appraising the stumpage value.

CHAPTER I

DESCRIPTION AND CONDITIONS OF THE MONTMORENCY LIMITS

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DESCRIPTION AND CONDITION OF THE MONTMORENCY LIMITS

The Quebec Seminary lands comprise a total area of 400,000 acres and are in a single block in Montmorency and Charlevoix Counties, north-east of Quebec City. These lands are drained by three turbulent rivers, the Montmorency, St. Ann and du Gouffre, and their tributaries.

The first one, the Montmorency River, drains an area of 400 square miles, of which 200 square miles are the Quebec Seminary lands, and an equal area of Crown lands in the Laurentide Park. (9) The following lines will give a brief description of the former area, the Quebec Seminary lands on the Montmorency River.

1. Accessibility.

Twenty miles north of Quebec, crossing the parish of Laval, a first class motor road leaves the settlements, enters the Seminary property and bisects it for four miles to the head-waters of the Snow River. The total length of this road, from Quebec to Snow Lake, is sixty miles, and of this thirty miles, following the banks of the Montmorency and Snow Rivers, are on the Seminary property. On this road, constructed by the Anglo-Canadian Pulp & Paper Company, loads of fifteen tons can be carried and an average speed of twenty miles per hour can be maintained.

2. Forest Description.

The unusual forest conditions on this limit call for unusual methods of management, as it called for particular methods of logging. (3) Two Forest Regions, as described by W. E. D. Halliday, with their own cover-types and side-types, are represented. (9) The line of separation between the two regions, indicated by the northern limit of yellow birch, is sharp and readily discernible, particularly in the autumn when the leaves are turning color. This line, located a few miles above the confluence of the Montmorency and Snow Rivers, marks the northern boundary of the tolerant hardwood-softwood forests of the Great Lakes - St. Lawrence Region. The area adjoining the north lies in the north-eastern coniferous section of the Boreal Forest. The Seminary property lies north of the range of hard maple, extends across that of yellow birch in the Southern Region, and reaches into the Northern Region for a few miles.

The principal cover-types of the Southern Region are Yellow Birch, Balsam and Spruce, varying in proportion of composition with site-type. A great occurence of conifers appears on the hill tops and slopes and valleys. The cover-type of the undisturbed stands on the upper reaches indicates the Cornus, or Oxalis-Cornus, site-type, which characterizes the lower slopes in the Lake Edward country. The site-type on the lower slopes and valleys appears to be Viburnum-Oxalis.

In the Northern Region the major cover-type is Balsam-Spruce-White Birch, of which the birch is probably only a transition species. The dominant site-types are Hylocomium-Cornus, a type favorable to balsam and black spruce. (9) Pure stands of black spruce are to be found scattered on lower slopes and flats of both regions, particularly in the more poorly drained areas.

3. Topography.

Situated in the Laurentian Shield, the topography is mountainous on all the Montmorency watershed. The precipitous terrain makes for difficulty in logging operations, and demands logging engineering of a high order. The forests throughout cover a series of hilltops, upper slopes, lower slopes and valleys, each situation with its own site-types and species composition.

In many places during the logging operations made on these limits by the Anglo-Canadian Company, between 1926 and 1934, dry log-chutes were used with a great deal of success, and on each creek a series of dams of special construction have been built.

The road construction itself is, in this mountainous country, a serious problem. In recent years, however, it has been solved by the introduction and use of bull-dozers and other modern road-building machinery.

4. Cutting Practice.

In the beginning of the logging operations, in 1926, it was assumed that the growth rate was half a cord per acre per year, and the rotation age was assumed to be sixty years divided in three twenty-year cutting cycles. In practice the annual cut has been about 130,000 cords per year from 1926 to 1934.

The justification given for this overcut was that most of the stands were mature. Consequently, overcutting during the first cycle was necessary to remove the mature timber, and also to adjust the stand into three age groups - reproduction, immature and mature.

There was little difficulty in determining a suitable cutting method for conifers in the Yellow Birch-Balsam-Spruce cover-type. The standard, as prescribed by the Quebec Forest Service, cutting to a seven-inch diameter limit, has proved to be satisfactory where no provision can be made for removal of a portion of the hardwood. The remaining stand is fully protected from the wind, and as soon as the uncut poles and saplings enter the upper-crown their growth becomes rapid and these give promise of a second cut during the second cycle. (9)

The diameter limit system was tried in the Balsam-Spruce-Yellow Birch stands, but with disastrous results. Invariably the remaining stand was windthrown with a serious loss as a consequence. The material was too small to permit any salvage operation. Where straight clear-cutting, or clear-cutting in strips was applied, a windfall immediately followed, but in that case some salvage was possible. As a compromise clear-cutting in selected groups was adopted, and the location of each group was selected with a view to creating the minimum of exposure to the remaining stand. By this means one-third of the area is covered every twenty years, and the remaining two-thirds are less susceptible to wind damage than in virgin stands.

This group cutting system is probably unique in the pulpwood industry in Canada. Now the first cutting cycle is about complete on the Montmorency watershed, and as far as could be seen from cross-section view, not a single blow-down as a result of cutting is in evidence. (9)

Let us now describe a part of the Montmorency limits, the Creek La Foi, which we intend to log.

CHAPTER II

DESCRIPTION OF THE CREEK LA FOI AND CONDITIONS OF THE TRACT

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DESCRIPTION OF THE CREEK LA FOI AND CONDITIONS OF THE TRACT TO BE LOGGED

1. Description and Area.

Four miles up to the confluence of the Montmorency and Snow Rivers the truck-road meets the Brule River, principal tributary of the Snow River. The Brule River itself has many tributaries, among which we find the Creek La Foi, a drivable stream which drains a valley of irregular form and receives the waters of two small lakes: La Foi and L'Esperance, located in the center. The total area of that valley is about four square miles. On both sides of the lakes this valley is about 9,000 feet wide, but in the northern part it is only 4,000 feet wide. For logging purposes this territory has been divided into seven blocks with regard to topography, small streams and volume of pulpwood. The area of these blocks is as follows:

Block I	261	acres
" II	402	"
" III	394	"
" IV	312	"
" V	314	"
" VI	304	"
" VII	393	"

Each of these blocks will constitute a unit for logging operations.

A. Topography: - Like the region of the Laurentian Shield, this valley has a rough topography. The level varies from 2,300 to 3,200 feet and slopes are sometimes very steep. The map shows that the northern part of the tract is the most hilly, the slopes having a grade of 30 to 40 percent. On the sides of lakes slopes are more smooth and their grade varies between 10 and 20 percent. These ground conditions called for a special care of road location and logging practices. We must say also that steeper slopes often tend to be very rocky. In places the footing is very treacherous because of underlying beds of rock covered by only thin soil or moss. Footing for horses in such places is very hard, and only skidding on snow can be done in such places.

B. Soil: - The soil cover, except around the lakes and lower slopes, is usually thin. All this region is covered by sandy soil which contains a large amount of stones and boulders. This soil has a low quantity of slime and clay, although in some places it has a tendency to be clayey. Its composition recalls to mind that it was at one time handled by glaciers. Around the lakes and on lower slopes the soil is heavier and its texture richer.

The subjacent layer, as shown by the rocky levellings, is composed of granitic gneiss. Although little study has been done of these soils it is true that the regeneration after cuts in the same region has been very satisfactory. For instance, on a watershed next to the one under study at present, a dense regeneration of fir covered the soil five or six years after cutting.

C. Climate: - The climate of this region is temperate; v.z. characterized by a cold winter and a warm summer. During winter the mercury sometimes drops to -30° F.; although usually it does not fall below -5° to -6° F. We can say that this climate is nearly the same as that of the St. Lawrence region. Another factor important enough to mention is that the insolation is sufficient to guarantee the normal growth of the forest.

As this region is situated in a watershed which drains many lakes and the action of the Laurentian's winds facilitates the condensation of vapor of the atmosphere, the precipitation is sufficient. A more complete study of this subject made on the Montmorency watershed shows a precipitation of about 30 inches between April and November and a snowfall of 4 to 5 feet during the winter season. This precipitation is not only favorable to the growth of trees but allows advantageous skidding in winter and driving in spring.

D. Site-types: - The following notes have been borrowed from a special study on site-types and rate of growth at Lake Edward, Champlain County by Mr. R. G. Ray. (8) As the conditions of our region are very nearly the same as the Lake Edward Region we feel that the same classification for forest-types is justified.

The term "forest-type" is generally understood to denote forest cover-type, but the meaning intended above is the site-type (growth-quality type) which may be identified by certain associations of plant species. The term "site-type" will be used hereafter in that sense, as distinguished from cover-type. The following site-types are recognized in ascending order of quality.

(1) Kalmia-Ledum and Sphagnum-Oxalis: - Swamp types are of little importance in this region, and only the best of each supports a merchantable stand of timber. The former is black spruce swamp or muskeg type, the latter is a higher type containing some hardwoods as well as balsam fir and spruce. The vegetation is generally composed of dense alders and a complete ground-cover of sphagnum moss.

(2) Cornus; (Softwood): - This type is found on steep hillsides and cliffs, on borders of swamps and streams. In the main stand the principal species is balsam fir, followed by yellow birch; hardwoods, among which yellow birch predominates, are less than 20 percent by volume.

(3) Oxalis-Cornus; (Softwood-Hardwood): - On this site-type the ground is usually level to moderately sloping, fairly well drained, and moist. This is the optimum site for balsam fir, all things considered. It has a greater volume than spruce in the main stand, and it is far more abundant than in any other type. Yellow birch amounts to 25 percent of the total volume of the stand, but its percentage of defect is very high.

(4) Viburnum-Oxalis; (Hardwood-Softwood): - This type is found on the upper levels of well-drained hillsides or hilltops, where the forest cover is about 75 percent hardwoods. Indicator species are not as frequent as they are in the lower types because of the thick leaf litter. This type is favorable for the growth of conifers, but it is still more so for hardwoods, so that in the ensuing competition conifers do not win through as they generally do in the Oxalis-Cornus type.

Then, as we said in the first chapter, the territory of Creek La Foi is at the interference of two regions, say between the limit north of the Great Lakes-St. Lawrence Forest Region and the Boreal Forest Region. We meet again the yellow birch, but the predominance of balsam fir and white spruce reveals the greater influence of the Boreal Forest Region.

2. Volume.

In the spring of 1940 the forest engineers of the Anglo-Canadian Pulp & Paper Company made a cruise of the area of Creek La Foi. The data and maps which appear in this work have been kindly supplied by that company. * The territory has been divided into seven blocks with consideration of the topography and the volume of pulpwood available. The cruise considered the softwood stands only and the following classifications, as shown on the map, have been made:

Softwood No. 1	SW	This type is made of any combination of species, but with a stand per acre of 12 cords or more.
Softwood No. 2	SW^2	This stand varies from 5 to 12 cords per acre.
Softwood No. 3	SW^3	This stand varying from 3 cords up.

The volume found by this cruise is as follows:

Block No.	Area in Acres	No. of Cords (90 c.f.)	Average Cords per Acre
I	261	2,583	9.9
II	402	4,403	10.9
III	394	1,923	4.8
IV	312	2,041	6.5
V	314	2,209	7.0
VI	304	4,457	14.7
VII	393	3,314	8.4

We have now a fairly good description of the Creek La Foi, and of the conditions which prevail on the area we intend to log. Let us now consider what will be the most economical way of logging this area of four square miles.

* The author is specially indebted to Mr. J. O. Wilson, Wood Manager, and Mr. E. Porter, Chief Forester of the Anglo-Canadian Pulp & Paper Co., for useful information and maps supplied.

CHAPTER III

HORSE-SKIDDING AND TRUCK HAULING

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HORSE SKIDDING AND TRUCK HAULING

The transportation problem has been and remains always the headache of forest engineers. In the pulp and paper industry factors of costs are generally well under control, so that it is possible to estimate the cost from the stick running into the mill to the paper produced with some degree of accuracy, but the big variable is the logging cost, the cost of transportation from the stump to the mill, which differs with every "chance" and local conditions. Good judgment in the determination of the best methods, equipment and personnel to be used is of very great importance, and it is often a serious problem as to whether tractors, trucks or other methods of transportation may be used to advantage. (1) Frequently combinations of transportation systems must be employed and each one used where it will handle the wood on the cheapest basis. When the timber to be moved is close to existing transport facilities, such as drivable streams or public roads, efficient management of the pre-haul operations is all that is required to keep costs at a satisfactory level. As long as the major transportation facilities have to be developed by the logger, then the cost of the transport system, of hauling on that system, and of pre-hauling all have to be kept in balance. (4) Careful planning of the whole operation is then necessary if maximum economy is to be achieved, and success in planning is dependent upon a knowledge of costs which will permit accurate prediction of total costs under given conditions. Roads should be classified to service standards, and unit cost of construction of these roads and of hauling on them determined as accurately as may be possible. Likewise, the unit cost of prehauling on these roads with various types of machines must be available so that the road lay-out may be planned for maximum economy. The writer has fortunately been supplied with the data and costs appearing in this work, some kindly furnished by the engineers of the Anglo-Canadian Pulp & Paper Company, others adapted to the local conditions from different reports on logging operations. All the formulae used here have been borrowed from the text-book, "Cost Control in the Logging Industry" by D. M. Matthews.

1. Truck Hauling Cost.

The truck investment schedule from which operating cost have been developed are based on a schedule prepared for the Lake State region, but adapted to Quebec conditions.

Machine rate for truck (1½ ton load): 3 cords of pulpwood.
(Based on operating year of 2,000 hours and 3-year life.)

A. Fixed cost per hour: -

License and Insurance:	\$180 ÷ 2,000 =	\$0.09
Depreciation: Original cost:	\$1,800	
Less tires:	300	
	\$1,500	
Less wrecking value:	200	
To be depreciated:	\$1,300 ÷ 6,000 =	0.216
Labor: Drivers' wages:		.60
Helpers' wages:		.50
Total fixed cost per hour:		\$1.406

B. Operating cost per hour: -

Oil @ \$0.35 per quart - 10 qts. every 50 hrs.:	\$0.07
Repairs - average of \$400 per year:	.20
Greasing and Maintenance:	.03
Fuel (average):	.50
Tires: \$300 1,000 hours	.30
Total operating cost per hour:	\$1.10
Total hauling cost per hour:	\$2.50

The calculations for hauling cost per mile have been determined by means of the formula: $\frac{2\ HC}{mph \times L}$

HC = total hourly cost
mph = average speed maintained on the road
L = load of the truck
2 = round trip

For example, the hauling cost on Class I road will be:

$$\frac{2 \times \$2.50}{25 \times 3} = \frac{500}{75} = 6.6¢ \text{ per mile per cord.}$$

From similar calculations costs of hauling on roads of other classifications have been set up and are presented here:

Road Class	Speed mph	Construction Cost		Hauling Cost per Cord	
		Per station of 100 feet (dollars)	Per mile (dollars)	Per station of 100 feet (cents)	Per mile (cents)
I	25	$47.30	$2,500	0.12	6.6
II	20	38.00	2,000	0.16	8.3
III	15	30.00	1,600	0.21	11.1
IV	10	19.00	1,000	0.32	16.6
V	5	9.50	500	0.64	33.3

2. Determination of the Standard for the Main Logging Road.

From the schedule of truck hauling cost given we have seen that the hauling cost varies with the class of road which is in use. We know also that the choice of road class may be determined by different objectives, as fire protection, management, or only logging transportation.

In the present work the sole purpose of facilitating the transport of forest products has been considered, and the cost of construction charged off against the products moved over the road system. The standard to be adopted for a main logging road will be justified by the amount of wood to be moved over this road, and the application of the "break-even point" formula is all that is required to determine the standard which will be adopted. This formula, normally written $N = \frac{F' - F}{V - V'}$ can be written as Volume in Cords $= \frac{R' - R}{H - H'}$ where R' and R are cost of construction for two standards of service and H' and H are hauling costs on the roads built to the respective standards. (4)

First we have to decide between class I and class II standards. Substituting the value from the table we will have:

$$\frac{250{,}000 - 200{,}000}{8.3 - 6.6} = \frac{50{,}000}{1.7} = 29{,}411 \text{ cords.}$$

This means that this number of cords is required to warrant the Class I road. As the tract to be logged contains only 20,900 cords we are forced to eliminate this class of road and investigate between road-class II and III as follows: $\frac{200{,}000 - 160{,}000}{11.1 - 8.5} = \frac{40{,}000}{2.7} = 14{,}815$ cords. Then, as the road will carry a volume of 14,815 cords of pulpwood, the class II designation, at a cost of $2,000 per mile, is justified. We must also take note of the fact that we could determine the length of the road to be built on each class standard by the amount of pulpwood to be moved on it. The same calculations made for class III and IV have determined that 10,904 cords to be moved will justify the class III designation.

The volume of pulpwood and the localization of skidding or spur-roads on the map allowed us to feel that:

90 chains will be built at class II standard.

65 " " " " " " III "

62 " " " " " " IV "

The length of each part of this road being established by a map-measure. For the class IV designation, the length has been determined by means of the break-even point for hauling with truck and horse skidding. Then the point at which both costs are the same determines the limit of the truck road system. Each one of these class standards is shown in different color on the map.

3. The Access-Road.

To reach the tract to be logged, an access-road must be built for a distance of two miles. The class II designation is therefore allowed because all the pulpwood will be moved on that road.

4. Pre-hauling Transportation and Spur-Roads.

As the present logging plan demands, we must now determine the most economical way to carry out the pulpwood to the main truck road. Three kinds of machines - truck, tractor and horse - may be used for this minor transportation, and a complete study and comparison between their cost is necessary to fix the best one.

In the first we will compare the tractor with the horse prehauling. Let us study the cost of each machine.

A. Machine rate for tractor (Caterpillar D 4): - This cost is based on charges made by the Anglo-Canadian Pulp & Paper Company when the company leases a similar tractor. The daily charge is $40 for an eight-hour day, all expenses included. We found this cost accurate, and we assumed that the hourly cost is about $4.20 per hour. The following machine rate has been determined for an average haul of half a mile.

Loading and unloading time:	30 minutes per turn
Delay time:	10 " " "
Total fixed time:	40 " " "
Load per turn:	5 cords (on sleds)
Total fixed time per cord:	40' 5 cords 8 minutes

Cost per minute: $4.20 ÷ 60 = 7¢
Fixed cost per cord: 7¢ x 8 minutes = 56¢

Variable time per turn: 52 minutes
" " " 100 feet: 52' ÷ 52 = 1 minute
" " " cord: 1' ÷ 5 cords = 0.2'

Variable cost per cord per 100 feet of distance: 0.2' x 7¢ = 1.4¢.

That is to say that for every cord of pulpwood moved by tractor the cost per cord will be 56¢ plus 1.4¢ for every 100 feet of hauling distance.

B. <u>Machine rate for horse</u>: - If the pulpwood is skidded to the main truck road by single horse and teamster on snow road the following data are available. Loading and unloading (done by the teamster): 45 minutes per turn. Variable time per turn: (skidding distance ½ mile) 35 minutes.

Total time per turn: 80 minutes
Load per turn: 1.5 cord
Average number of trips per day of 8 hours: $\frac{8 \times 60}{80} = 6$ trips

Daily production: 6 trips x 1.5 = 9 cords.
Hourly cost for teamster and horse: $1.00
Cost per minute: $1 ÷ 60 = 1.66¢

Fixed cost per turn: 45' x 1.66¢ = 75¢
" " per cord: 75¢ ÷ 1.5 = 50¢

Variable time per 100 feet of distance: 35' ÷ 26.4 = 1.33'
" " per 100 feet per cord: 1.33' ÷ 1.5 = 0.9'

Variable cost per cord per 100 feet: 0.9' x 1.66¢ = 1.5¢

Then for every cord of pulpwood skidded by horse it will cost 50¢ plus 1.5¢ for each 100 feet of hauling distance.

Using the break-even point we can now determine which of these two machines should be used economically, and find the distance at which the pre-hauling cost is the same for both.

Substituting the value of each letter in the formula: $N = \frac{F' - F}{V - V'}$, we will have: $\frac{56¢ - 50¢}{1.5 - 1.4} = \frac{6}{.1} = 60$ Stations (of 100 feet). This means that if the skidding distance is 6,000 feet or more the tractor will be used with economy, and if the skidding distance is less than 60 stations the pre-hauling will be made by horse and more economical. Examining carefully the hauling distance on each block we found that it is less than 60 stations; therefore the use of the tractor is out of the picture.

C. Pre-hauling with truck or horse: - The question now arises whether we can use the truck (1.5 ton) with advantage instead of skidding with horse. A fair answer can not be given without taking consideration of the volume of pulpwwod to be skidded and the length and cost of road on which each machine could be used. For a better study of this cost comparison two different blocks of the tract have been considered: Block V, with a volume of 2,200 cords to be hauled and a length of 4,000 feet, and Block VI, with a volume of 4,457 cords and a length of one mile as hauling distance. Each block has been studied separately.

Block V

A truck road (spur) could be built in the center of this block and the wood should be skidded to that road by horse during the winter. We could also skid all the wood by horse to the main truck road during the winter. The cost of the truck road will be about $400 per mile, and the cost of iced road for horses will be $200 per mile. If the spur road is constructed trucks instead of being loaded on the main road will be loaded on the spur road; then the fixed time for loading in woods and unloading at the delivery point is the same. But as the speed on these spur roads is only 4 mph the variable cost will be as follows.

We estimated that for a round-trip of a mile 15 minutes will be required; the variable time per 100 feet will be: 15' ÷ 26.4 = 0.56', and the variable time per 100 feet per cord: $\frac{0.56'}{3}$ = 0.186'

The variable cost " " " " " : 0.186' x 0.04 = 0.75¢

The fixed cost " " " " " : 96.2¢ (as determined later).

what are these costs?

We also know that horse skidding shows the following costs:

Fixed cost per cord:	50¢
Variable cost per cord per 100 feet:	1.5¢

Then the "break-even distance" will be determined by use of the formula:

$$D = \frac{F' - F}{V - V'} \quad \text{or} \quad D = \frac{96.2 - 50}{1.5 - 0.75} = 61.6 \text{ stations.*}$$

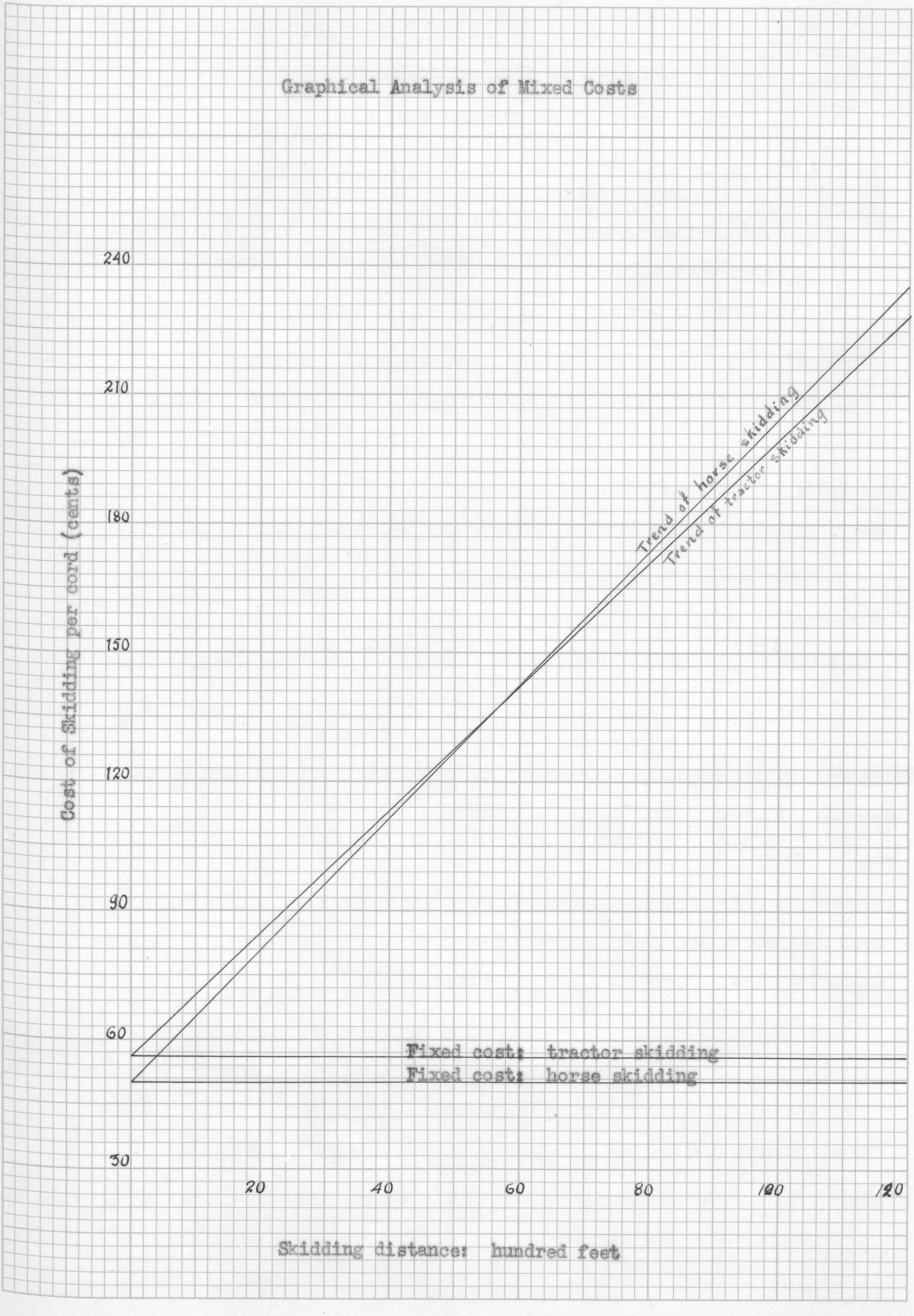
This means that where the pre-hauling distance averages 6,100 feet or less skidding by horse will be more economical than truck skidding. As the maximum skidding distance on Block V is about 5,300 feet, we can not use the truck for hauling.

Another proof can be made by the following calculation, using the comparative costs for the combination of two machines, truck and horse, and for horse skidding alone.

(1) Trucks running on spur road costing $400 per mile and horses skidding wood to this road where trucks are loaded.

Truck:	Cost per Cord
Hauling cost: $0.75¢ \times \frac{40}{2}$	15.0¢
Road cost: $\frac{40s \times 40,000¢}{52.8}$ = $308 ÷ 2,2000 =	14.0¢
Horse skidding:	
Fixed cost per cord:	50.0¢
Variable cost per cord: $1.5 \times \frac{26}{2}$ =	19.5¢
Total cost using both machines:	98.5¢ per cord

* The graphical analysis of mixed costs will indicate directly the relative economy of each device at various skidding distances. (Page 18)


Graphical Analysis of Mixed Costs
Cost of Skidding per cord (cents)
240
210
180
150
120
90
60
30
Trend of horse skidding
Trend of tractor skidding
Fixed cost: tractor skidding
Fixed cost: horse skidding
20
40
60
80
100
120
Skidding distance: hundred feet

(2) Horses skidding on iced road costing \$200 per mile or \$3.75 per station of 100 feet.

	Cost per Cord
Fixed cost per cord:	50.0¢
Variable cost per cord: 1.5¢ x $\frac{53}{2}$	39.7¢
Road cost: $\frac{40s \times \$3.75}{2,200 \text{ cords}}$	6.3¢
Total cost per cord for horse skidding:	96.5¢

Conclusion: The skidding with horse on iced road is the most economical system to adopt and a saving of: 98.5 - 96.5 = 2¢ x 2,200 cords, or \$44 will be realized for this block.

One could now say that if we can improve the road for the truck, we can also reduce the skidding cost by a higher speed. This can be estimated by calculating the net saving for hauling the 2,200 cords on these three different road standards. In this calculation we have used the trucking cost schedule which has been prepared for and appeared on page .

Road Class	Average Speed m.p.h.	Cost per Mile	Saving on 2,200 Cords		Net Saving
V	4	\$400	22 x \$41.67	\$916.74	\$516.74
IV	10	1,000	22 x \$66.67	\$1,466.74	466.74
III	16	1,600	22 x \$72.92	\$1,604.24	4.24

Conclusion: The only road class standard to be used will be Class V, because the net saving is higher than on the others and it remains that the most economical skidding system to adopt will be horse skidding on iced roads.

Similar calculations have been made for Block VI, as follows:

Block VI (4,457 cords to skid)

Using the trucking cost schedule (p.20), we see that for this block we can improve the road and reduce the skidding cost. The length

TRUCKING COST SCHEDULE

Average round trip speed in m.p.h.	Hauling cost per 100 cords per mile	Cost reduction per 100 cords per mile resulting from increased speed - Cumulative from various base speeds.					
		Base speed in m.p.h.					
		2	4	6	8	10	12
2	$83.34						
4	41.67	$41.67					
6	33.34	50.00	$8.33				
8	20.84	62.50	20.84	$12.51			
10	16.67	66.67	25.00	16.67	$4.16		
12	13.88	69.46	27.79	19.46	6.95	$2.79	
14	11.90	71.44	29.77	21.44	8.93	4.77	$1.98
16	10.42	72.92	31.25	22.92	10.41	6.25	3.46
18	9.26	74.08	32.41	24.08	11.57	7.41	4.62
20	8.34	75.00	33.33	25.00	12.49	8.33	5.54
22	7.57	75.77	34.10	25.77	13.26	9.10	6.31
24	7.00	76.34	34.67	26.34	13.83	9.67	6.88
26	6.41	76.93	35.26	26.93	14.42	10.28	7.49
28	5.95	77.39	35.72	27.39	14.88	10.72	7.93
30	5.55	77.79	36.12	27.79	15.28	11.12	8.33

Hauling cost per 100 cords per mile calculated from formula: $Cost = \frac{2\ HC}{mph \times L} \times 100$

where HC = Hourly cost of truck - $2.50
L = Loading cords - 3 cords
mph = Average round trip travel speed of truck determined by

formula: $MPH = \frac{2 \times H \times L}{H \quad L}$

where H = Speed in mph on empty run
L = " " " " loaded "

of this block is one mile, and it is about 2,700 feet wide.

Road Class	Average Speed m.p.h.	Cost per Mile	Saving on 4,450 cords		Net Saving
V	4	$400	44.5 x $41.67	$1,854.31	$1,454.31
IV	10	$1,000	44.5 x $66.67	2,966.81	1,966.81
III	16	1,600	44.5 x $72.92	3,244.94	1,644.94

Then we may conclude that that Class IV road will be more economical because the net saving is greater than on the other standards. Now what will be the cost of skidding with truck on this spur road, horse skidding the wood to that road, and what will be the skidding cost by horse alone?

(1) Truck:

Hauling cost: $0.79¢ \times \frac{52.8}{2} =$ 20.8¢

Road Cost: $\frac{\$1,000}{4,450\ C} =$ 22.4¢

Horse Skidding:

Fixed Cost: 50¢

Variable cost: $1.5¢ \times \frac{13.5}{2} =$ 10.1¢

Total cost per cord: 103.3¢

(2) Horse skidding alone:

Fixed cost per cord: 50.0¢

Variable cost: $1.5¢ \times \frac{52.8}{2} =$ 39.6¢

Road cost: $\frac{20,000}{4,450} =$ 4.5¢

Total cost per cord: 94.1¢

Conclusion: Since horse skidding is cheaper than the combination of truck and horse, the truck cannot be used on any of the blocks of this area before the same study has been made for each of them.

5. Estimation of Costs.

- Thus far we have determined the most economical methods of major and minor transportation under the present logging plan, and we have compared the costs of each of them. What is the cost of all the operation and all its phases? The following lines will try to answer that question.

A. Felling and bucking: - The cost of felling anc bucking has been fixed at \$2.50 per cord. This price is actually paid in present logging operations in the Province of Quebec. We must say that this price includes many operations, such as felling, bucking, piling sticks on road-sides and clearing branches and brush to prepare horse-road for skidding during the following winter. These horse-roads are established by the camp foreman before the operation of felling. It is customary that one man work alone for felling and bucking trees, but sometimes two men are working together.

Cost per cord for felling and bucking: \$2.50

B. Horse skidding: - The cost of skidding by single horse and sled on snow roads has been calculated as follows: As determined previously, the hourly cost for a driver and his horse has been fixed at \$1.00 per hour. (6) The fixed cost determinated at \$0.50 per cord, with an average load of 1.5 cord, and the variable cost at 1.5¢ per cord per 100 feet of hauling distance. The average skidding distance has been measured on the map with a map-measure, and the cost determined by use of the formula: $F + C\frac{D}{2}$ where F is the fixed cost per cord, C the variable cost per cord per 100 feet of distance and D the maximum skidding distance. For example, on Block V we found that the maximum skidding distance is 5,300 feet; then the cost of skidding for this block is: $F \quad C\frac{D}{2}$ or $50¢ + 1.5\frac{53}{2} = 89.7¢$ per cord. To the present cost of skidding we must add the cost of the road on which the wood is to be moved, and this cost varies with the number of cords to be skidded on each block. The cost of snow road and its maintenance during the season is estimated at $200 per mile, or at $3.75 per station of 100 feet. For Block V we found that a road of 40 stations should be sufficient to serve this area; then dividing the total cost of road by the number of cords to be carried on it we have the cost per unit or by cord:

$$\text{Cost of road: } \frac{40S \times \$3.75}{2{,}200 \text{ cords}} = 6.8¢ \text{ per cord.}$$

We can now add this cost to the cost of skidding and determine the total cost of skidding for this block, which is: 89.7¢ 6.8¢ 96.5¢

Similar calculations have been made for each of the seven blocks of the tract to be logged and give the following figures:

Block:	I	II	III	IV	V	VI	VII
Cost of Skidding per cord (cents)	92.1	68.7	94	86.8	96.5	94.1	86

C. Truck hauling cost determination: - All the pulpwood piled on both sides of the main truck road will be transported to the mill. What will be the trucking cost per unit for each one of the blocks? As we said previously, this cost will vary with the standard of road on which the wood is to be moved and the cost of the road itself. It is true that all the wood will pass through the highway and the access-road on which trucks maintain a speed of 20 miles per hour, but into the tract various classes of roads appear and the length of these roads is not the same.

The first step is to determine the fixed and the variable cost of trucking per unit. Using the machine rate previously determined, the trucking cost will be as follows:

Trucking Cost Determination

Load of the truck: 3 cords	Time per trip	Per cent
Loading, unloading and delay time	1.2 hr.	26%
Average distance of hauling: 38 m. at 20 mph	3.4 "	74%
Total trip time:	4.6 hrs.	100%

Average number of trips per day: 9 hrs. ÷ 4.6 = 2 trips

Estimated average production per day: 2 trips x 3 cords = 6 cords.

We can now determine the variable and fixed cost per unit distance for trucking:

Total turn time:	276	minutes
Fixed " " :	72	"
Variable " " :	204	"

Cost per minute: $2.50 ÷ 60 = 4.01¢

Fixed cost per cord: $\frac{72 \text{ m. x } 4.01¢}{3 \text{ cords}}$ = 96.2¢

Variable time per mile: $\frac{276'}{38}$ = 7 minutes

Variable cost per mile per cord: $\frac{7' \text{ x } 4.01¢}{3 \text{ cords}}$ = 9.3¢

Variable cost per 100 feet per cord: $\frac{9.3¢}{52.8}$ = 0.18¢

These fixed and variable costs have been used previously to determine the standard of roads to be built for the main logging road and to compare the skidding cost between the truck skidding and horse skidding.

Let us now consider the hauling of wood for Block III to determine the truck hauling cost.

All the pulpwood of this block will be carried on the highway for a distance of 34 miles, on the access-road for 2 miles, on the Class II standard road for 1 1/8 miles and on a Class II standard road for a distance of 65 chains. As the cost is the same for hauling on the highway, the access-road and Class II road, we can say that the hauling cost for this distance will be: $\frac{2 \text{ x } 2.50}{20 \text{ x } 3}$ = 8.3¢ per cord per mile, and as the hauling distance on these roads is 37 1/8 miles we will have: 8.3¢ x 37 1/8 $3.091, which is the hauling cost per cord on these roads. But on the Class III road the speed is only 15 m.p.h.; then the cost per cord is now: $\frac{2 \times 2.50}{15 \times 3}$ = 11.1¢ per cord, and the hauling distance is 65 chains. Then the hauling cost per cord for this part of the road will be: 11.1¢ x $\frac{65}{80}$ = 9.2¢. This cost added to $3.091 will give a total hauling cost of $3.182 for the wood of Block III.

The same calculations have been made for each block and gave the following figures:

Block	Cost of Skidding per Cord
I	$3.091
II	3.091
III	3.183
IV	3.21
V	3.23
VI	3.23
VII	3.23

As we have seen, the hauling cost varies directly with the distance of hauling, and the hauling cost per cord varies indirectly with the speed maintained by the machine on each class road. In the calculation of this cost we have used the formula: $\frac{2\ HC}{m.p.h. \times L}$ of which we have spoken in the preceding chapter.

Let us now estimate the road-construction cost.

D <u>Road construction cost</u>: - A foregoing discussion has determined the various standards of road to be chosen for the access-road and different parts of the hauling roads. The cost will be as follows:

Class road	Cost per mile	Length of road to be constructed	Total Cost
Access Road II	$2,000	2 miles	$4,000
Interior Road II	2,000	1 1/8 miles	2,250
" " III	1,600	65 chains	1,300
" " IV	1,000	62 chains	775
		Total cost:	$8,325

Cost per cord: $8,325 ÷ 20,900 = 39.83¢

E. Maintenance of the hauling road: - An amount of $500 per year must be reasonably estimated to take care of this road for each season. Then the cost of maintenance for 2 years of operation will be $1,000.

Cost per cord: $1,000 ÷ 20,900 = 5¢ approximately.

F. Camp cost: - The first step is to determine which blocks will be cut and skidded each year. That is to say, how many cords will be cut and skidded each year. This distribution has been made in regard to the site of lakes and the amount of pulpwood on each block. As camps will be located near the dams to be built on each lake it is necessary that half of the total cords be cut and skidded by both camps each year. We have also taken into account the construction of the hauling road which will be used for both camps and all the area during the two years of logging operations.

	Block to be Cut & Skidded	Number of Cords
1st Year:	I	2,583
	III	1,923
	IV	2,209
	VII	3,319
Total		10,028 cords

This number of 10,028 to be distributed as follows:

Camp I: Block I & III 4,506 cords

Camp II: Block V & VII 5,528 "

	Block to be Cut & Skidded	Camp	Number of Cords
	Block II	I	4,403 cords
2nd Year:	" IV	II	2,041 "
	" VI	II	4,457 "

Then in Camp I 4,506 cords will be cut during the first year
and 4,403 " " " " " " second "
And in Camp II 5,528 " " " " " " first "
and 6,498 " " " " " " second "

We can now determine the number of men required for cutting. A man cuts an average of 2 cords daily, and the cut is made in the autumn from August to October. The average number of working days every month is 22 days; then a period of three months, or 66 days, and 4,506 cords to be cut will require: 4,506 ÷ (66 x 2) = 34 men (in practice we can say 40 men).

The same calculations have been made for each camp for each year, and the results are as follows:

		Number of Cords	Number of Men	Days of Cut
Camp I	1st year	4,506	40	66
" II	1st "	4,403	40	66
Camp I	2nd "	5,528	50	66
" II	2nd "	6,498	60	66

Then Camp I will be built for 40 to 50 men, and Camp II for 50 to 60 men. The cost of each camp will be:

Men's camp:	30' x 50'	1,500 sq. ft.
Kitchen:	30' x 50'	1,500 " "
Office:	20' x 20'	400 " "
Stable:	25' x 50'	1,250 " "
Blacksmith shop:	20' x 20'	400 " "

5,050 sq. ft. @ 20¢ =	$1,050
Contingency	50
	$1,100

Then the construction of the two camps @ $1,100 = $2,200

Cost per cord: $2,200 ÷ 20,900 = 10.4¢

G. Supervision: - A forest engineer will supervise all the operations each year.

Time for cut:	4 months (1 extra month allowed)	
" " skidding:	1.5 months	
	5.5 months x 2 years = 11 months	

Wages: 11 x $300	$3,300
Board & traveling expenses	700
	$4,000

Cost per cord: $4,000 ÷ 20,900 = 19.1¢ per cord.

H. Scaling: -

Cut:	1 scaler @ $175 x 3 months	$525
	1 ass. scaler @ $125 x 3 months	375
Skidding:	2 scalers @ $175 x 1 month	350
	2 ass. scalers @ $125 x 1 month	250
	Total per year	$1,500

Cost per cord: $3,000 ÷ 20,900 = 14.4¢

I. Foreman: -

Cut:	4 months (1 month allowed to prepare the operations)
Skidding:	1.5 "
	5.5 " per camp each year.

22 months of labor x $150 = $3,300

Cost per cord: $3,300 ÷ 20,900 cords = 15.8¢

J. Cook & Helpers: - For each camp one cook and one helper will be necessary all the time of cutting and skidding operations.

Cutting:	3 months
Skidding:	1.5 "
	4.5 " x 2 camps = 9 months

Cook:	9 months x $180	$1,620
Helper:	9 " x $100	900
		$2,520 per year x 2 = $5,040

Cost per cord: $5,040 ÷ 20,900 = 25.8¢

K. <u>Clerical Expenses</u>: - One clerk for each camp will be required:

Cutting:	3 months		
Skidding:	1.5 "		
Total	4.5 "	x 2 camps x 2 years	18 months

$125 x 18 = $2,250

Cost per cord: $2,250 ÷ 20,900 = 10.8¢

L. <u>Blacksmith and Barn-boss</u>: - During the skidding one blacksmith will be required at each camp for repairs, and a barn-boss will also be required for the stables.

Blacksmith:	1 month x 2 camps x 2 years	4 months	@ $150 =	$600
Barn-boss:	1 " x 2 X x 2 "	4 "	@ $100	400
				$1,000

Cost per cord: $1,000 ÷ 20,900 = 5¢

M. <u>Firewood for camps</u>: - One man with one horse will be required to serve each camp during the two years' operations. His work will start one month before cutting to secure the wood necessary for the beginning of the cut.

An amount of $1,000 per year for each camp is estimated to pay for labor and stumpage of that wood.

Total expenses for fire-wood: $4,000

Cost per cord: $4,000 ÷ 20,900 = 20¢

N. <u>Insurance for workers</u>: - The Labor Accident Law of the Province of Quebec requires 8% of all wages paid to protect the workers.

Supervision:	$3,300
Scalers	3,000
Foreman:	3,300
Cook & Helpers:	5,040
Clerical:	2,250
Blacksmith:	1,000
Cut: 20,900 x $2.50	52,250
Skidding: " x 90¢	18,810
Total Wages	$88,950

($88,950 x .08) ÷ 20,900 cords = 34¢ per cord.

6. <u>Total Cost of Logging.</u>

If we gather the foregoing costs established we will have the total cost per unit or per cord under the present logging plan. For the variable costs of skidding and truck hauling we have determined an average cost for each transportation system. These costs added to the others have given an average total cost of $8.75 per cord delivered to the mill, and we estimated that cost very accurately.

7. <u>Stumpage Appraisal.</u>

As the foregoing costs have been estimated with accuracy we believe that they meet all possible contingencies and risk. Therefore, substracting this total cost from the price paid by the company for the pulpwood delivered to the mill we will have: $10 - $8.75 = $1.25, which should be the value of stumpage of the wood under the present plan. Is there another transportation method which will be more economical? That is what we will study in the following chapter.

CHAPTER IV

HORSE-SKIDDING AND DRIVE

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HORSE SKIDDING AND DRIVE

Instead of carrying the pulpwood out by truck, the present plan will show that the most economical process of transporting wood-sticks is "by floating them in loose aggregations in water with the motive power supplied by the natural or flushed stream flow." (2)

All the pulpwood cut during the summer will be skidded by horses on snow or ice covered roads and yarded up in piles on both lakes or banked along the stream below the splash dams during the winter. An access truck road will be constructed to carry all the material necessary for the cutting, skidding and driving seasons from the highway to the camps, and a splash dam will be built on each lake to raise the level of the stream. We will now discuss in this second plan the cost of skidding on each block and explain other operating costs which must be added to felling and bucking costs.

1. Horse-Skidding.

In the first logging plan all the pulpwood was skidded to the truck road and loaded on trucks, but in this plan all the wood must be skidded to the lakes or on the banks of the stream; then the average skidding distance for each block will vary; for some blocks it will be greater, for others smaller. For example, on Block VI we found that the skidding distance was one mile and the cost of skidding and road was 94.1¢ per cord on the first logging plan. Now, the skidding distance will be 64 stations, or 6,400 feet; then as the road costs are 4.5¢ per cord we must calculate a new cost for skidding:

Fixed cost per cord:	50¢
Variable cost per cord: $1.5¢ \times \frac{64}{2}$	48¢
Road cost:	4.5¢
Total cost per cord for Block VI:	$1.025

The same calculations have been made for each block of the area and variable cost of skidding established as follows:

Block:	I	II	III	IV	V	VI	VII
Cost of skidding: per cord in cents	95.2	70.4	91.6	86.8	98	102.5	114

For the tract a weighted cost has been determined and shows a cost of 93.7¢ per cord. Under this plan this is the only cost which is variable, depending as it does on the distance of skidding for each block. Other costs, such as supervision, kitchen, clerk, and so on, as we will see later, will not vary for each block as they are established on the number of cords to be handled which is the same for both logging plans.

2. <u>Drive Possibility.</u>

The conditions which should be present for successful stream driving are as follows: (2)

A: - An ample and reliable water flow, preferably throughout the season, but at least a sufficient seasonal supply in the spring. Advantages are generally taken of spring freshets and the additional supply from the melting of the winter snows.

B: - The stream should be sufficiently wide to take the longest logs. In our case the four foot pulpwood is the ideal size for stream driving.

C: - Steep, high banks along the water-course are much preferred. Sloughs, marshes, low banks subject to flooding or overflow are not desirable because of the possibility of loss of logs.

D: - There must be a sufficient volume of floatable species. Balsam and spruce are very light-weight drivable species.

E: - Swift currents without obstructions and curves which may cause jams present ideal conditions.

The Creek La Foi possesses all these conditions and, with some improvements in regard to the fifth one, it is judged as perfectly drivable. Many years ago two storage dams were constructed on these lakes by the Anglo-Canadian Pulp & Paper Company for driving purposes.

We can determine the driving possibility in the following manner: The area drained by the Creek La Foi is 2,379 acres, or 103,629,000 sq. ft., and the annual precipitation is 36". If 50% of this precipitation is allowed for the drive we will have 103,629,000 x 1.5' = 155,443,000 cubic feet of water. We assumed that with the gates of the dams open 100 c. f. per second will pass through, or 6,000 c.f. per minute. Then dividing 155,443,000 c.f. by 6,000 c.f. we will operate during 25,903 minutes. In practice, however, 66% of the efficiency is taken in account. Then 25,903 x .66 = 17, 268 minutes for driving time. We estimate that .75 cord runs through the gates every minute, and that 15 hours a day may be used for the drive. Then the number of cords to be driven each year will be: 17,268 x .75 = 12,950 cords; and the number of days required for this drive will be: 12,950 ÷ (15 x 60) = 15 days.

As we have only 10,400 cords to drive each year, the drivability will be assured, and with regular condition of temperature the drive will be done in fifteen days.

3. Improvements.

A. Dams: - At the outlet of lakes and on the headwaters of streams used for driving, from one to several dams are often constructed to furnish a reservoir of water. Concurrent with the melting of the winter's accumulation of snow and the spring rains the gates of these dams are opened to flush the stream below. On this elevated and swifter current of water the bolts, sticks, etc. are floated to the mill or to other means of transportation. Then at the outlet of each lake in the tract a splash dam will be built and local materials, such as logs, rock and earth, will be the chief sources of construction. The Rafter Type dam, as described by Brown (2) will be the best type because these dams will be used only for two or three year driving operations. They will be constructed during the summer or autumn preceding the drive, and the front of each dam site will be well grubbed out of all stumps, stones or vegetative material. The gate will be located in the center of each dam where maximum depth and rate of water flow will be found. These gates will be twelve feet wide and made of planks; squared logs, called "drops", which could be lifted separately by means of a capstan, will be placed horizontally.

The following summarizes the construction cost of each dam:

150 man-days for dam construction @ $.00 per day	$750.00
100 man-days to clear reservoir site @ $5.00 per day	500.00
80 team-days @ $4.00 per day	320.00
Value of logs used in the construction	200.00
Bolts, iron, nails, etc. & contingencies	130.00
Supervision	100.00
Total for each dam	$2,000.00
Total for two dams	4,000.00

Cost per cord: $4,000 ÷ 20,900 = $0.192

B. <u>Stream</u>: - The Creek La Foi, used ten years ago for driving, will need some improvement, especially between the lakes where there is a swamp. Here it will be necessary to erect a cribbing on each side of the stream to keep the sticks in the stream channel. The stream will also be cleared of any obstructions or accumulation of debris, floating trees, brush and rocks. Large rocks, leaning trees, sunken logs in the main bed will be blasted out or removed during periods of low water. The cost of such improvement, as estimated by an engineer of the Anglo-Canadian Pulp & Paper Company, should not be more than $1,00, including labor, tools, and dynamite.

Cost per cord: $1,000 ÷ 20,900 = $0.048

4. <u>Transportation of the Material.</u>

It is usually estimated that each cord of pulpwood requires thirty-five pounds of material for cutting, skidding and driving operations. This material consists of food, tools and all kinds of equipment necessary. For our logging plan we have to estimate the transportation for 20,900 cords; then, 20,900 x 35 lb. 731,500 lb., or 366 tons of material. This material will be transported by trucks to the access-road, and the cost of transportation on these 34 miles is as follows:

Cost per ton-mile: $\frac{2 \times HCL}{mph \times L}$ (formula developed by Mr. Matthews) (4)

$$\frac{2 \times \$2.50}{20 \times 5 \text{ tons}} = \$0.05 \text{ per ton-mile.}$$

Total cost per ton: $0.05 x 34 miles $1.70 per ton.

From the highway to the camps an access-road will be built, at a cost of $500.00 per mile, on which trucks shall maintain an average speed of five miles per hour. The cost of transportation on this road will be:

$\frac{2 \times \$2.50}{5 \times 5 \text{ gons}}$ = $0.20 per ton-mile, for 4 miles then: $0.80

Cost of road will be $500 x 4 miles = $2,000

Total cost of transportation per ton: $1.70 + $0.80 = $2.50
Total cost of transportation for the material:
$2.50 x 366 tons $915.00
Cost of road: 2,000.00

Total cost for the operations: $2,915

Cost per cord: $,915 ÷ 20,900 = 13.9¢

5. Other Costs. -

In the following items we have put the costs for cutting and bucking first because they remain the same in this plan. To these costs we have added the different costs incurred by the driving operation.

Cutting and bucking cost per cord: $2.50

A. Supervision: -

The cost of supervison for cutting and driving:	$4,000
Supervision on drive, one month each year:	600
Total Cost:	$4,600

Cost per cord: $4,600 ÷ 20,900 cords = 22¢

B. Foreman: -

Cutting & skidding:	$3,300
Drive:	600
	$3,900

Cost per cord: $3,900 ÷ 20,900 = 18.6¢

C. Kitchen: -

Cutting & skidding:	$5,040
Drive: 2 cooks, 1 month, 2 years	720
	$5,760

Cost per cord: $5,760 ÷ 20,900 = 27.5¢

D. Clerk: -

Cutting & skidding:	$2,250
Drive: 1 clerk, 1 month, 2 years	250
	$2,500

Cost per cord: $2,500 ÷ 20,900 = 12¢

E. Drivers: -

Each year:
5 men on each lake: 10 men
20 men on the stream: 20 men
30 men

Labor: 30 x 22 days x 2 years 1,320 mand-days
As this work is hard and days long $6.00 per day will be paid,
then: 1,320 x $6 $7,920

Cost per cord: $7,920 ÷ 20,900 = 37.9¢

F. Fluming and Booming: - This pulpwood driven on the Creek La Foi, on the Brule River, the Snow River and the Montmorency River will come down to Mount Mill. At this place it will pass through a flume to get to the St. Lawrence River, on which it is boomed to the mill.

The cost of fluming and booming, as fixed by the Anglo-Canadian Pulp & Paper Company, is 90¢ per cord.

G. Insurance: - Amount of wages paid for cutting and skidding: $88,950. Surplus paid for dam construction, drive and sweep is as follows:

Supervision	$600
Foreman	600
Cook	720
Clerk	250
Drivers	7,920
Total	$99,040

The law of the Province of Quebec calls for 8 percent for the Labor Accident Commission, then we will have to pay:

$99,040 x .08 = $7,923.20

Cost per cord: $7,923.20 ÷ 20,900 = 37.9¢

H. Contingencies: - As the drive is not regular and sometimes requires more time than previously established, we believe that 20¢ per cord must be charged for contingencies.

6. Total Cost and Stumpage Appraisal.

If we gather all the different costs previously established, that is to say the fixed costs for all the operations exclusive of skidding and the variable cost of skidding itself, for which an average cost has been estimated, we will have the total cost per cord under the present logging plan. This cost is \$7.04 per cord delivered at the mill.

As the price paid by the company is \$10 per cord delivered to the mill, the stumpage value will be: \$10 - \$7.04 = \$2.96 per cord.

7. Conclusion.

In the beginning of this chapter we said that the present logging plan is the most economical one. Skidding with horse and driving gives us a value of \$2.96 per cord of pulpwood, instead of \$1.25 per cord as on the first logging plan. In practice this plan will be adopted instead of the other one.

CHAPTER V

SELECTIVE CUT

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SELECTIVE CUT

1. Determination of the Cutting Cycle.

The cruise made in 1940 has indicated that this area contained an average of 8.8 cords of pulpwood per acre. This is true and the volume estimated should be handled if clear-cutting were practiced, but it is not the intention of the Seminary to see such practice realized and they wish to operate on a sustained yield basis if economic advantages allow that policy. The present chapter, therefore, will study these advantages; that is to say, whether the investment made by a partial cut will be justified by the amount of the future crops.

To appreciate adequately the possibility of a sustained yield plan we need to know the rate of growth of this forest. Unfortunately we have no data on this subject; therefore we have assumed that the local conditions of this tract might be compared with those existing at Lake Edward County where a growth study has been made by Mr. Ray (8), and we have assumed that the rate of growth of our forest is 4.7 percent.

As we said previously, it is our intention to study the economic advantages of both plans, the first one by which we would practice clear_ cutting and obtain an actual crop of 20,900 cords of pulpwood, and the second that would allow a cut of 60% of the stand; that is to say, about 12,500 cords, immediately, and considering the effects of this selective_ cut will insure a rate of growth of 6%, which we believe should be equitable. In these conditions we could anticipate a new crop every 25 years forever. Then a clear-cutting will give us immediately 20,900 cords, and the selective-cut should allow an actual cut of 12,500 cords, and the same amount every 25 years.

To determine the cycle of 25 years, the following calculations have been made. If we cut 60% of the stand, we leave on the ground 20,900 - 12,500 = 8,400 cords of pulpwood in trees of low diameters. Considering the annual growth anticipated of 6%, and using the simple interest to insure the most conservative figures, the forest will grow at a rate of 8,400 x .06 = 500 cords annually. Then dividing the number of cords, 12,500, that we cut, by 500, the annual growth, we find that the area will be restocked every 25 years, and will allow at this period a cut of 60% of the stand.

Another method of calculating the cutting cycle should give us the same result - let us see. As we have actually 20,900 cords on 2,380 acres, each acre bears 8.8 cords of pulpwood. As we cut 60% of the stand each acre will give 5.2 cords, keeping 3.6 cords in young trees. The growth being 6%, we can anticipate an annual growth of 3.6 x .06 0.2 cords each year; and dividing 5.2 cords, that is to say the number of cords required to restock the forest, by the annual rate of growth, 12 cords, we find 25 years as the cutting cycle. These last calculations conform perfectly with the rate of growth in some regions of the Province of Quebec, which is about 17 cubic feet per year, or .2 cord.

2. Estimation of Costs for a Selective Cut.

We must first say that the most economical logging plan should be adopted for this operation, that is to say, horse-skidding for the minor transportation system and drive for the major transportation. We will now see what would be the cost of each operation in this plan.

A. Transportation of the material: - We remember that 35 pounds of material are required for each cord of pulpwood to be cut, skidded and driven; then for 12,500 cords we will have to haul 12,500 x 35 = 437,500 pound, or 220 tons of material (food, hay, tools, etc.)

The fixed cost of trucking that material has been fixed at $2.10 per ton; then the total cost will be: 220 tons x $2.10 = $462. But we must add the cost of the road which will be built from the highway to the farther camp. This cost is $500 per mile on a distance of 4 miles; then $2,000. The sum of these costs divided by the number of cords to be moved on that road will give the cost per cord for the transportation of all the material.

Cost per cord: $462 + $2,000 = $2,462 ÷ 12,500 cords = 19.7¢

B. <u>Felling and bucking</u>: - This cost will not vary with the volume to be cut, and it remains the same as previously established.

Cost per cord for felling and bucking: $2.50

C. <u>Skidding</u>: - If, in this plan, the skidding distance is the same that we established in Chapter IV, the cost of skidding will vary for each of the blocks. The cost of the snow-roads is not the same now because it varies inversely with the number of cords to be moved on the road. For example, on Block IV, the fixed and variable skidding costs were 80¢ per cord, and the cost of the road 6.8¢ per cord, because 2,200 cords were moved on the snow-road. But now we have only 1,320 cords to be moved on that road, which will cost the same amount of money. Then the new cost of road will be: $137.50 ÷ 1,320 = 10.4¢, which, added to the skidding cost, will give 90.4¢ for each cord skidded on this block.

Similar calculations have been made for each block and give the following figures:

Block	I	II	III	IV	V	VI	VII
Cost of skidding per cord (cents)	97.3	73.2	101.4	90.4	101.7	104.5	1.17

D. Maintenance of the road: - The road we have built for the transportation of the material will be maintained during one season; then we assumed that $500 must be allowed for this maintenance, which gives as the cost per cord: $500 ÷ 12,500 = 4¢

E. Camp buildings, equipment and tools: - We estimated that the same camps will be necessary for this selective cut at a total cost of $2,180 for both camps, cook-houses, offices, etc.; then the cost per cord will be $2,180 ÷ 12,500 cords = 17.4¢. The cost of equipment and tools has been fixed at $2,000 for both camps and gives as the cost per cord: $2,000 ÷ 12,500 = 16¢

F. Days required for cutting and skidding: - This selective-cut will be done in one year; then the distribution must be as follows:

	No. cords to cut	Blocks	Man-days	Men	Days
Camp I:	6,540	I to IV	3,270	50	65
Camp II:	5,960	V to VII	2,980	50	60

The cut, therefore, will be effectuated in three months with an average of 50 cutters per camp.

The time for skidding has been established as follows:

	No. cords to skid	Daily Prod.	Horse-days	Horses	Days
Camp I:	6,540	9	727	33	22
Camp II:	5,960	9	651	30	22

All the pulpwood will be skidded in a month (22 working days) with an average of 30 horses for each center. We can now determine the cost of supervision, scaling, kitchen, etc., which depends on the time for each logging operation. We must say also that the drive will be made in a month with the same number of drivers we have fixed in Chapter IV.

G. <u>Supervision</u>: - We have distributed the supervision for each operation in this manner:

Cut:	3.5 months	
Skidding:	1 month	
Drive	1 "	Then; 5.5 months @ $300 = $1,650

Cost per cord: $1,650 ÷ 12,500 = 13.2¢

H. <u>Scale</u>: - The amount to be paid to scalers and their assistants will be:

For cut:	3 months @ $300	$900
For skidding:	1 month @ $300	300
		$1,200

Cost per cord: $1,200 ÷ 12,500 cords = 9.6¢

I. <u>Foreman</u>: - A foreman will be necessary for each camp and for the operation of cutting and skidding we will have:

Cut:	3.5 months @ $150	$525
Skidding:	1 month @ 150	150
		$675

For both camps: $675 x 2 = $1,350

For the drive one foreman will be sufficient; then the total cost will be: $1,350 + $150 = $1,500

Cost per cord: $1,500 ÷ 12,500 = 12¢

J. <u>Kitchen</u>: - Wages will be paid to two cooks and two helpers during the cut and the skidding, but one cook and one helper could run the kitchen during the drive. The cost then will be:

Cut:	3 months x 2 camps x 2	12 @ $280	$3,360
Skidding:	1 month x 2 camps x 2	4 @ $280	1,120
Drive:	1 month x 1 camp x 2	2 @ $280	560
Total cost			$5,040

Cost per cord: $5,040 ÷ 12,500 = 40¢

K. Dam building and improvements: - As this selective cut will be made in a year, cheaper dams must be built, and we estimated that a sum of $3,000 and $1,00 for the stream's improvements are equitable.

Cost per cord: $4,000 ÷ 12,500 cords = 32¢

L. Drivers' wages: - We estimated that the drive could be made in a month, and with the same number of drivers as previously fixed. That is to say with five men on each lake and 20 men on the stream and the rivers for a period of 22 days of drive.

Total cost will be: 30 men x 22 days x $5 = $3,300

Cost per cord: $3,300 ÷ 12,500 cords = 26.4¢

M. Fire-wood: - The wood necessary for 5½ months and for each set of camps, including the cost of felling and stumpage is estimated at $2,000; then the cost per cord will be: $2,000 ÷ 12,500 = 16¢

N. Blacksmith and barn-boss: -

Skidding:	3 months @ $150	$450	for the blacksmith
	3 months @ $100	300	for the barn-boss
		$750	

Cost per cord: $750 ÷ 12,500 = 6¢

O. Insurance: - The amount to be paid for insurance is established on wages paid, which are as follows:

Supervision:	$1,650
Scale:	1,200
Foreman:	1,500
Cook & helpers:	5,040
Clerks:	1,125
Blacksmith:	750
Cutters:	31,250
Skidders:	12,250
Drivers:	3,300
Construction wages:	1,000
Total:	$59,065

As we pay 8% on this amount, we will have: \$59,065 x .08 = \$4,725.20 to give for the insurance.

Cost per cord: \$4,725.20 ÷ 12,500 = 38¢

P. <u>Clerk</u>: - One clerk will be required for each camp during the cut and skidding, but one clerk only during the drive could do the work. Then we will have to pay 9 months of wages at \$125 per month, or \$1,125.

Cost per cord: \$1,125 ÷ 12,500 = 9¢

Q. <u>Fluming and booming</u>: - The cost of transportation from the head of the flume to the mill, as previously discussed, has been fixed at 90¢ per cord.

R. <u>Contingencies</u>: To cover the risk of the logging operation and all other unexpected expenses we assumed that 20¢ per cord is equitable.

S. <u>Total cost and stumpage appraisal</u>: - If we gather all those costs we find that the total cost per cord on this selective cut is \$6.96. Then as we said, the company pays \$10 per cord for the pulpwood delivered to the mill, then the value of stumpage will be:

\$10 - \$6.96 = \$3.04 per cord

3. <u>Value of the Forest Under Both Plans.</u>

If we assume that 3% must be taken as the rate of interest for an investment on a long period we can estimate what will be the value of this tract on a selective cut as follows:

(1) Actual cut: 12,500 cord @ 3.04 = \$38,000

(2) Subsequent cuts: 12,500 cords every 25 years, capitalized at 3% will give: $\frac{12{,}500 \times \$3.04}{1.03^{25} - 1}$, using the formula $Co = \frac{Cn}{1.op^{n} - 1}$ (5)

The value of the future crops will be therefore:

$$38,000 ÷ 1.09 = $34,770

As the expenses for fire protection are $44 per year for the tract we have to subtract from the total value the amount necessary to pay these expenses each year; so we will have:

$\frac{\$44}{.04}$ = $1,100 to deduct.

Total value will be:

First cut:	$38,000
Following cuts:	34,770
	$72,770
Less expenses:	1,100
	$71,670

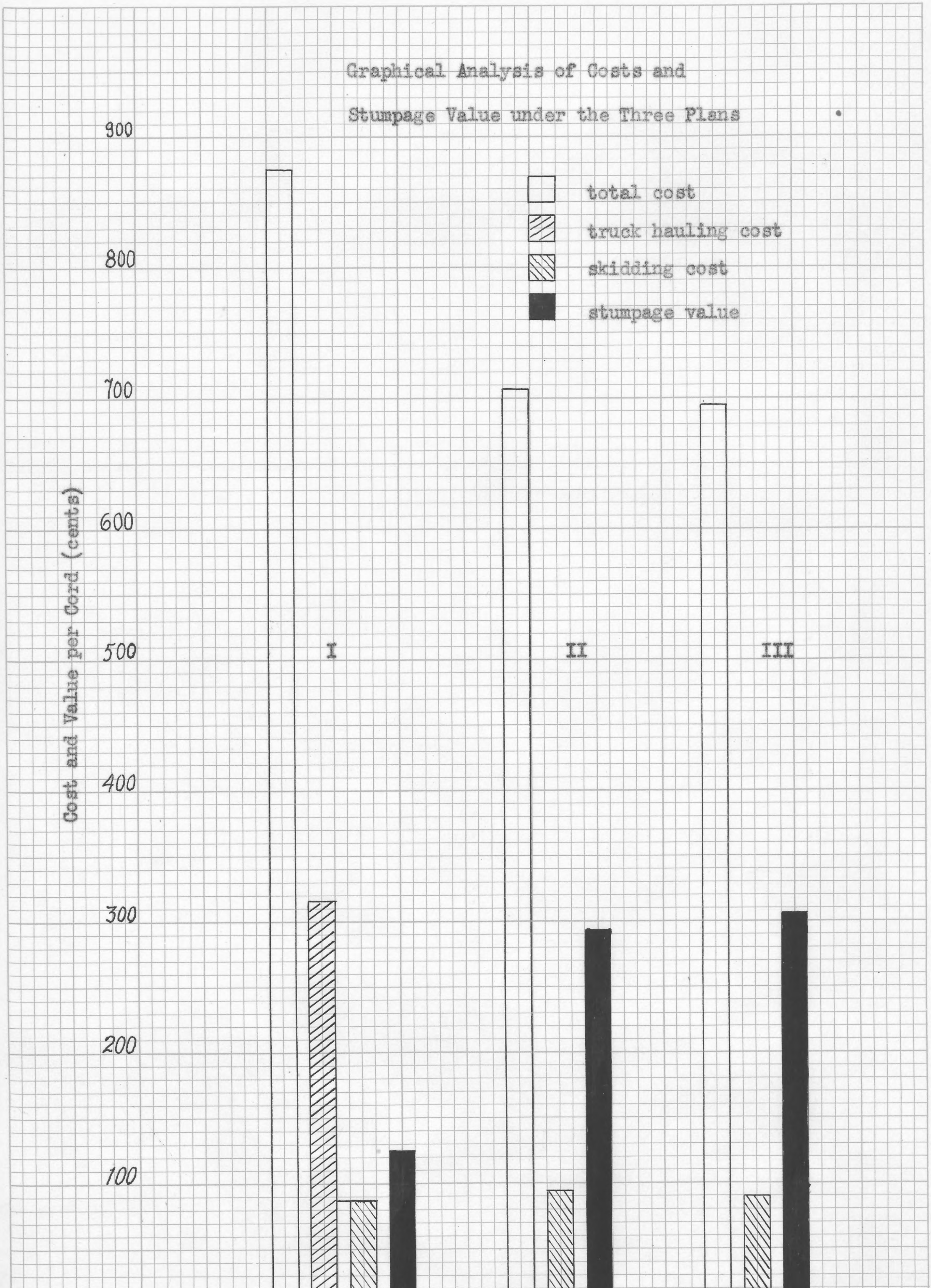
The value of the forest on a clear-cutting system will be:

$2.95 per cord x 20,900 = $61,555

<u>Conclusion</u>: - These calculations show that the value of the forest is greater on a sustained-yield system; therefore it will be preferable to cut 60% of the stand now and the same amount every 25 years thereafter.

Cost Schedule per Cord

	Horse-Skidding & Truck-Hauling	Horse-Skidding and Drive	Selective cut, Horse-Skidding and Drive
I Unchanged cost:			
Felling & bucking:	$2.50	$2.50	$2.50
II Changed costs:			
Skidding or pre-hauling:	0.867	0.94	0.98
Truck hauling:	3.18		
Dams' construction:		0.192	0.24
Improvements:		0.048	0.08
Material transportation:		0.139	0.04
Camp cost:	0.104	0.104	0.174
Camp equipment:	0.10	0.10	0.16
Supervision:	0.191	0.22	0.132
Foreman:	0.158	0.186	0.12
Kitchen:	0.258	0.275	0.40
Clerk:	0.108	0.12	0.09
Fire-wood:	0.20	0.20	0.16
Scale:	0.144	0.144	0.096
Drivers' wages:		0.379	0.264
Fluming & booming:		0.90	0.90
Insurance:	0.34	0.348	0.38
Contingencies:	0.10	0.20	0.20
Road & maintenance:	0.448		
Blacksmith & barnboss:	0.05	0.05	0.05
Total costs:	$8.748	$7.045	$6.966


Graphical Analysis of Costs and
Stumpage Value under the Three Plans
total cost
truck hauling cost
skidding cost
stumpage value
Cost and Value per Cord (cents)
900
800
700
600
500
400
300
200
100
I
II
III

CHAPTER VI

MANAGEMENT OF THIS FOREST

CHAPTER VI

MANAGEMENT OF THIS FOREST

In the foregoing chapters we have compared various logging plans and we have shown the financial results under these plans. The present work would be incomplete if it did not consider the possibility of planning on a sustained yield basis; that is to say, to look over a plan of management which should be adopted for this forest. Is this plan necessary in this case? What supplementary data should be required to adequately prepare such a plan? And what financial results would it give? The following lines will try to answer these questions without bias toward a particular line of action.

1. Is a Management Plan Necessary?

Every forest owner must consider the best possibilities in regard to his property. He cannot forget, for his own interest and for the community, that the forest is an investment which will give him the best income not only for the present year but in the future. His task, as defined by Roth (5): "is to take a piece of wildwoods and convert this gradually into a forest business which shall produce timber, as much and as good as the land and climate permit, and to have this timber in such a condition of age and arrangement that a crop may be cut each year, and thus an income secured in keeping with the investment."

It is also the task of foresters to promote sound forest management and to suggest ways and means of obtaining such policy. In Canada, as in the United States, "it is now very generally recognised that all the established forest industries have passed out of the pioneering stage when "cut out and move on" was regarded as the accepted procedure. We are now faced with the problem of keeping established mills continually supplied with wood. Our pulp and paper mills are fixed and have important communities dependent upon them. It is a matter of national importance to keep these mills going and assure to these dependent communities continuous and prosperous means of existence."*

Those words prove adequately the necessity for the owner of a forest property to face the problem of management for that property. This necessity is greater when the forest is accessible and when various markets must be found for the crops.

We believe that we have not to face here all three possibilities or lines of action that every forest owner must consider in regard to his property. The Seminary of Quebec, owner of large forest property for more than two hundred seventy-five years, will never be interested in selling these properties. However, the Seminary has obtained good revenues from this forest in the past, and it will be a good policy to secure the same income in the future.

The second line of action to look over should be the liquidation of this investment through destructive logging. Too often forest owners have fallen into that mistake. The actual income they received for their products blinded them and then they stared with amazement in the presence of cut-over areas and the prospect of waiting two or three generations for another crop.

* "Notes on Forest Management Problems", paper presented by J. O. Wilson to the Canadian Pulp & Paper Association, Woodlands Section; Dec.1944

A third possibility appears as the best one; that is to manage the forest on the basis of a permanent forest business in order to secure the future wood supplies of our established forest industries, and this in quantity and in quality by sound management. Silvicultural measures in young stands, involving cleaning and thinning, and the use of proper cutting systems to promote future natural regeneration and rapid growth, are all necessary measures to warrant the perpetuity of our forest. We hope that the foregoing lines have sufficiently proved the necessity of a management plan, and we will now consider what supplementary data would be required to prepare such a plan.

2. Supplementary Data Required for a Management Plan.

It would be a proud policy to make a detailed cruise of the area studied. Such a cruise should not cost too much and "is an essential factor of successful management, whether or not subsequent yields are expected from the area after it is first cut over". As Mr. Matthews said (5): "The extent to which a detailed survey and report can aid all lines of management has, up to the present, been generally unappreciated by forest owners and timber operators - partly because they have been uninformed as to the data thus made available to them and partly because they have had very erroneous ideas as to the cost of such work in relation to the service that it will render."

We believe that the cost of such a cruise and report should not be more than 20¢ per acre, and that a crew of three cruisers could do the work in less than a month. As we already have good maps of this area, it should be necessary only to check the up-lands lines, to secure the boundaries of the tract and the compartments. The cruise should be made by means of parallel strip-lines, one chain wide and ten chains apart, and the cruisers should give special care to collecting data in regard to the following points:

A. The site: - The character of the land from the standpoint of growing timber is of great importance, and its classification and distribution through the area by percentage of the total very useful.

B. The growing stock: - The data used in the present work was taken from a report of a cruise made in regard to a pulpwood operation; therefore the merchantable and non-merchantable growing stock has not been considered with sufficient accuracy. It would be necessary to classify them by species, and to see if the all-aged stands are represented on such and such area, and how the different age-classes are represented in a single stand, and what the natural rotation is.

C. The growth: - The answers to the following questions should be considered with care in regard to the growth of the forest and various species.

(1) What is the growth of the timber on the area, and what is the rate in board feet or in cords per year and as a percentage of the total stand?

(2) What is the individual tree growth by species at different sizes in uncut stands?

(3) How large is the average tree at the age of 25, 50, 100 and 150 years, and how fast do various species grow in partially cut areas at various sizes. (5)

D. Reproduction: - If clear cutting has been practiced in the region what kind of reproduction has followed, and what species should be favored from the market standpoint? What is the relation between cover and the reproduction, and in mixed stands what species are most likely to follow partial cutting?

E. The current possible production: - As the foregoing studies will give accurate data in regard to quality, quantity and growth of the timber, a good stock and yield table will be possible, and we will have a reliable estimation of how much timber would be produced on a program of cutting, looking toward sustained yield. We will also know the possibility of the annual cut with regard to species and sizes. The various logging operations studied and the costs analyzed, interviewing odd jobbers and workers in the region would give us a better insurance as to the sale of the stumpage; or we might come to the conclusion that it would be better to keep in our hands the milling and marketing and let out the logging on contracts, or to keep in our hands both logging and milling operations.

All those details should be obtained, not only from the cruise as we said, but by a complete study of the logging and milling operations actually made in the region. The data collected by cruisers should make an important report and will answer the following points as noted by Mr. Matthews (5):

(1) What are the causes of understocking?

(2) Do maximum stands represent full stocking?

(3) What proportion of the average stand in each type is now overmature?

(4) Do individual stands represent yield value or growing stock value?

(5) How is the growing stock distributed through the age classes if the stand is all aged?

(6) How are the various species represented in the reproduction?

(7) What is the average total growing stock for the various classes of forest?

(8) What is the approximate current annual growth in volume?

(9) What growing stock should the area carry per acre under successful management?

(10) What rotation and cutting cycle should be adopted, and what could the annual cut be during the first cycle?

(11) What will be the probable cut during the second cycle?

All this information will constitute the means of establishing and controlling not only the policy to be followed, but will be used and checked in the future to insure the most effective results of the management plan and sometimes to make necessary readjustments.

Let us now consider the management of the tract for permanent production of timber products.

3. The Management Plan and its Results.

If all the information we have spoken about has been assembled, especially the data with regard to the growing stock, its condition, age-class distribution and rate of growth, it will be of great service in the preparation of the management plan. The stock and yield table, the basal-area table control and the growth study will be chiefly considered to decide upon the following points:

A. The rotation: - As three principal species appear on the tract, maybe the cruise will fix a natural rotation of 60 - 80 years for the spruce and the fir and a natural rotation of 150 years for the birch. An economical rotation may be established also after considering the rate of growth after the first cut and the conditions of the market.

B. The cutting cycle:- The principal factor in deciding the cutting cycle is "the continuous production of timber crops of the highest possible value", and the use of the stand and stock tables will be of material assistance in this point." The second factor will be the investment and the working capital required for the operations during the first cut and the investment made by the value and quantity of timber laid out for the subsequent cuts.

C. Estimation of the volume and value of the first cut: - If most of the timber is overmature or mature, the first cut will comprise a higher volume than the one estimated in the present study. The value of the first crop will vary with the quality of that wood and conditions of logging and marketing. A careful study of the natural regeneration and the growth of the young forest will be of great assistance in that case.

D. Volume and value of the cut during the second cutting cycle: This is the principal point, and it will decide for or against organizing for permanent production. Here also the growth study made in stands following cutting is essential and will clearly state the necessity of a fixed policy.

E. The financial forecast: - The income we will receive for the products depends upon the following various factors:

(1) The volume and quality of timber cut in the first cycle and subsequent cycles.

(2) The investment required for logging or milling operations.

(3) The rate of interest used in the calculations.

(4) The present and future conditions of the market.

(5) The danger of fire and insects.

In the light of these factors and considerations a good plan of management should be stressed with impartiality and the owner will be assured that this property will give not only an actual income but future and regular income.

We will now consider the real value of this forest, and how it can be determined on various plans when additional date in regard to stock and yield tables obtained by an adequate cruise.

4. Value of the Forest Under Various Plans.

To illustrate the possibility of determining the value of a forest the following lines will show a demonstration case in which assumptions have been made.

A: - An accurate cruise on the area has determined the number of trees per acre and the number of sticks per tree as follows:

D.B.H. (O.B.)	Number of 100-inch sticks per tree: 0	1	2	3	4	5
	Number of trees per acre					
2	240					
3	150					
4	40	40				
5		30	30			
6			20	10		
7				30		
8				10	10	
9				2	10	
10					6	2
11					2	2
12						3

From these figures we see that a large number of trees in small diameters have not, or have a little number of, sticks; we see also that the medium diameters show a greater number of trees per acre and a larger number of sticks per tree. What is the volume of this stand exactly in cords of pulpwood? The following volume table, made by means of curve, will determine it.

Volume Table for Coniferous Species
In cubic feet of peeled merchantable wood
by number of 100" sticks per tree

(East End of Upper Peninsula, Michigan)

Number of 100" sticks per tree

D.B.H. (O.B.)	1	2	3	4	5	6	7	Basis Tree
4	0.80							11
5	1.31	2.20	3.00					65
6	1.58	2.70	3.90	5.10				90
7	2.25	3.60	4.95	6.25	7.60			50
8	3.40	4.90	6.40	7.85	9.35	10.8		30
9	4.80	6.40	8.00	9.60	11.2	12.8		15
10		8.30	10.00	11.8	13.5	15.2	17.0	88
11			12.1	14.0	16.0	17.9	19.8	5
12			14.8	16.9	19.0	21.2	23.3	55
13			17.5	20.0	22.4	25.0	27.4	1
14			20.6	23.6	26.4	29.4	32.2	
15				27.7	31.0	34.4	37.6	
16				32.4	36.0	39.6	43.0	
								275

Derivation of table:

(1) This table is based upon the field measurements of 103 black spruce, 97 balsam fir and 75 jack pine trees. Separate tables prepared for each of these species showed such little difference in volume it was felt that one table with all the measurements combined would be more desirable than separate tables by specie.

(2) Block indicates extent of data.

(3) Volume represents average utilization to a usable top diameter; the minimum top diameter acceptable for pulpwood sticks in this area is 4 inches inside the bark.

(4) Stump heights range from ½ a foot for 1-stick trees to 1 foot for 5-stick trees.

From the foregoing tables calculations have established that the volume per acre for trees of 8" in diameter and more is 5.2 cords and for all trees of 4" in diameter and more 9.4 cords. As the area is 2,380 acres, we will have: 2,380 x 9.4 = 22,560 cords of pulpwood for trees of all diameters, and 2,380 x 5.2 = 12,416 cords for the trees of 8" in diameter and more.

We see that if the cutting rights are sold in liquidating the tract the purchaser could cut more than 22,500 cords of pulpwood. Would such a policy be the best one for the owner of the property, or should another one be chosen? If we consider the possibility of managing this forest on a sustained yield basis it will be necessary to know the rate of growth and the volume to be cut at each cutting cycle. For that purpose we assumed that a growth study had been made with accuracy and the following figures determined:

Growth Study
(10 Year Period)

D.B.H.	Periodic Growth (inches d.b.h.)	Mortality Percent
2	1.15	50
3	1.35	30
4	1.55	20
5	1.70	10
6	1.85	10
7	2.00	10
8	2.15	10
9	2.25	10
10	2.35	10
11	2.45	10
12	2.50	10

By means of Reynold's method calculations we have shown that ten years from now, if the first cut is made of trees of 8" and more only, the remaining trees will give a crop of 4.6 cords per acre, and that the same crop will be possible every ten years thereafter.

Is it preferable to cut clean the area immediately and to realize a large amount of money, or to manage on a sustained yield basis? That is what the determination of the stumpage value will tell us. In both cases we assumed that the total logging and driving cost is approximately the same, $7 per cord delivered to the mill, and that the value of this wood is $10 per cord in the mill yard; then the value of stumpage is $3 per cord in both cases.

B. Stumpage value, or present worth of the forest: -

(1) Stumpage value on the liquidation plan: - The total volume to be cut on this plan will be 22,560 cords, and we assumed that two years will be required for logging and driving operations; then the annual cut will be 11,280 cords.

Value of the cut, 1st year:	11,280 cords x $3	$33,850
Value of the cut, 2nd year:	$\frac{11,280 \text{ cords x } \$3}{1.03}$	32,850
Present worth of the forest:		$66,690

From this amount we deducted the expenses for fire protection at $44 per year for the tract; then we will have the net stumpage value of $66,690 - $88 = $66,602 , or the present value of the forest on a liquidation system. This amount should be paid by a purchaser if the owner agreed with such a plan; that is, to cut all trees of 4" and more in diameter and liquidate the property.

The second plan will be now the subject of our study.

(2) Stumpage value on a sustained yield plan: - We said previously that considering the rate of growth the first cut will give us now 5.2 cord per acre and following cuts every ten years thereafter will give 4.6 cords per acre; then we can estimate the present worth of the forest on this plan. We have also assumed that the total cost of logging

and driving and the price of pulpwood paid by the company are approximately the same.

a. Value of the first cut: 2,380 acres x 5.2 cords x $3 = $37,125

b. Value of future cuts 10 years from now and for ever:

$$2,380 \times 4.6 \text{ cords} \times 3 = \frac{\$32,250}{1.03^{10} - 1} = \$93,748$$

Total value of the forest: $37,125 + $93,748 = $130,873

From this we must subtract the amount necessary to pay the expenses for fire protection every year, which is $44 per year; then we will have for expenses: $\frac{\$44}{.03} = \$1,466.$

The net stumpage value will be therefore: $130,873 - $1,466 $129,407. This amount should be paid to the owner if a company bought the tract and managed it on a sustained yield basis.

Such calculations show clearly that it is preferable to put the forest under a management plan and we estimate that such a plan on the silvicultural point of view should be the most equitable.

The practice of this silvicultural method, called "shelterwood method", in these kind of stands - spruce, balsam-fir and birch - has given the best results. Its application made with judgement sufficiently opens the forest cover, bringing more light and humidity to the soil and facilitating the natural regeneration and the growth of the remaining trees. Therefore thse trees, promoted in their growth, protect the saplings against the insolation and the wind. We believe that such a plan should be adopted for this property to the benefit of the owner.

We hope that these calculations will have proved also the necessity for supplementary cruise data which would lead us to a better study of the tract and a better evaluation of the stumpage on various plans.

CONCLUSION

The present work has tried to applicate the principles of cost control logging to a particular area on the Montmorency limits. These principles have determined that the most economical logging plan was horse-skidding in winter and driving, which gives us the best value for the stumpage. It has determined also that such a forest must be managed on a sustained yield basis which should give the largest profits to the owner.

We must say also that the plan chosen must not be considered a definite one as the data used was incomplete. However we hope that this work has proved the necessity for planning and controlling all the factors influencing the wood operations and consequently the value of a forest property.

The present work has also tried to prove that every forest owner, for present and future economical purposes, must study carefully the value of his forest on various plans before setting up any kind of contract, and should include in such contracts definite clauses to protect his property and obtain from it the best value.

Should these lines bring a little more light on the choice of such plans and contribute in a small part to the success of forest management, that would be for us the best compensation.

Reverend Arthur Jobidon

BIBLIOGRAPHY

1. Brown, N. C. "Logging - Principles and Practices"
   John Wiley & Sons, Inc., New York. 1936

2. Brown, N. C. "Logging - Transportation"
   John Wiley & Sons, Inc., New York, 1944

3. Halliday, W. E. D. "A Forest Classification for Canada"
   Canada, Department of Mines and Resources,
   Dominion Forest Service, Bulletin 89, Ottawa
   1937

4. Matthews, D. M. "Cost Control in the Logging Industry"
   McGraw-Hill Book Company, Inc.
   New York and London. 1942

5. Matthews, D. M. "Management of American Forests"
   McGraw-Hill Book Company, Inc.
   New York and London. 1935

6. "Pulpwood Skidding with Horses. Efficiency of Technique"
   Canadian Pulp & Paper Association,
   Woodland Section, and Pulp & Paper
   Research Institute of Canada

7. Townsend, C. L. "Practical Pulpwood Production"
   Woodland Review. Extracts from the
   1940 issue. Gardenvale, Quebec

8. Ray, R. B. "Site-Types and Rate of Growth"
   Canada, Department of Mines and Resources,
   Dominion Forest Service, Bulletin 65, Ottawa.
   1941

9. Robertson, W. M. "Some Observations on a Tour of the Montmorency Forests"
   Woodland Review; August 1943
   Gardenvale, Quebec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Compartment Division Line
Section Division Line
Compartment Numbers
27
Section Numbers
IV
Motor Road
Portage
Drivable Stream
Small Creek
Muskeg
Dam, Proposed Dam
Logging Camp, Proposed Log. Camp
Bridge
Height of Land
Type Boundaries
Type: - Acreage/Cordage
SW: 7.6 / 127
Cruise Line Location
Contour Line, Elevation
2000
Depot
Cut Boundaries
Cut Over Areas
Class II road
Class III road
Class IV road
Iced road
Skidding road
22
24A
23
25
24B
26
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