A 20 YEAR CUTTING PLAN OF MANAGEMENT FOR A STAND OF 100 YEAR-OLD DOUGLAS-FIR

by

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OBJECTIVES

The aim of this paper is to determine which of the two methods presented for cutting a stand of second-growth Douglas-fir, known as the Panther Creek stand is the better. This determination will be made on the basis of the best silvicultural practice coupled with that method which is better economically. The best silvicultural practice may not be the best economically and vice versa, so an attempt will be made here to compare two methods that are silviculturally acceptable and determine which one is the most economical from the logger's standpoint.

In choosing a plan that is silviculturally sound, it is well to realize the fact that this stand is at such an age that merchantable trees are being lost through natural mortality. Our applied silvicultural cutting system must take this into account and attempt to salvage this loss as soon as possible. The mortality which is spoken of here means trees that have died of suppression from their surrounding more vigorous companions, windfalls, and trees windfallen or killed standing particularly in this stand due to the root rot caused by the fungus, Poria Weirii. Special emphasis is to be given to this fungus because it is quite prevalent in this stand and is the cause of much mortality.

LOCATION

This area is known as the Panther Creek Division of the Wind River Experimental Forest and is located in

Skamania county in the state of Washington in Township 4N, Range 7½E and 8E of the Willamette meridian. This area forms part of the water-shed of the Wind River, which is a tributary of the Columbia River. It is about 12 miles from the town of Carson, Washington.

CLIMATE

The climate is fairly representative of a large area along the west slope of the Cascade Range in Washington and Oregon. It is characterized by heavy precipitation falling mostly on many days in the fall, winter, and spring months, an acute summer drougth with dry, hot days, absence of excessively cold weather, a rather short frost-free period, and cool nights even in summer.

The precipitation is heavier and the winters colder here than the altitude would indicate because of the site being surrounded by mountains. Also, being so close to the axis of the Cascade Range, it receives to a larger degree than points to the west the extreme of heat and cold brought in by the periodic continential east winds. The following weather data was taken from records kept at the headquarters of the Wind River Experimental Forest:- 1/

Annual precipitation........Average 86.52"
Annual temperature..........Average 48.3°

TOPOGRAPHY

The topography varies from level at the long flat at the east end near the Panther Creek bridge to very very

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1/ Munger, T. T., "The Wind River Arboretum Report No. 3", Pacific Northwest Forest Experiment Station, 1947.

steep slopes and rock cliffs. The land is cut by many small draws, but mostly embraces the "Mouse Creek" drainage which joins Panther Creek at the first major switchback in the main road. Two long prominent ridges form the north and south boundaries, coming together at Big Huckleberry Mountain. The area is for the most part rugged and is typical of land in western Washington and Oregon that probably will always be devoted to forest production.

BOUNDARIES

Of the total area shown on the following topographic maps, 3309 acres will be considered here as the management unit. This management unit may be considered as one "block" in the "Wind River Working Circle" of the Columbia National Forest. Only the area within the Experimental Forest boundary plus the west half of section 13 and the SW$\frac{1}{4}$ of the SE$\frac{1}{4}$ of section 12 of T4N, R7$\frac{1}{2}$E will be used here.

The tract is owned by the government and is administered jointly by the Director of the Pacific Northwest Forest Experiment Station and the Supervisor of the Columbia National Forest. The latter has charge of protecting the area from fire and maintains the transportation and the communication systems; while the former is responsible for all cutting operations and uses of the resources found thereon.

HISTORY OF THE STAND

It is evident that this stand of pure even-aged second growth Douglas-fir resulted from a severe and rather clean burn about 110 years ago. The fire must have been severe and a clean burn because only a very few small, low, pitch filled stumps remain. The eveness and adequacy of the stocking indicate that the area seeded in quite completely during a relatively few years. The fact that there are only a few brush filled openings also indicates that this young forest of 110 years ago was well stocked.

From about 1840 until 1913, when the area was acquired by the Experiment Station, nothing was done on it. During this period; however, several small ground fires must have run through the stand because examination of fire scarred trees showed that fire had burned through about 45 years ago.

The next step in the development of this area was the laying out of growth plots. These growth plots were established in 1915 by J. V. Hoffman. They are one acre in size and are located in the NE$\frac{1}{4}$ of the NW$\frac{1}{4}$ of section 12 and in the SW$\frac{1}{4}$ of the SE$\frac{1}{4}$ of section 12, T4n, R7$\frac{1}{2}$E respectively. These permanent sample plots have been measured every 5 years since their establishment and much of the data and growth prediction attempts in this paper are based on the results of these periodic measurements.

In 1932, the area was mapped and curised as a C.C.C. project with C. V. Zaayer as chief of party under the direction of the Experiment Station. The vertical control for the survey was based on a double rodded spirit level line run from the U.S. Coast and Geodedic survey bench mark at

Cascade Locks, Oregon to the south boundary of Section 13. The mapping was done with strips covering 10% of the area using staff compass, abney level, and 2½ chain trailer tape.

The area was cruised at the same time the topographic map was being made. Trees were tallied by DBH and species down to 10 inch diameter limit. The cruise amounted to a 10% sample of the timber volume and cubic and board foot volumes were computed from "Interregional Volume Tables for Douglas-fir" by W. H. Meyer, Aug. 1, 1932. Local height-on-diameter curve values were applied to the volume table to make it applicable to the local conditions. The board foot volumes used are Scribner Dec. C computed for 16 foot logs to an 8 inch top diameter.

This cruise revealed that the area is covered with an even-aged stand of pure Douglas-fir then approximately 90 years old. Except for a small patch of timber in the SE¼ of the NE¼ of section 8 estimated to be 135 years old and some 40 year old timber along some of the higher ridges, the stand may be considered quite even-aged and well stocked.

Height measurements indicate that the site varies from a good site III at the south-west edge to site IV at the east and higher portion of the area. On the site III portions, the average height now (1948) is about 145 feet, while on the site IV portion, the average height of the trees is about 135 feet. The average number of trees per acre is roughly 105, though this number may vary considerably throughout the stand.

In 1938, a road was constructed into the area for the purpose of taking out piling from a sale made chiefly as a thinning experiment, and sample plots were laid out in the thinned area. The results of these plots showed that at the time of cutting the average diameter was 19.4 inches, the average height 140, feet, and there were 113 trees per acre. The cut amounted to 8,000 board feet Scribner Rule, per acre or approximately 12 per cent of an original stand of 66,000 board feet. Piling was taken from 101 trees, indicationg that on the average each tree cut produced 66 feet of piling. On this operation 8,321 board feet were cut to produce 1,000 lineal feet of piling; conversely, of each 1,000 board feet cut, 120 lineal feet was in piling.

The results of this thinning study showed that about a 12 or 15 percent volume removal increased the net growth considerably and did not cause excessive windfall. The following table shows the results of measurements made on the thinned area and on an unthinned area in the same general locality.

Growth of thinned and unthinned 100-year-old Douglas-fir at Wind River 1/

Treatment	Dates measured	Net growth per acre					
		Periodic annual			Mean annual including thinnings		
		Cubic	Intern.	Scribner	Cubic	Intern.	Scribner
Thinned Plots	Oct. 1939 / Oct. 1946	111.0	862	769	131 130	976 968	677 683
Unthinned Plots	Oct. 1939 / May 1945	20.9	272	274	129 123	953 919	664 645

The logging was done with a "D-4" tractor in the fall of the year. These factors, plus the light intensity of the cut account for the small amount of logging injury to the remaining stand; for actually only 3.4% of the residual trees were scarred, leaving the stand in good condition for future growth.

Figures 9 and 10 show the Piling Sale area. (Note the clean appearance of the logging operation).

Nothing of importance took place on this area from 1939 through the War, and up until 1947 except fire protection. In 1947, it was decided to widen the existing road; this was done with money appropriated by the Government and therefore no charge for this road work appears in

1/ Steele, R. W. "Thinning in Century-Old Douglas-Fir" Forest Research Notes No. 43, Pacific Northwest Forest Experiment Station, 1947.

Figure 9. Piling Sale
(Note spacing of trees)

Figure 10. Piling Sale
(Note the low stumps)

the logging costs to follow.

In 1948 it was decided to run some preliminary control survey lines. The E : W section line between sections 7 and 18, and 8 and 17 was laid out on the ground. This line was continued from the NW corner of section 18 to the NE corner of section 17. The survey was then run north for a mile to the NE corner of section 8. Some of the "forty" lines in section 9 were also surveyed. This preliminary control survey will make it possible to locate roads and cutting areas more accurately in the field because all lines were blazed and corners marked.

A road location was also run during 1948. This location line starts at the end of the existing Panther Creek road and runs on a 6% grade through sections 8 and 9 to a saddle at the extreme north-eastern part of the area where it is to connect with an existing forest road.

PHYSICAL CONDITION OF THE STAND

Generally speaking, this stand is in a thrifty, well stocked condition and is about 80% normal when volume and number of trees are considered. It was discovered in 1946; however, that the entire area contained trees dying from root rot. A rough estimation was made and it was found that about 5 trees per acre were infected.

Poria weirii had commonly been found on Western Red Cedar, but it had not been known to attack Douglas-fir. Unlike many other wood rotting fungi, this one does not have to have an open wound to enter, but enters through the roots, and spreads from one tree to another through root grafts. The fungus attacks the wood and considerably retards the growth of the tree. In some instances, the roots callous over in an attempt to heal after the Poria strikes. This process goes along while the rot is at work, but the healing process cannot keep pace with the fungal attack. Figures 1 and 2 show typical examples of the rot at work. 1/

In the incipient stage of the rot there first appears a yellowish discoloration to the wood which remains firm. Next, the yellowish color intensifies and the wood softens. In the advanced stage, the affected wood has a yellowish or brownish discoloration, is soft, and the annual rings separate, giving the wood a laminated look on the radial surface. This separation of annual rings occurs because the early wood decays readily, whereas the late wood is reduced to a brown stringy or crumbly mass and a hollow then forms. Usually the rot is confined to the butt, extending up 8 or 10 feet, but it may run higher. The rot column is cone shaped at its upper limit. On the ends of the logs the rot is circular or crescent shaped, and before the stage is reached where the annual rings separate, it resembles a typical ring rot.

The conks are light to dark brown flattened crusts with stratifications or layers, showing that they are perennial. The substance of the conk is brown with the mouths of the tubes numerous and small. The conks on living trees

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1/ These photos were taken by Dr. Toby Childs, Division of Forest Pathology, Region 6, U. S. Forest Service, Portland, Oregon.

Figure 1. Base of a windfallen tree showing typical Poria weirii rot. (Note separation of annual rings in the infected wood)

Figure 2. A typical windfall caused by Poria weirii root rot.

are commonly on the root crotches and are very inconspicuous, often being obscured by the duff. 1/ It is almost impossible to tell infected trees by looking for the conks.

It is often noted that where one infected tree is found, there may be several others nearby infected also. These "foci" or groups of infected trees can be spotted by the appearance of the tree crown. Crowns of the infected trees appear sparse, more open than those of healthy trees and sometimes have noticeably shorter twigs. Infected trees sometimes have more flattened crowns in relation to those of similar age which are healthy. Figures 3 to 8 show live trees that are infected with the rot.

It is these infected trees that our system of cutting should remove before they die or are windthrown due to the root rot. An attempt is now being made to devise a good usable system for determining trees that have Poria root rot so that they can be recognized five or six years in advance of the time they will die. Such a system is only in the development stage now, but it is possible to tell which trees will die from Poria in the next two or three years, and it is these that should be marked for cutting at the earliest date possible. Trees of this size and age that are windfallen must be salvaged within two or three years because of the rapid decay of the sapwood which makes up a large proportion of the volume in trees of the

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1/ Boyce, J. S., "Forest Pathology", Page 463.

Figure 3. Healthy Trees
(Note pointed crowns)

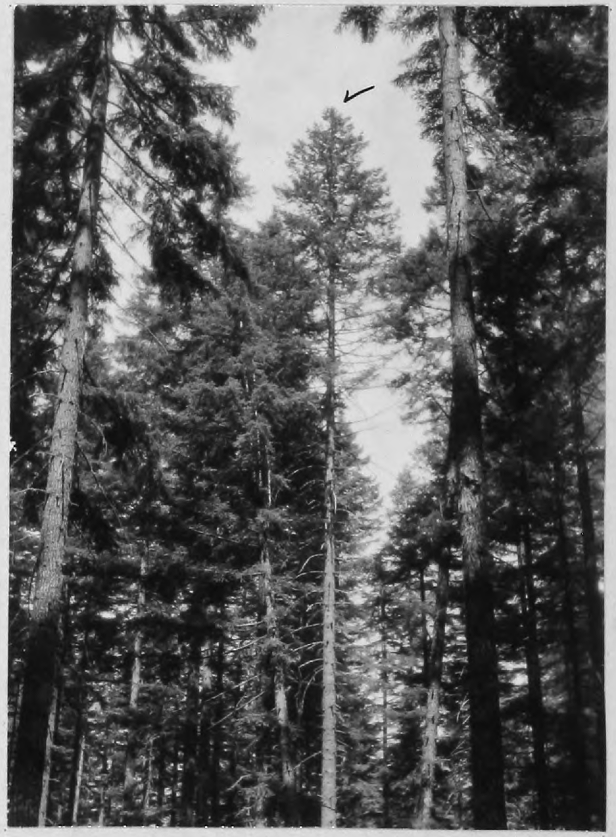

Figure 4. Infected Tree
(Note sparse foliage)

Figure 5. Infected Tree
(Note the poor vigor)

Figure 6. Infected Trees
(Advanced stages , note the short needles)

Figure 7. Infected Trees
(Note three infected trees
in a group or focus)

Figure 8. Infected Tree
(Note sparse crown)

size class encountered here.

It is part of the overall management plan for this area to salvage the mortality caused by Poria weirii by an applied cutting system. Even though the timber is immature, it will be possible to partially cut a large part of it because merchantable trees are being lost from root rot.

A system of cutting whereby selected trees are taken must necessarily be one of a "selection" or better termed "partial cut". The topography of the Panther Creek area is such that parts of it may be partially cut using tractor logging and parts of it must be cut using cable systems in the form of clear cuts. These two systems of logging will be combined in two different ways and the merits of each discussed.

PRESENTATION OF THE DATA

Because the cruise of this area was made in 1933, it was necessary to bring the volume figures up to date. The data from the growth plots (mentioned earlier) provided a means of bringing the 1933 volume figures up to date. The procedure was to take the 1933 volume and add to it the net mean annual increment occurring over the intervening 15 years. The increment figures were segregated according to site classification. The average net mean annual growth figure used for site III land was 500 board feet per acre per year, while that for site IV land was 400 board feet per acre per year. These figures are a little low for site III and a little high for site IV, but over the whole area they should tend to balance out to a sufficiently accurate estimation of the volume present in the year 1948.

Experience with the piling sale mentioned earlier has shown that these growth rates make it possible to thin the stand at 10 year intervals if no more than 15% of the volume is removed and has thus demonstrated that partial cutting is feasible in a stand of this age.

An indication of how the stand density is changing is expressed in the spacing factor, which is the ratio of the distance between the trees in feet to the diameter breast high in inches.1/ A spacing factor of 1.00 has been found to indicate stocking for Douglas-fir of this age which allows "room to grow, but none to spare." The following calculations involving the use of the spacing factor indicate that a 10 year return period for thinning is feasible. The figures used here came from the thinning study made in 1939 on the piling sale and carried on to the present time.

1939 Before Thinning:-

$$\text{Distance between trees} = \sqrt{\frac{43560}{\text{No. trees/acre}}}$$

$$D = \sqrt{\frac{43560}{128}} = 18 \text{ feet}$$

$$\text{Spacing Factor} = \frac{\text{Distance between trees in feet}}{\text{D.B.H. in inches}}$$

$$S.\ F. = \frac{18}{19.4} = .93$$

1/ Matthews, D. M., "Management of American Forests", Page 26.

<u>1939 After Thinning:-</u>

$$\text{Distance between trees} = \sqrt{\frac{43560}{\text{No. trees/acre}}}$$

$$D = \sqrt{\frac{43560}{113}} = 20 \text{ feet}$$

$$\text{Spacing Factor} \quad \frac{\text{Distance between trees in feet}}{\text{D.B.H. in inches}}$$

$$S. F. = \frac{20}{19.4} = 1.03$$

The growth records showed that about one tree per acre per year was lost through mortality which would leave 119 trees to the acre. The growth plots also indicate a growth rate of .08" per year, so the average diameter would now be 20.7". An allowance of .6" has been made because the average diameter will have been increased because some of the smaller trees have died of suppression. The present day calculations are:-

<u>1948 Before Thinning</u>

$$\text{Distance between trees} = \sqrt{\frac{43560}{\text{No. trees/acre}}}$$

$$D = \sqrt{\frac{43560}{119}} = 19.1 \text{ feet}$$

$$\text{Spacing Factor} = \frac{\text{Distance between trees in feet}}{\text{D.B.H. in inches}}$$

$$S. F. = \frac{19.1}{20.7} = .921$$

The spacing factor of .921 at the present time indicates that the stand is ready for a thinning which will bring it up to a stocking that will result in a spacing factor of 1.00.

Thinning the stand in 1939 by taking out about 12 or

15 percent of the volume changed the spacing factor from .9 to 1.0, which brought the stand to optimum stocking. The growth was sufficient in 10 years to make it possible to thin the stand again with about the same volume removal per acre. With a cut of 785 M per year from the partial cut areas and approximately 153 acres cut every year, the average cut per acre would be 5.1 M. Now, if a growth rate of 500 board feet per acre per year can continue, and it should in a thinned stand, then by the time we return to a given acre 10 years later, that acre should have about the same volume on it as it had for the first cutting cycle because 500 times 10 equals 5,000 board feet. This fact makes it possible to use the same percentage of cut for the first cutting cycle, that is, 15%. The plans call for a second thinning of the same percent removal followed by a clear cut 10 years after the second thinning.

The annual cut of 2,000 MBM is not enough to keep a large operation going, but because the area is chiefly used as an experimental forest, it was thought that a small operation could be kept going for a number of years. This would afford an excellent opportunity to demonstrate the various types of cutting involved and the logging equipment used. It is for this reason that the cutting of the stand is prolonged over a period of 40 or 50 years rather than a more rapid cut which would certainly be possible under present day logging methods.

The two plans developed here consist of alternatives by which partial cutting and clear cutting are done in conjunction with each other to obtain a desired annual cut. There may be other systems for cutting the stand that will prove to be better in the long run, but in this paper only two possibilities will be compared and they are as follows:-

First, the area was divided into two general parts, one representing the portion that, due to topography, could be partially cut by the use of tractor logging; and the other representing the portion that, because of the steep topography would be limited to clear cutting by some system of cable logging.

The growth of the whole forest is such that an annual cut of 2,000 MBM could be removed each year. 1/ The two cutting plans outlined here are both based on an annual cut of 2,000 MBM.

<u>Alternative No. 1</u>

This plan divides the tractor loggable area up into 10 compartments of almost equal volume each. Every year 15% of this volume is to be removed from one of these compartments and the remainder of the 2 million feet of annual cut is to be obtained from additional small clear cut areas located throughout the stand as shown on the map. In this plan the annual cut is to come from partially cut areas for the first 10 years. At the end of the first 10 years (cutting cycle No. 1), a second partial cut is to be made over the same compartments as during the first 10 years and the annual cut again supplemented by clear cuts located as indicated on the map (cutting cycle No. 2). At

1/ Matthews, D. M., "Management of American Forests", Chapter V.

the end of 20 years then, the tractor loggable area will have supported two thinnings each of 15% removal and at time there will also have been made 20 small clear cuts. The 21st year will find cutting beginning on partial cut compartment No. 1 again, but this time the logging will be a clear cut and cutting will progress on this basis every year, the same annual cut being used.

Total volume on the tractor loggable area................	52,375 MBM
15% of 52,375 MBM....................	7,850 MBM
1/10th of 7,850......................	785 MBM to come from partial cuts
2,000 MBM - 785 MBM..................	1,215 MBM to come from clear cuts

Alternative No. 2

This plan also divides the tractor loggable area into compartments, only this time 4 compartments instead of 10 will be used. The annual cut of 2 million board feet will be 15% of the volume of each one of these compartments. In this plan, the entire partial cut area is to be cut over in 4 years, and the cut is to come entirely from partial cutting. At the end of the fourth year, the cut is to come entirely from clear cuts located as shown on the map. The annual cut, 2 million board feet, will come from clear cuts for the next six years, then in the eleventh year, (the beginning of cutting cycle No. 2) partial cut compartment number one will be ready for its second thinning from which the annual cut will again be taken, and so forth until the 15th year when the cut will again come entirely from clear cuts. When the 20th year is reached the tractor loggable area will have had two partial cuts and will then be clear cut at the rate of 2 million board feet a year.

In cutting cycle No. 1 of both alternatives, some over-cutting has been called for, but is is justified by the fact that more roads must be built during this cutting cycle. When cutting cycle No. 2 arrives, the planned volumes may be more strictly aheared to.

From year 20 on, Alternative No. 1 and Alternative No. 2 would be the same. There is insufficient data available to predict conditions beyond this point, so the comparisons here will be limited to the first 20 year period.

In laying out the boundaries for the compartments to be partially cut in both alternatives, volume was the chief consideration, rather than topography. In laying out the boundaries for the clear cut areas, an effort was made in each case to fit the cutting area to the topography as far as location was concerned, the size being limited of course by the volume called for in that particular year of cut. In fitting the cutting area to the topography, landing location was the chief consideration, the location being where in most cases two or more settings could serve each clear cut. This effort was made to reduce the cost of skidding due to moving the rigging and setting up additional landings, for it was thought that in this way a more just comparison of costs could be made between tractor skidding and cable skidding. Where the topography was more or less unbroken, the "forty" lines were used as cutting area boundaries.

LOGGING METHODS

Partial Cuts

The size of the timber involved makes it possible to use a small tractor for logging the partial cut areas. A "D-4" Caterpillar tractor was used on the piling sale and this size machine proved to be quite adequate to do the skidding job and did very very little damage to the residual stand. The cost figures used in this paper are for a "D-4" Caterpillar tractor using a towing winch to pull logs to the skid roads.

It is planned to have the timber marked and the roads and skid roads laid out by a Forester before any cutting or construction begins. There will also be an effort made to locate roads and skid roads that will result in proper spacing for economic logging, as well as for protection to the site.

Clear Cuts

To avoid the necessity of having two types of skidding machines involved, it is planned to log the clear cut areas with the "D-4" tractor rigged as a "tractor donkey". With this method of logging, either single or double drum winches are mounted on the rear of the tractor. They enable the machines to skid in places that, because of topography, are inaccessable to other equipment. Such a unit provides line pulls greater than the pull available at the tractor drawbar because of the gear reduction in the winches. With this equipment, timber can be logged off steep hillsides, out of steep draws, or out of swamps. The fact that the tractor can move quickly from one set to another with considerable ease, makes it an efficient skidding machine.

In dense timber such as is the case here, the double drum attachment is to be used, one line as a main line and the second line to act as the haulback.1/ By using the tractor in this manner, a lower cost should result especially when clear cutting and partial cutting are to be done during the same year. In the case of the clear cuts with the tractor donkey logging, the fixed skidding cost will be the same and the variable skidding cost will be lower than for the regular tractor skidding. This is so because the hook and unhook time will be the same for the cable skidding as it was for tractor skidding, but the turns of logs will move faster in the cable set-up and hence the variable skidding cost will be lower.

In the case of the cable set-up, however, there will be the cost of settings involved. Tables 24 and 25 show the costs incurred. These setting costs include the cost of changing the rigging throughout a setting.

Where the settings have to be made at quite a distance from the landing at the end of spur roads, the logs will be swung from the cold deck at the setting to the landing by means of the "North Bend" cable rigging system. The North Bend system makes it possible to swing turns of logs over the distance about equal to the drum capacity of

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1/ Brown, N. C., "Logging", page 168.

the tractor donkey. This particular cable system was chosen for the swinging job because it uses just two drums, such as are available on the tractor being used. 1/ Tables 26 and 27 show the costs of the swinging operation.

Loading in the case of the clear cuts will be done at the landings where the logs have been cold-decked by the tractor donkey or have been swung from a cold deck. The same shovel type loader used in the partial cuts will be used here.

Since the same volumes will be loaded for Alternative No. 1 as for Alternative No. 2 during the period under test, no cost comparison between the two for loading has been made since it should be very nearly the same for both alternatives.

COST COMPARISON

It was assumed that both Alternatives were silviculturally sound at the outset, and the choice of method would be made upon economic considerations. The costs that will vary in these two Alternatives are skidding, hauling, road construction, landings, and swinging. All other costs involved in getting the timber to the sawmill would be the same for both Alternatives.

Skidding costs were determined from average skidding distances figured from various formulae.2/ It was assumed

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1/ Brown, N. C., "Logging", page

2/ Matthews, D. M., "Cost Control in the Logging Industry", page 88.

that direct skidding would be done in the partial cut areas and no landings would be constructed, and that a mobile shovel type loader used to load the logs on trucks. In the case of the clear-cuts, skidding distances were figured to the settings as governed by the length of cable the double drum attachment could hold. Swinging distances were measured from the settings to the landings where there were more sets than landings.

Hauling costs were figured for each year of cut and each compartment from the landings in the case of clear cuts and from the middle of the compartment in the case of the partial cut areas to the south west corner entrance to the tract. From this point to the sawmill, costs would be the same for each one of the Alternatives, so there was no use computing them for this comparison.

Road construction costs were determined for each year of cut and for each compartment and were charged against the timber to come out over these roads during the year that they were to be built. Road costs were charged in this manner because Government owned timber is often sold to more than one operator during a long period of time.

As an example of the method used to determine whether it was economical to build a spur road or to skid direct to the main road, the following calculation is presented. 1/

1/ Matthews, D. M., "Cost Control in the Logging Industry", page 112.

R is the cost of road in cents per mile.
D is the depth of timber required in stations
S is the existing road spacing in stations
V is the volume per acre in MBM
C is the variable skidding cost for one station/MBM.

$$D = \frac{S}{2} \quad \frac{2R}{12.1\ VSC}$$

$$D = \frac{11.5}{2} \quad \frac{2 \times 530000}{12.1 \times 35 \times 11.5 \times 20}$$

D = 16.6 stations

The values inserted in this demonstration formula come from compartments 2 and 3 in Alternative No. 2 and are to decide whether the spur road through these compartments should be built or not. The depth of timber came out 16.6 stations, and since the actual depth of the timber from the main road to the back boundary of the area was much more than this figure, it was justifiable economically to build the spur road.

All these logging cost figures were computed as a cost per MBM and tabulated for each Alternative according to the year of cut and the compartment involved. This tabulation is shown in the following table and the supporting calculations for this final tabulation table are found in the appendix of this paper. The explanation preceeding the tables in the appendix shows how each value was determined. According to the total cost figure shown in the tabulation table, Alternative No. 2 is more economical, but there was only $1.42 difference between the logging costs for Alternative No. 1 and Alternative No. 2, showing that it does not make very much difference in cost which method is chosen.

TABULATION TABLE

Alternative No.1 Vs. Alternative No. 2

Year of Cut	Cost Items Involved in Dollars Per MBM — Skidding: Alternative #1	Skidding: Alternative #2	Hauling: Alternative #1	Hauling: Alternative #2	Roads: Alternative #1	Roads: Alternative #2	Landings: Alternative #1	Landings: Alternative #2	Swinging Costs: Alternative #1	Swinging Costs: Alternative #2	Total Cost Per MBM: Alternative #1	Total Cost Per MBM: Alternative #2
1949	3.32	3.22	.06	.17	1.63	.91	.16	--	2.99	--	8.16	4.30
1950	2.77	3.64	.22	.53	2.26	2.01	.25	--	--	--	5.50	6.18
1951	2.94	3.80	.36	.74	2.39	3.06	.17	--	2.99	--	8.85	7.60
1952	2.90	2.98	.50	1.09	.74	3.89	.25	--	2.99	--	7.38	7.96
1953	2.86	2.66	.53	.13	3.28	1.24	.08	.30	--	2.99	6.75	7.32
1954	3.31	2.63	.85	.33	6.24	1.61	.25	.19	3.30	--	13.95	4.76
1955	2.73	2.74	.68	.56	1.14	1.96	.17	.10	2.75	2.67	7.47	7.93
1956	2.77	2.57	.82	.92	.90	.91	.12	.18	--	3.30	4.61	7.88
1957	2.87	2.69	.95	.82	2.12	--	.16	.10	2.67	--	8.77	3.61
1958	2.91	2.48	1.02	.93	4.15	2.31	.32	.14	3.30	3.30	11.70	9.16
Total	29.38	29.41	5.99	6.22	24.85	17.90	1.93	1.01	20.99	12.26	83.14	66.70
Average	$2.94	$2.94	$.60	$.62	$2.48	$1.79	$0.19	$0.10	$2.10	$1.23	$8.31	$6.67
1959	3.23	3.22	.06	.17	--	--	.17	--	2.60	--	6.06	3.39
1960	2.85	3.64	.24	.53	.80	--	.10	--	2.99	--	6.98	4.17
1961	2.83	3.80	.34	.74	--	--	.27	--	2.99	--	6.43	4.54
1962	3.02	2.98	.53	1.09	1.79	--	.16	--	2.75	--	8.25	4.07
1963	2.81	2.54	.59	.38	1.13	.94	.17	.24	2.80	2.99	7.50	7.09
1964	3.32	2.51	.83	.52	--	.61	.26	.15	3.20	2.67	7.61	6.46
1965	2.76	2.51	.84	.77	.58	.95	.17	.20	2.65	2.99	7.00	7.42
1966	2.66	2.57	.91	.62	--	--	.24	.15	2.99	2.45	6.80	5.79
1967	2.82	2.51	.94	.95	1.33	.30	.30	.18	2.99	2.99	8.38	6.93
1968	2.83	2.74	1.04	.80	--	.29	.14	.08	--	3.20	4.01	7.11
Total	29.13	29.02	6.32	6.57	5.63	3.09	1.98	1.00	25.96	17.29	69.02	56.97
Average	$2.91	$2.90	$0.63	$0.66	$0.56	$0.31	$0.20	$0.10	$2.60	$1.73	$6.90	$5.70
Grand Total	58.51	58.43	12.31	12.79	30.48	20.99	3.91	2.01	46.95	29.55	152.16	123.67
Final Average	$2.92	$2.92	$0.61	$0.64	$1.52	$1.05	$0.20	$0.10	$2.34	$1.47	$7.60	$6.18

SILVICULTURAL CONSIDERATIONS

In the management of any stand of timber, the species to be raised is one of the primary considerations, and in this case it will be assumed that Douglas-fir is the species because of its high value in the northwest. It is necessary in this case to know specifically what species is to be raised because Douglas-fir will not reproduce in its own shade; consequently, the form of silvicultural system employed must take this fact into account. It makes our choice of cutting system limited to clear cutting and light partial cutting. The partial cutting must be light because of the danger of windfall present when stands of this type are opened up too much. Because of this, no reproduction cut can be made, only light thinnings to salvage mortality followed later by a harvest clear cut after two thinnings have been made. This harvest cut will then, be the reproduction cut. These clear cut areas should seed in naturally by seed from the surrounding timber, as each clear cut will be surrounded by a bank of uncut timber. Since this is Government owned timber and a charge is made for planting when the stumpage is appraised, some of the clear cuts can be planted. Planting is recommended by the author for the following reasons:-

1. A superior strain of seed can be used.[1/]
2. Better spacing can be attained.
3. No time is lost in waiting for natural reproduction.
4. Some erosion can be stopped.

1/ Isaac, Leo A., "Better Douglas-fir from Seed". University of Washington, 1948.

Another consideration with regard to planting is that conditions may prove to indicate that Douglas-fir is not the best species to plant because of the root rot present in this ground. To date there is insufficient knowledge of this disease to predict any future trends as to its seriousness. Since this is an experimental area, it is conceivable to plant other species in the clear cut areas as a kind of crop rotation idea to see whether or not such a practice would reduce the root rot.

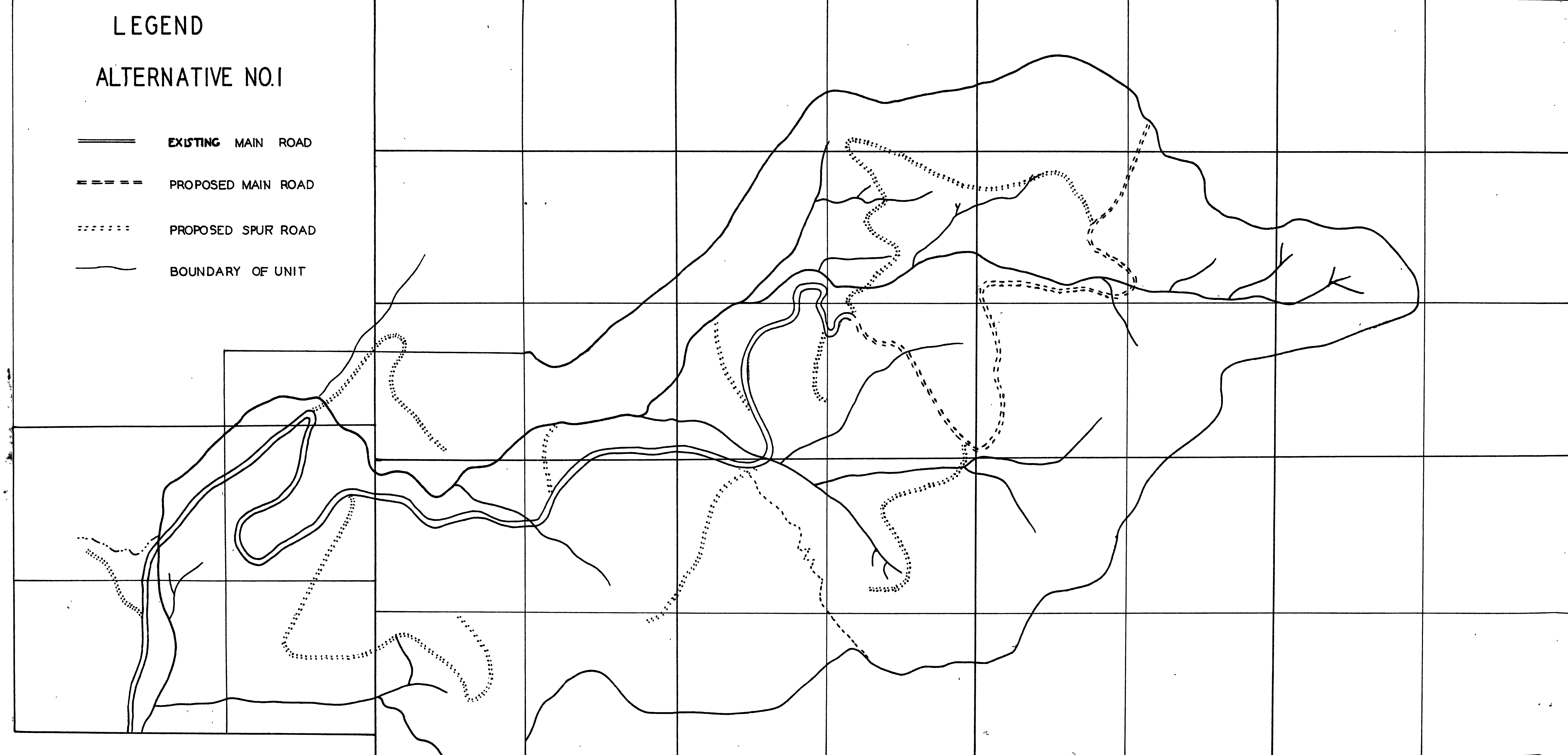
With regard to the advantages and disadvantages of the two Alternatives, in Alternative No. 1 the size of the clear cut areas will be smaller and the chance of large accumulations of slash less. These smaller areas will reduce erosion possibilities some, but not to a very large extent. Other than these, Alternative No. 1 does not have many advantages.

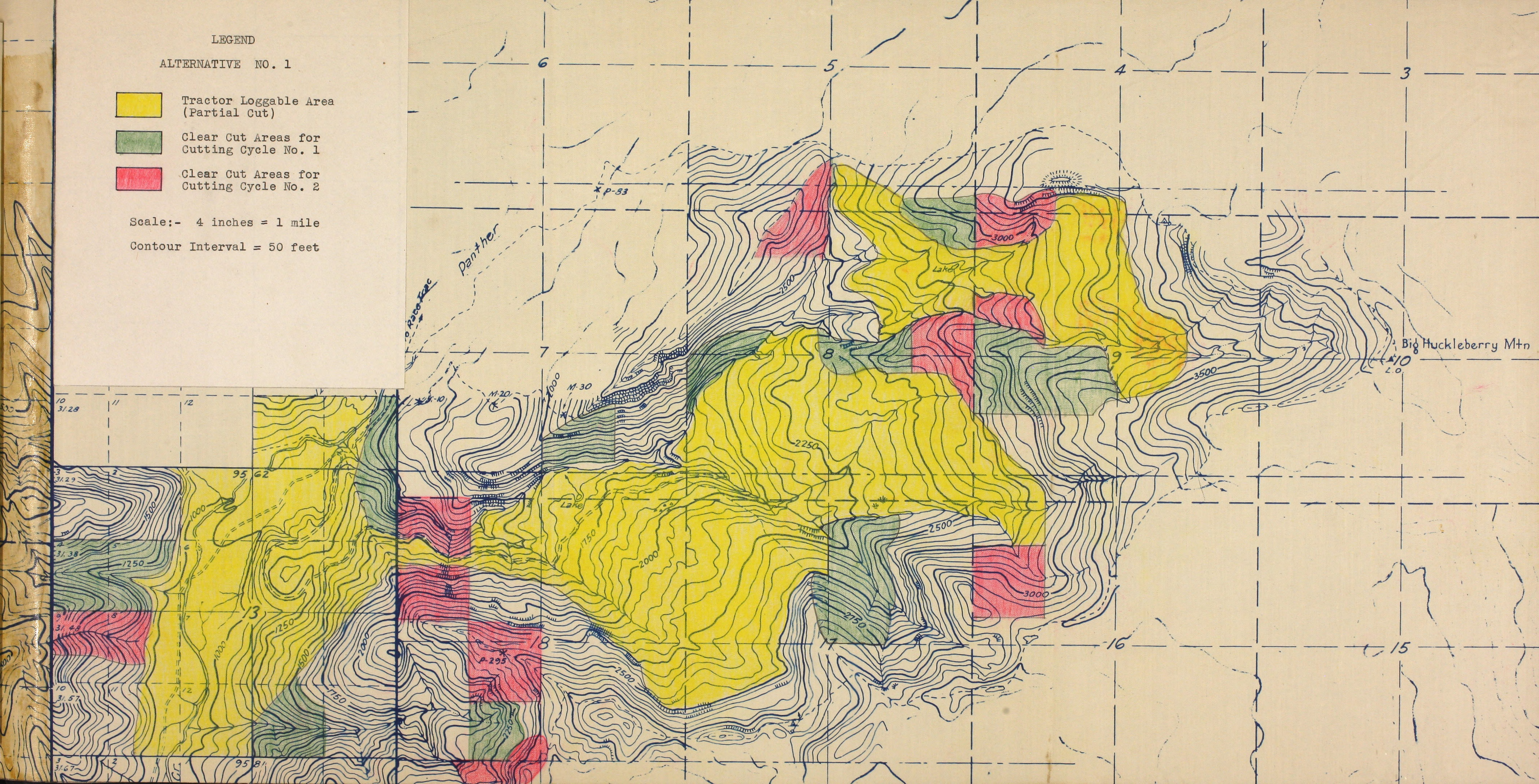
The chief silvicultural advantage of Alternative No. 2 is that the tractor loggable area will be completely cut over by a partial cut which removes the potential mortality in 4 years rather than in 10 years. This will avert loss by Poria weirii earlier and more of the stand will be converted to a better growing condition sooner. The clear cut areas will be larger, which is a disadvantage, but they are placed in such a way that an adequate seed source surrounds each of them.

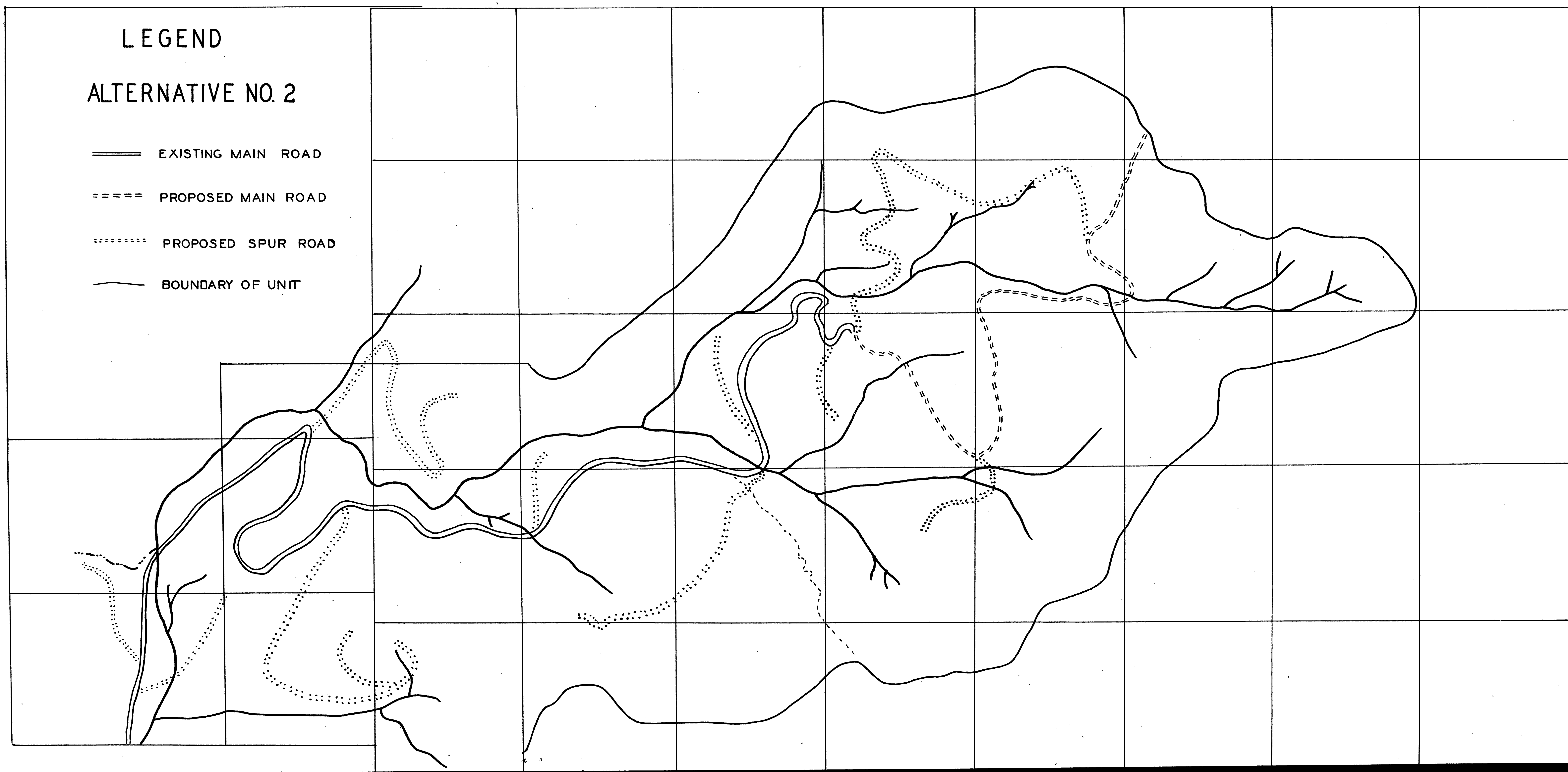
CONCLUSIONS

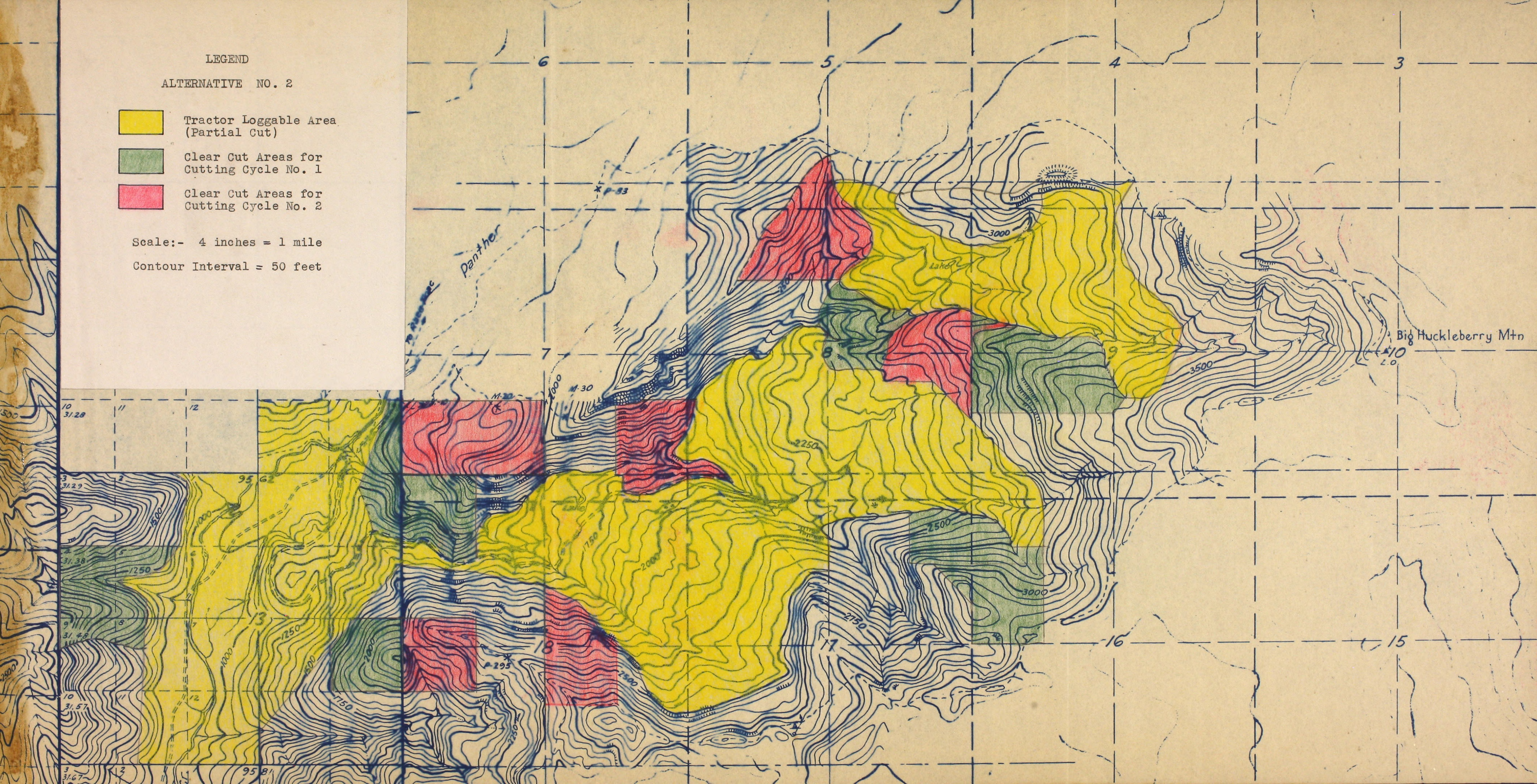
Taking the silvicultural considerations as a whole, Alternative No. 2 seems to be the better of the two methods for this stand. I believe that the disadvantage of the larger size clear cut areas is more than offset by the fact that the mortality in the tractor loggable area will be salvaged sooner and this, the better portion of the area as to site quality, will be put into a more thrifty condition earlier.

The logging cost analysis showed that Alternative No. 2 was better from an economical standpoint, which makes it the better of the two without question.


LEGEND
ALTERNATIVE NO.1
EXISTING MAIN ROAD
PROPOSED MAIN ROAD
PROPOSED SPUR ROAD
BOUNDARY OF UNIT


LEGEND
ALTERNATIVE NO. 1
Tractor Loggable Area (Partial Cut)
Clear Cut Areas for Cutting Cycle No. 1
Clear Cut Areas for Cutting Cycle No. 2
Scale:- 4 inches = 1 mile
Contour Interval = 50 feet
Big Huckleberry Mtn
Panther
Lake
Lake
P-83
P-295
M-20
M-30
2500
3000
3500
2250
2000
1750
1500
1250
1000
2750
6
5
4
3
7
8
9
10
16
15
17
18
13
95 62
95 81


LEGEND
ALTERNATIVE NO. 2
EXISTING MAIN ROAD
PROPOSED MAIN ROAD
PROPOSED SPUR ROAD
BOUNDARY OF UNIT


LEGEND
ALTERNATIVE NO. 2
Tractor Loggable Area (Partial Cut)
Clear Cut Areas for Cutting Cycle No. 1
Clear Cut Areas for Cutting Cycle No. 2
Scale:- 4 inches = 1 mile
Contour Interval = 50 feet
Panther
Big Huckleberry Mtn
L.O.
Lake
3000
3500
2250
2500
2750
2000
1250
1000
6
5
4
3
7
8
9
10
18
17
16
15
13
12

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APPENDIX

Explanation of Tables

Table 1

The figures found in this table were derived by adding the appropriate mean annual increment for the 15 year period to the 1933 volume figures. The 1933 volume figures came from the cruise made in 1933 and described in the text. Approximately 500 board feet per acre per year mean annual growth was used for site III land and 400 board feet per acre per year was used for site IV land.

Table 2

The whole area was divided into two parts, one that because of topography could be logged by tractor, and the other because of steep topography should be logged by some cable system. The dividing line was made on the basis of topography alone. This table shows the area and volume of the "forty" and fraction of "forty" involved in the tractor loggable area.

Table 3

This table, derived the same way as table 2, shows each "forty" and fraction of the "forty" involved in the Cable logging area.

Tables 4, 14, and 19

The compartments mentioned in the text and shown on the maps are delineated on the basis of volume and these tables show the "forties" involved and the volume of each. An effort was made to come as close to the 2,000M annual cut as possible and still keep the compartments in keeping with topography or subdivision survey lines.

Tables 5, 10, 15, and 20

The method for computing average skidding distance in stations of 100 feet each is shown here. The formulae come from Matthew's, "Cost Control in the Logging Industry", page 88.

Tables 6, 11, 16, and 21

The skidding costs were determined as follows:-

Partial Cut

Fixed Skidding .... $2.00 per MBM
Variable Skidding .... $0.20 per MBM per Sta.

Clear Cut

Fixed Skidding .... $2.00 per MBM
Variable Skidding .... $0.15 per MBM per Sta.

The average skidding distances figured in table 5 were multiplied by the variable skidding cost per M per sta. and the fixed skidding cost per M. added to this product.[1] The skidding cost figures were obtained from regional averages for Region 6 of the U. S. Forest Service.

Tables 7, 12, 17, and 22

Hauling distances were scaled off on the map and computed to the nearest tenth of a station. The cost per M for various standards of road comes from data obtained from tim-

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1. Matthews, D. M., "Cost Control in the Logging Industry", P. 80.

ber sales made on the same general area during the past few years.[2]

Tables 8, 13, 18, and 23

The number of stations of spur road and main road to be built each year was determined by scaling off the distances on the map and then using appropriated cost figures for the class of road involved. The cost of spur roads was figured at $5,300 per mile, while main road construction was figured at $10,000 per mile.[2]

Table 9

In this table, the volume to be removed during the second partial cut will be the same as in the first cut. Since 10 years growth will add sufficient volume, the stand will sustain a second thinning to cut to the same degree as the first. The "theoretical clear cut volume" is the 2,000M annual cut minus the volume of partial cut. The "actual volume in clear cut" represents the volume on the actual area laid out. The two figures do not agree exactly because the clear cut areas were located with respect to topography as well as volume.

Tables 24 and 25

These tables show landing costs for the various clear-cut areas involved. The costs were figured on the basis of $100. per landing and include changing the rigging in order to log a complete setting. The number of landings for each

2. Files, District Ranger, Hemlock Ranger Station, Carson, Washington. 1948.

clear-cut was determined by the size of the area and the fact that the "tractor donkey" skidding device used has a mamimum reach of 660 feet. [3]

Tables 26 and 27

These tables show swinging and roading costs for clear-cut settings which are beyond the cable reach of the "tractor donkey". Tractor roading was used whenever topography permitted. These costs were based on use of the same tractor used for skidding and are based on a maximum cable reach of 660 feet.

3. "Hyster Equipment for Logging with "Caterpillar" D 4 Tractors", Hyster Catalog No. 18, Portland, Oregon. 1944.

Table I

COVERTING 1933 VOLUMES TO 1948 VOLUMES

Subdivision	Acres	Net Volume	
		1933	1948
Sec 12		M Bd. Ft.	M Bd. Ft.
SW:SE	40	1210	1530
SE:SE	40	1301	1621
Sec 13			
NE:NE	40	1308	1628
NW:NE	40	1095	1415
SW:NE	40	1430	1750
SE:NE	40	1267	1587
Lot #1	40	795	1015
Lot #2	40	1108	1428
Lot #3	31.3	1096	1336
Lot #4	31.4	402	642
Lot #5	40	625	945
Lot #6	40	927	1247
Lot #7	40	692	1012
Lot #8	40	1043	1363
Lot #9	31.5	309	549
Lot #10	31.6	119	219
Lot #11	40	581	901
Lot #12	40	959	1279
NE:SE	40	1861	2181
NW:SE	40	1419	1739
SW:SE	40	1254	1574
SE:SE	40	1043	1363
Sec 24			
NE:NE	40	128	228
NW:NE	20	43	60
Sec 4			
SW:SW	25	945	1265
Sec 5			
SW:SW	18	610	930
SE:SW	20.5	702	852
SW:SE	13	684	788
SE:SE	14	622	726
Sec 7			
SW:SW	40	190	295
SE:SW	40	1047	1367
NE:SE	40	1096	1416
SW:SE	40	1042	1362
SE:SE	40	1338	1658

Table 1 (Continued - Page 2)

Subdivision	Acres	Net Volume 1933	Net Volume 1948
Sec 8			
NE: NE	40	2556	2876
NW: NE	40	2015	2335
SW: NE	40	2020	2340
SE: NE	40	1899	2219
NE: NW	40	829	1149
NW: NW	40	624	944
SW: NW	40	696	1016
SE: NW	40	1167	1487
NE: SW	40	767	1087
NW: SW	40	728	1048
SW: SW	40	1329	1649
SE: SW	40	1136	1456
NE: SE	40	1134	1454
NW: SE	40	1238	1558
SW: SE	40	1644	1964
SE: SE	40	1411	1731
Sec 9			
NW: NE	26	none	----
SW: NE	40	261	350
SE: NE	40	none	----
NE: NW	40	565	785
NW: NW	40	1515	1835
SW: NW	40	1178	1498
SE: NW	40	641	961
NE: SW	40	286	606
NW: SW	40	410	730
SW: SW	40	37	68
SE: SW	40	none	----
NE: SE	40	43	76
NW: SE	40	554	874
SW: SE	40	none	----
SE: SE	12	none	----
Sec 10			
NW: NW	8	none	----
SW: NW	40	none	150
SE: NW	14	none	----
NE: SW	12	none	100
NW: SW	38	none	100

Table I (Continued - Page 3)

Subdivision	Acres	Net Volume	
		1933	1948
Sec 16			
NW:NW	19	none	----
NE:NW	40	187	407
NW:NW	40	617	937
SW:NW	40	627	947
SE:NW	37	161	240
NW:SW	29	89	166
Sec 17			
NE:NE	40	839	1159
NW:NE	40	1133	1453
SW:NE	40	190	340
SE:NE	40	44	80
NE:NW	40	971	1291
NW:NW	40	1521	1841
SW:NW	40	1634	1954
SE:NW	40	850	1170
NE:SW	40	511	831
NW:SW	40	1721	2041
SW:SW	26	738	1058
SE:SW	27	604	924
NE:SE	40	161	270
NW:SE	40	213	360
SW:SE	22	593	758
Sec 18			
NE:NE	40	1131	1451
NW:NE	40	1370	1690
SW:NE	40	1040	1360
SE:NE	40	1350	1670
NE:NW	40	1057	1377
NW:NW	40	733	1053
SW:NW	40	1113	1433
SE:NW	40	896	1216
NE:SW	40	625	945
NW:SW	40	1534	1854
SW:SW	40	2201	2521
SE:SW	40	1121	1441
NE:SE	40	1389	1709
NW:SE	40	954	1274
SW:SE	40	716	1036
SE:SE	40	1175	1495
Sec 19			
NE:NW	40	1319	1639
NW:NW	40	2211	2531

Table 2

AREA AND PRESENT DAY VOLUMES TO BE LOGGED BY TRACTOR

Section	Forty	No. Acres	Total 1948 Volume	Fraction of Area Involved	Area to Be Partially Cut	Volume to Be Partially Cut
			MBM		Acres	MBM
13	Lot #11	40	901	6/10	24	541
	Lot #8	40	1363	5/10	20	681
	Lot #5	40	945	3/10	12	283
	Lot #12	40	1279	10/10	40	1279
	Lot #7	40	1012	10/10	40	1012
	Lot #6	40	1247	10/10	40	1247
	Lot #1	40	1015	9/10	36	913
	SW:SE	40	1574	1/8	5	218
	NW:SE	40	1739	8/10	32	1390
	NE:SE	40	2181	1/8	5	273
	SW:NE	40	1750	10/10	40	1750
	NW:NE	40	1415	10/10	40	1415
	NE:NE	40	1628	6/10	24	976
	SE:NE	40	1587	7/10	28	1261
12	SW:SE	40	1530	10/10	40	1530
	SE:SE	40	1621	7/10	28	1135
5	SW:SE	13	788	5/10	6	394
18	SW:NW	40	1433	3/10	12	429
	NW:NW	40	1053	1/10	4	105
	NE:NW	40	1377	5/10	20	688
	SE:NW	40	1216	4/10	16	486
	SW:NE	40	1360	7/10	28	952
	NW:NE	40	1690	10/10	40	1690
	NE:NE	40	1451	10/10	40	1451
	SE:NE	40	1670	10/10	40	1670
	NE:SE	40	1709	7/10	28	1196
	SE:SE	40	1495	1/10	4	149
17	SW:SW	26	1058	2/10	6	212
	NW:SW	40	2041	10/10	40	2041
	SW:NW	40	1954	10/10	40	1954
	NW:NW	40	1841	10/10	40	1841
	NE:NW	40	1291	10/10	40	1291
	SE:NW	40	1170	7/10	28	819
	NE:SW	40	831	4/10	16	332
	NW:NE	40	1453	6/10	24	872
	NE:NE	40	1159	5/10	20	580

Table 2 (Continued - Page 2)

AREA AND PRESENT DAY VOLUMES TO BE LOGGED BY TRACTOR

Section	Forty	No. Acres	Total 1948 Volume	Fraction of Area Involved	Area to Be Partially Cut	Volume to Be Partially Cut
			MBM		Acres	MBM
8	SW:SW	40	1649	10/10	40	1649
	NW:SW	40	1048	4/10	16	419
	NE:SW	40	1087	7/10	28	761
	SE:SW	40	1456	10/10	40	1456
	SW:SE	40	1964	10/10	40	1964
	NW:SE	40	1558	5/10	20	779
	SW:NE	40	2340	3/10	12	702
	NW:NE	40	2335	5/10	20	1167
	NE:NE	40	2876	4/10	16	1150
	SE:NE	40	2219	6/10	24	1331
	NE:SE	40	1454	4/10	16	582
	SE:SE	40	1731	10/10	40	1731
16	NW:NW	40	937	6/10	24	562
9	SW:SW	40	68	2/10	8	14
	SW:NW	40	1498	7/10	28	909
	NW:NW	40	1835	3/10	12	559
	NE:NW	40	785	10/10	40	785
	SE:NW	40	961	10/10	40	961
	NE:SW	40	606	3/10	12	182
	NW:SE	40	874	9/10	36	786
	SW:NE	40	350	6/10	24	210
				Totals	1532	53415

Table 3

AREA AND PRESENT DAY VOLUMES TO BE LOGGED BY CABLE

Section	Forty	No. Acres	Total 1948 Volume	Fraction of Area Involved	Area to be Clear Cut	Volume to be Clear Cut
			MBM		Acres	MBM
13	Lot #10	31.6	219	10/10	31.6	219
	Lot #11	40	901	4/10	16	360
	Lot #9	31.5	549	10/10	31.5	549
	Lot #8	40	1363	5/10	20	782
	Lot #4	31.4	642	10/10	31.4	642
	Lot #5	40	945	7/10	28	661
	Lot #3	31.3	1336	10/10	31.3	1336
	Lot #2	40	1428	10/10	40	1428
	Lot #1	40	1015	1/10	4	102
	SW:SE	40	1574	7/8	35	1376
	NW:SE	40	1739	2/10	8	348
	SE:SE	40	1363	10/10	40	1363
	NE:SE	40	2181	7/8	35	1910
	SE:NE	40	1587	3/10	12	476
	NE:NE	40	1628	4/10	16	652
24	NW:NE	20	60	10/10	20	60
	NE:NE	40	228	10/10	40	228
5	SE:SW	20.5	852	1/10	2.1	85
19	NW:NW	40	2531	5/10	20	1265
	NE:NW	40	1639	4/10	16	656
18	SW:SW	40	2521	10/10	40	2521
	NW:SW	40	1854	10/10	40	1854
	SW:NW	40	1433	7/10	28	1003
	NW:NW	40	1053	9/10	36	949
	NE:NW	40	1377	5/10	20	688
	SE:NW	40	1216	6/10	24	729
	NE:SW	40	945	10/10	40	945
	SE:SW	40	1441	10/10	40	1441
	SW:SE	40	1036	5/10	20	518
	NW:SE	40	1274	10/10	40	1274
	SW:NE	40	1360	3/10	12	408
	NE:SE	40	1709	3/10	12	514
	SE:SE	40	1495	5/10	20	748
12	SE:SE	40	1621	3/10	12	487

Table 3 (Continued - Page 2)

AREA AND PRESENT DAY VOLUMES TO BE LOGGED BY CABLE

Section	Forty	No. Acres	Total 1948 Volume	Fraction of Area Involved	Area to be Clear Cut	Volume to be Clear Cut
			MBM		Acres	MBM
17	SW:SW	26	1058	8/10	18	847
	SE:NW	40	1170	3/10	12	351
	NE:SW	40	831	6/10	24	498
	SE:SW	27	270	10/10	27	270
	SW:SE	22	758	10/10	22	758
	NW:SE	40	360	10/10	40	360
	SW:NE	40	340	10/10	40	340
	NW:NE	40	1453	4/10	16	580
	NE:NE	40	1159	5/10	20	580
	SE:NE	40	80	10/10	40	80
	NE:SE	40	270	10/10	40	270
8	NW:SW	40	1048	6/10	24	629
	SW:NW	40	1016	5/10	20	508
	NE:NW	40	1149	7/10	28	804
	NW:NE	40	2335	4/10	16	934
	SW:NE	40	2340	7/10	28	1638
	NW:SE	40	1558	5/10	20	780
	NE:SE	40	1454	6/10	24	873
	SE:NW	40	1487	10/10	40	1487
	NE:SW	40	1087	3/10	12	326
	NE:NE	40	2876	4/10	16	1150
	SE:NE	40	2219	4/10	16	887
9	SW:SW	40	68	8/10	32	54
	NW:SW	40	730	10/10	40	730
	SW:NW	40	1498	3/10	12	450
	NW:NW	40	1835	5/10	20	917
	NE:SW	40	606	7/10	28	424
16	NW:SW	29	166	5/10	15	83
	SW:NW	40	947	10/10	40	947
	NW:NW	40	937	4/10	16	375
	SE:NW	37	240	2/10	7	48
7	SW:SW	40	295	10/10	40	295
	SE:SW	40	1367	10/10	40	1367
	SW:SE	40	1362	10/10	40	1362
	SE:SE	40	1658	10/10	40	1658
	NE:SE	40	1416	2/10	8	283
				Totals	1783	52,520

Table 4

Alternative No. 1 Cutting Cycle No. 1

Year of Cut	Compartment	Method of Logging: Tractor (Partial cut): Subdivision	Vol.	Cable (clear cut): Subdivision	Vol.	Remarks
			MBM		MBM	
1949	1	13- Lot 11	83	13- Lot 4	554	Easy show
		13- Lot 12	195	13- Lot 5	661	only ¼ mile
		13- Lot 8	104			spur road
		13- Lot 7	155			to build.
		13- SW:SE	33			
		13- NW:SE	211			
		13- Lot 5	17			
		Total	798	Total	1215	
1950	2	13- Lot 6	193	12- SE:SE	499	About ½ mile
		13- Lot 5	27	13- NE:NE	668	of spur road
		13- Lot 1	142			to be built
		12- SW:SE	255			from Mouse
		13- NW:NE	218			Creek junct-
		13- NE:NE	51			ion with
		13- SW:NE	88			Panther Creek
		Total	974	Total	1167	to SW:SW
						section 7.
1951	3	12- SE:SE	176	13- SW:SE	1170	About ½
		13- NE:NE	97			mile of
		13- SE:NE	196			spur road
		13- NE:SE	41			to build
		13- SW:NE	180			into clear-
		18- SW:NW	65			cut in
		18- SE:NW	75			SW:SE,
		Total	830	Total	1170	section 13
1952	4	18- NE:NW	109	7- SW:SE	1191	1/8 mile of
		18- NW:NE	266			spur road
		18- SW:NE	151			to landing
		18- NE:NE	230			in SW:SE,
		18- SE:NE	53			section 7
		Total	809	Total	1191	
1953	5	18- SE:NE	230	18- SE:SW	1185	Extend the
		17- NW:NW	291			road started
		17- SW:NW	308			in 1951
		Total	829	Total	1185	about ½ mile
						and build 3/8
						mile spur road
						into SE:NE of
						section 18

Table 4 (Continued - Page 2)

Alternative No. 1 Cutting Cycle No. 1

Year of Cut	Compartment	Method of Logging: Tractor (partial cut): Subdivision	Vol. (MBM)	Method of Logging: Cable (clear cut): Subdivision	Vol. (MBM)	
1954	6	18- NE:SE	192	17- SW:NE	460	Extend main road
		17- NW:SW	324	17- NW:NE	628	for ¼ mile,
		17- SW:SW	34	17- NE:NE	93	build ¼
		17- NE:SW	54			mile spur
		18- SE:SE	23			road into
		17- SE:NW	135			clear-cut.
		17- NE:NW	77			
		Total	839	Total	1181	
1955	7	17- NE:NW	145	8- NW:SW	629	Build ¼
		8- SW:SW	268	8- SW:NW	250	mile spur
		8- NW:SW	69	8- NE:SW	326	into SW:SW
		8- SE:SW	239			of section
		8- NE:SW	131			8
		Total	1148	Total	1205	
1956	8	8- NW:SE	129	8- NW:SE	800	Build ¼
		8- SW:SE	322	8- NE:SW	25	mile spur
		17- NW:NE	145			through
		17- NE:NE	99			NW:SE of
		16- NW:NW	98			section 8
		9- SW:SW	2			for the
		8- SE:SE	284			clear-cut.
		8- NE:SE	99			
			1178	Total	825	
1957	9	8- SW:NE	113	8- NE:NE	1220	Extend
		8- NW:NE	189			spur road
		5- SW:SE	63			built last
		8- NE:NE	183			year on
		8- SE:NE	216			through
		9- SW:NW	154			the NE:NE
		9- NW:NW	92			of section
		Total	1010	Total	1220	8 for the clear-cut, a distance of 3/4 mile.

Table 4 (Continued - Page 3)

Alternative No. 1 Cutting Cycle No. 1

Year of Cut	Compartment	Method of Logging: Tractor (partial cut): Subdivision	Vol	Cable (clear cut): Subdivision	Vol.	Remarks
			MBM		MBM	
1958	10	9- NE:SW	36	9- NE:SW	564	
		9- SE:NW	174	9- NW:SW	870	
		9- NE:NW	148	9- SW:NW	150	
		9- SW:NE	39			
		9- NW:SE	148			
		Total	545	Total	1584	
Total			8664		11943	

Table 5

COMPUTING AVERAGE SKIDDING DISTANCES

Alternative No. 1 Cutting Cycle No. 1

Year of Cut	Comp.	Type of Cut	Formula that Applies	Explanation of Formula Symbols	Average Skidding Distance in Stations of 100'
1949	1	Partial	.523E	E is External	.523 x 18.1 = 9.48
		Clear	.746E	Distance	.746 x 6.60 = 4.92
1950	2	Partial	D/2	D is Max. skid Distance	9.9/2 = 4.95
		Clear	.578E .707E	External distance is the Radius of Circle.	.578 x 3.3 = 1.91 .707 x 7.0 = 4.95
1951	3	Partial	D/2	D is Max. skid Distance	11.5/2 = 5.75
		Clear	.746E	External distance from road to cutting boundary	.746 x 6.6 = 4.90
1952	4	Partial	D/2	Average Max. Skid distance	13.2/2 = 6.60
		Clear	.578E	External distance, boundary to boundary.	.578 x 5.7 = 3.30
1953	5	Partial	D/2	D is average Max. Skid Distance.	9.9/2 = 4.95
		Clear	.746E	External distance from Boundary to Boundary.	.746 x 6.6 = 4.92
1954	6	Partial	D/2	D is Distance through previously logged Area.	19.8/2 = 9.9
		Clear	.746E	E is External Distance to Back of Set	.746 x 5.8 = 4.32

Table 5 (Continued - Page 2)

COMPUTING AVERAGE SKIDDING DISTANCES

Alternative No. 1 Cutting Cycle No. 1

Year of Cut	Comp.	Type of Cut	Formula that Applies	Explanation of Formula Symbols	Average Skidding Distance in Stations of 100'
1955	7	Partial	D/2	D is Same	9.05/2 = 4.52
		Clear	.578E	E is Ext. Distance	.578 x 6.6 = 3.82
1956	8	Partial	D/2	D is Distance through Previously Logged Area.	9.9/2 = 4.95
		Clear	.578E	E is Ext. Distance.	.578 x 6.6 = 3.82
1957	9	Partial	D/2	D is same as above.	11.2/2 = 5.60
		Clear	.707E	E is Radius of Circle.	.707 x 5.9 = 4.16
1958	10	Partial	D/2	D is same as above.	13.2/2 = 6.6
		Clear	.523E	E is Ext. Distance.	.523 x 6.6 = 3.45

Table 6

SKIDDING COSTS

Alternative No. 1 — Cutting Cycle No. 1

Year of Cut	Compa-rtment	Volume in MBM		Partial Cut		Clear Cut		Total
		Partial Cut	Clear Cut	Ave. Skid Dist.	Cost Per MBM	Ave. Skid Dist.	Cost Per MBM	Ave. Cost Per M
1949	1	798	1215	9.5	3.90	4.9	2.74	3.32
1950	2	974	1167	4.9	2.98	3.8	2.57	2.77
1951	3	830	1170	5.7	3.14	4.9	2.74	2.94
1952	4	809	1191	6.6	3.32	3.3	2.49	2.90
1953	5	829	1185	4.9	2.98	4.9	2.74	2.86
1954	6	839	1181	9.9	3.98	4.3	2.64	3.31
1955	7	1148	1205	4.5	2.90	3.8	2.57	2.73
1956	8	1178	825	4.9	2.98	3.8	2.57	2.77
1957	9	1010	1220	5.6	3.12	4.2	2.63	2.87
1958	10	545	1584	6.6	3.32	3.4	2.51	2.91

Table 7

HAULING DISTANCES AND COSTS

Alternative No. 1 — Cutting Cycle No. 1

Year of Cut	Compartment	Spur Roads		Main Road		Total
		Distance in Stations	Cost Per M @ 4¢/sta.	Distance in Stations	Cost Per M @3¢/sta.	Cost Per MBM
			cents		cents	cents
Partial Cuts						
1949	1	--	--	13.2	3.9	3.9
1950	2	--	--	49.5	14.9	14.9
1951	3	--	--	99.0	29.7	29.7
1952	4	8	3.2	161.7	48.5	51.7
1953	5	18	7.2	198.0	59.5	66.7
1954	6	20	8.0	198.0	59.5	67.5
1955	7	9.9	3.9	217.8	65.2	69.1
1956	8	9.9	3.9	267.3	80.2	84.1
1957	9	39.6	15.8	257.4	77.2	93.0
1958	10	3.3	1.3	346.5	104.1	105.4
Clear Cuts						
1949	1	13.2	5.3	13.2	3.9	9.2
1950	2	19.8	7.9	69.3	20.8	28.7
1951	3	26.4	10.6	108.9	32.7	43.3
1952	4	28.0	11.2	155.1	46.5	47.7
1953	5	14.8	5.9	108.9	32.7	38.6
1954	6	33.0	13.2	295.3	88.6	101.8
1955	7	18.1	7.2	202.9	60.8	68.0
1956	8	8.2	3.3	257.4	77.2	80.5
1957	9	49.5	19.8	257.4	77.2	97.0
1958	10	--	--	326.7	98.0	98.0

Table 8

ROAD CONSTRUCTION COSTS

Alternative No. 1 — Cutting Cycle No. 1

Year of Cut	Comp.	Spur Road		Main Road		Volume to Charge Roads to	Total Cost Per M for all Roads.
		No. Sta.	Cost @ $100. Per Sta.	No. Sta.	Cost @ $190. Per Sta.		
1949	1	19.8	$1980	--	--	1215	$1.63
1950	2	26.4	$2640	--	--	1167	$2.26
1951	3	28.0	$2800	--	--	1170	$2.39
1952	4	14.8	$1480	--	--	2010	$0.74
1953	5	66.0	$6600	--	--	2014	$3.28
1954	6	33.0	$3300	21.4	$4060	1181	$6.24
1955	7	18.1	$1810	--	--	1587	$1.14
1956	8	18.1	$1810	--	--	2003	$0.90
1957	9	49.5	$4950	--	--	2330	$2.12
1958	10	33.0	$3300	29.7	$5643	2129	$4.15

Table 9

Alternative No. 1 Cutting Cycle No. 2

Year of Cut	Comp.	Partial Cut Volume	Theoretical Clear Cut Vol.	Location of Clear Cut	Actual Volume in Clear Cut	Remarks
		MBM	MBM		MBM	
1959	1	798	1202	13- #8 13- #9 Total	668 542 1210	1/8 mile spur road into Lot #8.
1960	2	974	1026	18- NW:NW	1165	Continue spur road built in 1950.
1961	3	830	1170	18- SW:NW	1195	¼ mile spur road into forty.
1962	4	809	1191	18- NE:SW	1225	Continue spur road ¼ mile.
1963	5	829	1171	19- NE:NW 18- SE:SW 19- NW:NW 18- SW:SE Total	676 301 100 100 1177	Extend spur ¼ mile.
1964	6	839	1161	16- SW:NW	1200	¼ mile spur.
1965	7	852	1148	8- SE:NE 8- NE:SE Total	576 1077 1653	1/8 Mile spur
1966	8	1178	822	9- SW:NW	558	Only 1/8 mile spur.
1967	9	1010	990	8- NE:NW 5- SE:SW Total	1010 85 1095	
1968	10	545	1445	9- NW:NW	1117	Road already in.
Total		8664			11595	

Table 10

COMPUTING AVERAGE SKIDDING DISTANCE

Alternative No. 1 Cutting Cycle No. 2

Year of Cut	Comp.	Type of Cut	Formula that Applies	Explanation of Formula Symbols	Average Skidding Distance in Sta. of 100 ft.
1959	1	Partial Clear	.523E .576E	E is dist. from road to boundary.	.523 x 18.1 = 9.48 .576 x 6.6 = 3.82
1960	2	Partial Clear	D/2 .746E	D is Ave. Max. Skid dist.	9.9/2 = 4.95 .746 x 6.6 = 4.92
1961	3	Partial Clear	D/2 .578E	Average Max. Skid dist.	11.5/2 = 5.75 .578 x 6.0 = 3.46
1962	4	Partial Clear	D/2 .746E	Average Max. Skid dist.	13.2/2 = 6.60 .746 x 6.6 = 4.92
1963	5	Partial Clear	D/2 .746E	Average Max. Skid dist.	9.9/2 = 4.95 .746 x 5.7 = 4.32
1964	6	Partial Clear	D/2 .746E	D is dist. through old Logging area.	18.4/2 = 9.2 .746 x 5.9 = 4.40
1965	7	Partial Clear	D/2 .707E	D is dist. through old Logging area.	9.05/2 = 4.52 .707 x6 = 4.24
1966	8	Partial Clear	D/2 .707E	D is dist. through old Logging area.	9.9/2 = 4.95 .707 x 3.3 = 2.33
1967	9	Partial Clear	D/2 .523E	D is dist. through old Logging area.	11.2/2 = 5.60 .523 x 6.6 = 3.46
1968	10	Partial Clear	D/2 .578E	D is dist. through old Logging area.	13.2/2 = 6.6 .578 x 4.0 = 2.32

Table 11

SKIDDING COSTS

Alternative No. 1 Cutting Cycle No. 2

Year of Cut	Compartment	Volume in MBM		Partial Cut		Clear Cut		Total Average Cost Per MBM
		Partial Cut	Clear Cut	Ave. Skid. Dist.	Cost Per MBM	Ave. Skid Dist.	Cost Per MBM	
1959	1	798	1202	9.5	3.90	3.8	2.57	3.23
1960	2	974	1026	4.9	2.98	4.9	2.73	2.85
1961	3	830	1170	5.7	3.14	3.5	2.52	2.83
1962	4	809	1191	6.6	3.32	4.9	2.73	3.02
1963	5	829	1171	4.9	2.98	4.3	2.64	2.81
1964	6	839	1161	9.9	3.98	4.4	2.66	3.32
1965	7	852	1148	4.5	2.90	4.2	2.63	2.76
1966	8	1178	822	4.9	2.98	2.3	2.34	2.66
1967	9	1010	990	5.6	3.12	3.5	2.52	2.82
1968	10	545	1445	6.6	3.32	2.3	2.34	2.83

Table 12

HAULING DISTANCES AND COSTS

Alternative No. 1 Cutting Cycle No. 2

Year of Cut	Compartment	SPUR Roads Distance in Stations	SPUR Roads Cost Per M @ 4¢/sta.	Main Roads Distance in Stations	Main Roads Cost Per M @ 3¢/sta.	Total Cost Per MBM
			cents		cents	cents
			Partial Cuts			
1959	1					
1960	2					
1961	3					
1962	4					
1963	5					
1964	6	SAME AS FOR CUTTING CYCLE NO. 1				
1965	7					
1966	8					
1967	9					
1968	10					
			Clear Cuts			
1959	1	13.2	5.3	13.2	3.9	9.2
1960	2	34.6	13.8	69.3	20.4	34.2
1961	3	--	--	130.1	39.1	39.1
1962	4	54.4	21.7	108.9	32.7	54.4
1963	5	46.2	18.5	108.9	32.7	51.2
1964	6	23.1	9.2	295.3	88.6	97.8
1965	7	6.6	2.6	321.7	96.5	99.1
1966	8	--	--	328.3	98.4	98.4
1967	9	46.2	18.5	257.4	77.1	95.6
1968	10	62.7	25.1	257.4	77.1	102.2

Table 13

ROAD CONSTRUCTION COSTS

Alternative No. 1 Cutting Cycle No. 2

Year of Cut	Compartment	No. Sta.	Cost @ $100. Per Sta.	No. Sta.	Cost @ $190. Per Sta.	Volume to Charge Roads to	Total Cost Per M for All Roads
1959	1	---	---	---	---	---	None
1960	2	8.2	$820	---	---	1026	$0.80
1961	3	---	---	---	---	---	None
1962	4	21.4	$2140	---	---	1191	$1.79
1963	5	13.2	$1320	---	---	1171	$1.13
1964	6	---	---	---	---	---	None
1965	7	6.6	$ 660	---	---	1148	$0.58
1966	8	---	---	---	---	---	None
1967	9	13.2	$1320	---	---	990	$1.33
1968	10	---	---	---	---	---	None

Table 14

Alternative No. 2 | Cutting Cycle No. 1

Year of Cut	Comp.	Method of Logging — Tractor (partial cut): Subdivision	Tractor (partial cut): Volume	Cable (clear cut): Subdivision	Cable (clear cut): Vol.	Remarks
			MBM			
		13- Lot 11	83			Easy show
		13- Lot 12	195			
		13- Lot 8	104			
		13- Lot 7	153			
		13- SW:SE	33			
		13- NW:SE	211			
		13- Lot 5	17			
1949	1	13- Lot 6	189			
		13- Lot 5	26			
		13- Lot 1	140			
		12- SW:SE	242			
		13- NW:NE	214			
		13- NE:NE	50			
		13- SW:NE	87			
		12- SE:SE	174			
		13- NE:NE	96			
		Total	2014			
		13- SE:NE	194			¼ mile of spur road to be built into the NW:NE of Sec. 18 and 3/8 mile spur road into SE:NE Sec. 18.
		13- NE:SE	41			
		13- SW:NE	177			
		18- SW:NW	64			
		18- SE:NW	73			
1950	2	18- NE:NW	106			
		18- NW:NE	260			
		18- SW:NE	145			
		18- NE:NE	224			
		18- SE:NE	50			
		18- SE:NE	215			
		17- NW:NW	282			
		17- SW:NW	299			
		Total	2130			
		18- NE:SE	186			Build ¼ mile spur road through SW:SW of Sec. 8.
		17- NW:SW	316			
		17- SW:SW	33			
		17- NE:SW	52			
		18- SE:SE	82			
		17- SE:NW	129			
		17- NE:NW	75			and
1951	3	17- NE:NW	130			
		8- SW:SW	256			Complete main road to N W corner Sec. 16.
		8- NW:SW	64			
		8- SE:SW	227			
		8- NE:SW	120			
		8- NW:SE	121			
		8- SW:SE	304			
		8- NE:SE	91			
		Total	2116			

Table 14 (Continued - Page 2)

Alternative No. 2 Cutting Cycle No. 1

Year of Cut	Comp.	Method of Logging: Tractor (partial cut): Subdivision	Volume	Cable (clear cut): Subdivision	Vol.	Remarks
1952	4	17- NW:NE	135			Build spur road from end of existing road through the NW $\frac{1}{4}$ of Sec. 8 on to the NW:NW of Sec. 9 to serve compartments 9 and 10.
		17- NE:NE	93			
		16- NW:NW	90			
		9- SW:SW	2			
		8- SE:SE	272			
		8- SW:NE	109			
		8- NW:NE	181			
		5- SW:SE	61			
		8- NE:NE	177			
		8- SE:NE	207			
		9- SW:NW	145			
		9- NW:NW	87			
		9- NE:SW	29			
		9- SE:NW	156			
		9- NE:NW	130			
		9- SW:NE	32			
		9- NW:SE	129			
		Total	2035			
1953	5			13- Lot 4	704	$\frac{1}{4}$ mile spur road through Lots 8 and 9 into 4 and 5.
				13- Lot 5	667	
				13- 1/3 Lot 9	203	
				13- $\frac{1}{2}$ Lot 8	441	
				Total	1985	
1954	6			12- SE:SE	517	$\frac{1}{2}$ mile spur into NW:NW 18.
				13- NE:NE	692	
				18- NW:NW	1039	
				Total	2148	
1955	7			13- NE:SE	2015	Build $\frac{1}{2}$ mile spur.
				Total	2015	
1956	8			16- SW:NW	1087	3/8 mile of spur road from main at road NW corner 16.
				16- NW:NW	431	
				17- NE:NE	650	
				Total	2168	
1957	9			8- NW:SE	430	Extend a spur road from existing road into clear cut.
				8- NE:SW	125	
				8- SE:NW	198	
				8- SW:NE	1247	
				Total	2000	

Table 14 (Continued - Page 3)

Alternative No. 2 Cutting Cycle No. 1

Year of Cut	Comp.	Method of Logging: Tractor (partial cut): Subdivision	Volume	Cable (clear cut): Subdivision	Vol.	Remarks
1958	10			9- NE:SW	1260	½ mile of main road.
				9- NW:SW	910	
				Total	2170	

Table 15

COMPUTING AVERAGE SKIDDING DISTANCES

Alternative No. 2 Cutting Cycle No. 1

Year of Cut	Comp.	Type of Cut	Formula that Applies	Explanation of formula Symbols	Average Skidding Distance in Stations of 100'
1949	1	Partial	.514E	E is external distance, road to edge of cut.	.514 x 12 = 6.16
1950	2	Partial	D/2	D is Av. Max. direct Skid. Distance	16.5/2 = 8.25
1951	3	Partial	D/2	Same as above	18/2 = 9.00
1952	4	Partial	D/2	Same as above	9.9/2 = 4.95
1953	5	Clear	.746E	Same as above	.746 x 5.90 = 4.40
1954	6	Clear	.707E	E is Radius of Circular Set.	.707 x 6.0 = 4.23
1955	7	Clear	.746E	E is External Skidding Dist.	.746 x 6.6 = 4.92
1956	8	Clear	.578E	Same as above	.578 x 6.6 = 3.82
1957	9	Clear	.707E	E is Radius of Circular Set	.707 x 6.6 = 4.65
1958	10	Clear	.578E	E is External Skidding Dist.	.578 x 5.6 = 3.24

Table 16

SKIDDING COSTS

Alternative No. 2 — Cutting Cycle No. 1

Year of Cut	Compartment	Volume in MBM: Partial Cut	Volume in MBM: Clear Cut	Partial Cut: Ave. Skid Dist.	Partial Cut: Cost Per MBM	Clear Cut: Ave. Skid Dist.	Clear Cut: Cost Per MBM	Total Ave. Cost Per M.
1949	1	2014	---	6.1	3.22	---	---	3.22
1950	2	2130	---	8.2	3.64	---	---	3.64
1951	3	2116	---	9.0	3.80	---	---	3.80
1952	4	2035	---	4.9	2.98	---	---	2.98
1953	5	---	1985	---	---	4.4	2.66	2.66
1954	6	---	2148	---	---	4.2	2.63	2.63
1955	7	---	2015	---	---	4.9	2.74	2.74
1956	8	---	2168	---	---	3.8	2.57	2.57
1957	9	---	2000	---	---	4.6	2.69	2.69
1958	10	---	2170	---	---	3.2	2.48	2.48

Table 17

HAULING DISTANCES AND COSTS

Alternative No. 2 Cutting Cycle No. 1

Year of Cut	Compartment	Partial Cuts and Clear Cuts				
		Spur Roads		Main Roads		Total Cost Per M
		Distance in Stations	Cost Per M @ 4¢/sta.	Distance in Stations	Cost Per M @ 3¢/sta.	
			cents		cents	cents
1949	1	9.9	3.9	42.9	12.9	16.8
1950	2	9.9	3.9	165.0	49.5	53.4
1951	3	9.9	3.9	243.3	70.2	74.1
1952	4	46.2	18.1	303.6	91.2	109.3
1953	5	21.4	8.5	16.5	4.9	13.4
1954	6	29.7	11.9	69.3	20.8	32.7
1955	7	59.4	23.8	108.9	32.6	56.4
1956	8	19.8	7.9	280.5	84.0	91.9
1957	9	13.2	5.3	254.1	76.2	81.5
1958	10	---	---	308.7	92.6	92.6

Table 18

ROAD CONSTRUCTION COSTS

Alternative No. 2 Cutting Cycle No. 1

Year of Cut	Comp.	Spur Road		Main Road		Volume to Charge Roads to	Total Cost Per M for all Roads
		No. Sta.	Cost @ $100. Per Sta.	No. Sta.	Cost @ $190. Per Sta.		
1949	1	18.2	$1820	---	---	2014	$0.91
1950	2	42.9	$4290	---	---	2130	$2.01
1951	3	14.8	$1480	23.1	$4390	2116	$3.06
1952	4	79.2	$7920	---	---	2035	$3.89
1953	5	24.7	$2470	---	---	1985	$1.24
1954	6	34.6	$3460	---	---	2148	$1.61
1955	7	39.6	$3960	---	---	2015	$1.96
1956	8	19.8	$1980	---	---	2168	$0.91
1957	9	---	---	---	---	---	None
1958	10	---	---	26.4	$5020	2170	$2.31

Table 19

Alternative No. 2 Cutting Cycle No. 2

Year of Cut	Compartment	Method of Logging				Remarks
		Partial Cut		Clear Cut		
		Subdivision	Volume	Subdivision	Vol.	
			MBM		MBM	
1959	1	See	2014			The roads
1960	2	Table	2130			will
1961	3	14	2116			already be
1962	4		2035			in from C. C. No. 1.
1963	5			7- SW:SW	445	½ mile spur
				7- SE:SW	1667	into the
				Total	2112	SE:SW #7.
1964	6			18- NW:SW	2174	Continue
				Total	2174	spur built into NE:SE 13 on into NW:SW #18.
1965	7			18- NW:SE	1594	Extend spur
				18- SW:NE	510	built last
				Total	2104	year for ¼ mile.
1966	8			7- SE:SE	2018	¼ mile
				Total	2018	spur.
1967	9			5- SE:SW	104	¼ mile spur
				8- NE:NW	1070	road from
				8- NW:NE	1087	spur road
				Total	2261	built before (long one).
1968	10			8- NE:SE	1113	
				8- SE:NE	707	
				8- NW:SE	690	
				Total	2510	

Table 20

COMPUTING AVERAGE SKIDDING DISTANCES

Alternative No. 2 Cutting Cycle No. 2

Year of Cut	Comp.	Type of Cut	Formula that Applies	Explanation of Formula Symbols	Average Skidding Distance in Sta. of 100'.
1959	1	Partial	.514E	E is external dist. from road to edge of cutting.	.514 x 12 = 6.16
1960	2	Partial	D/2	D is Average Max. skid Distance.	16.5/2 = 8.25
1961	3	Partial	D/2	Same as above	18/2 = 9.00
1962	4	Partial	D/2	Same as above	9.9/2 = 4.95
1963	5	Clear	.578E	E is External Skidding Dist.	.578 x 6.2 = 3.58
1964	6	Clear	.523E	Same as above	.523 x 6.6 = 3.45
1965	7	Clear	.746E	Same as above	.746 x 4.5 = 3.36
1966	8	Clear	.578E	Same as above	.578 x 6.6 = 3.82
1967	9	Clear	.523E	Same as above	.523 x 6.6 = 3.45
1968	10	Clear	.746E	Same as above	.746 x 6.6 = 4.92

Table 21

SKIDDING COSTS

Alternative No. 2   Cutting Cycle No. 2

Year of Cut	Compartment	Volume in MBM		Partial Cut		Clear Cut		Total Average Cost Per MBM
		Partial Cut	Clear Cut	Ave. Skid Dist.	Cost Per MBM	Ave. Skid Dist.	Cost Per MBM	
1959	1	2014	---	6.1	3.22	---	---	3.22
1960	2	2130	---	8.2	3.64	---	---	3.64
1961	3	2116	---	9.0	3.80	---	---	3.80
1962	4	2035	---	4.9	2.98	---	---	2.98
1963	5	---	2112	---	---	3.6	2.54	2.54
1964	6	---	2174	---	---	3.4	2.51	2.51
1965	7	---	2014	---	---	3.4	2.51	2.51
1966	8	---	2018	---	---	3.8	2.57	2.57
1967	9	---	2261	---	---	3.4	2.51	2.51
1968	10	---	2510	---	---	4.9	2.74	2.74

Table 22

HAULING DISTANCES AND COSTS

Alternative No. 2 Cutting Cycle No. 2

Year of Cut	Compartment	Partial Cuts and Clear Cuts				
		Spur Roads		Main Road		Total Cost Per M in Cents
		Distance in Stations	Cost Per M @ 4¢/sta.	Distance in Stations	Cost Per M @ 3¢/sta.	
			cents		cents	cents
1959	1	SAME AS FOR CUTTING CYCLE NO. 1				
1960	2					
1961	3					
1962	4					
1963	5	42.9	17.2	69.3	20.8	38.0
1964	6	49.5	19.8	108.9	32.6	52.4
1965	7	49.5	19.8	191.4	57.5	77.3
1966	8	6.6	2.6	196.6	59.0	61.6
1967	9	46.2	18.5	254.1	76.1	94.6
1968	10	9.9	3.9	254.1	76.1	80.0

Table 23

ROAD CONSTRUCTION COSTS

Alternative No. 2 Cutting Cycle No. 2

Year of Cut	Compartment	Spur Roads		Main Road		Volume to Charge Roads to	Total Cost Per M for All Roads
		No. Sta.	Cost @ $100. Per Sta.	No. Sta.	Cost @ $190. Per Sta.		
1959	1	---	---	---	---	---	---
1960	2	---	---	---	---	---	---
1961	3	---	---	---	---	---	---
1962	4	---	---	---	---	---	---
1963	5	19.8	$1980	---	---	2112	$0.94
1964	6	13.2	$1320	---	---	2174	$0.61
1965	7	20.1	$2010	---	---	2104	$0.95
1966	8	---	---	---	---	---	---
1967	9	6.6	$ 660	---	---	2261	$0.30
1968	10	7.4	$ 740	---	---	2510	$0.29

Table 24

LANDING COSTS

Alternative No. 1 Cutting Cycle 1 and 2.

Year of Cut	Compa-rtment	No. of Settings Needed	Volume Involved	Cost Per MBM @ $100 Per Landing
			MBM	dollars
1949	1	2	1215	$ .16
1950	2	3	1167	.25
1951	3	2	1170	.17
1952	4	3	1191	.25
1953	5	1	1185	.08
1954	6	3	1181	.25
1955	7	2	1205	.17
1956	8	1	825	.12
1957	9	2	1220	.16
1958	10	5	1584	.32
1959	1	2	1202	.17
1960	2	1	1026	.10
1961	3	3	1170	.26
1962	4	2	1191	.16
1963	5	2	1171	.17
1964	6	3	1161	.26
1965	7	2	1148	.17
1966	8	2	822	.24
1967	9	3	990	.30
1968	10	2	1445	.14

Table 25

LANDING COSTS

Alternative No. 2 Cutting Cycles No. 1 and 2.

Year of Cut	Compartment	No. of Settings Needed	Volume Involved	Cost Per MBM @ $100. per Landing
			MBM	dollars
1949	1	--	--	$ --
1950	2	--	--	--
1951	3	--	--	--
1952	4	--	--	--
1953	5	6	1985	.30
1954	6	4	2148	.19
1955	7	2	2015	.10
1956	8	4	2168	.18
1957	9	2	2000	.10
1958	10	3	2170	.14
1959	1	--	--	--
1960	2	--	--	--
1961	3	--	--	--
1962	4	--	--	--
1963	5	5	2112	.24
1964	6	3	2174	.15
1965	7	4	2104	.20
1966	8	3	2018	.15
1967	9	4	2261	.18
1968	10	2	2510	.08

Table 26

SWINGING COSTS

Alternative No. 1 Cutting Cycles 1 and 2.

Year of Cut	Compartment	Number of Swings or Roadings Needed	Volume involved MBM	Cost Per MBM: Swinging @ F = 2.00* C = .15	Cost Per MBM: Tractor Roading @ F = 2.00* C = .20
1949	1	1	1215	2.99	--
1950	2	0	1167	--	--
1951	3	1	1170	2.99	--
1952	4	2	1191	2.99	--
1953	5	0	1185	--	--
1954	6	2	1181	--	3.30
1955	7	1	1205	2.75	--
1956	8	0	825	--	--
1957	9	1	1220	--	2.67
1958	10	2	1584	--	3.30
1959	1	1	1202	2.60	--
1960	2	1	1026	2.99	--
1961	3	2	1170	2.99	--
1962	4	1	1191	2.75	--
1963	5	1	1171	--	2.80
1964	6	3	1161	--	3.20
1965	7	1	1148	--	2.65
1966	8	1	828	2.99	--
1967	9	2	990	2.99	--
1978	10	0	1445	--	--

* F = Fixed Skidding Cost Per MBM.
C = Variable Skidding Cost Per M/Station.

Table 27

SWINGING COSTS

Alternative No. 1 Cutting Cycles No. 1 and 2.

Year of Cut	Compartment	Number of Swings or Roadings Needed	Volume in MBM	Cost Per MBM: Swinging @ F = 2.50* C = .15	Cost Per MBM: Tractor Roading @ F = 2.00* C = .20
1949	1	--	1215	--	--
1950	2	--	1167	--	--
1951	3	--	1170	--	--
1952	4	--	1191	--	--
1953	5	3	1185	2.99	--
1954	6	0	1181	--	--
1955	7	2	1205	2.67	--
1956	8	3	825	--	3.30
1957	9	0	1220	--	--
1958	10	2	1584	--	3.30
1959	1	--	1202	--	--
1960	2	--	1026	--	--
1961	3	--	1170	--	--
1962	4	--	1191	--	--
1963	5	4	1171	2.99	--
1964	6	2	1161	2.67	--
1965	7	2	1148	2.99	--
1966	8	1	828	2.45	--
1967	9	2	990	2.99	--
1968	10	1	1445	--	3.20

* F = Fixed Skidding Cost Per MBM.

C = Variable Skidding Cost Per MBM/Station.