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TITLE: A METHOD OF SELECTION OF CABLE HARVESTING MACHINES FOR VERMONT

Abstract Approved: _____

There is much interest in the State of Vermont in cable harvesting. Since there are no time studies available for cable harvesting with various machines in Vermont, it is necessary to arrive at production and cost levels by a different method.

The method chosen for this paper is made up of four parts. In the first part a decision table is used to decide which machine or machines best meet the requirements of the Green Mountain National Forest in Vermont. Second, using the (SAP) program for the HP 9830 desktop calculator, the payloads are found for each machine for a representative profile. Third, using this payload in combination with individual machine characteristics, a theoretical production per day is calculated for each machine. Fourth, yarding costs are constructed for a given set of conditions and this is combined with the production per day to arrive at a cost per MBF for each machine.

In this paper the method for arriving at theoretical production

and thus cost per MBF, is compared against an actual study done with a Smith Timbermaster in Newfoundland. The cost from the model was $27.82 as compared to $28.35 per MBF from the study.

Using this method the machines found most suitable for conditions in Vermont that were specified were: 1) Ecologger II, 2) Rosedale Timbermaster, 3) Thunderbird, 4) Smith Timbermaster, and 5) Igland-Jones Trailer Alp. Payloads for a given profile were calculated for each machine. Using these payloads and individual characteristics, a theoretical daily production was calculated for each machine. Each machine was then costed out for situations when a skidder: 1) is required, 2) is not required to clear the landing. Both situations were then calculated twice: using 16% (taxes, interest and insurance) and using 20% (taxes, interest and insurance). The results show the inter-relationships between payload, production, initial costs, other costs, and the final cost per MBF.

Since under present conditions the initial cost may be as important to a purchaser as cost per MBF at the landing, this study allows the people on the Green Mountain National Forest a chance to estimate what they will be loosing or gaining by buying a particular machine.

A METHOD OF SELECTION OF CABLE HARVESTING MACHINES FOR VERMONT

by

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A METHOD OF SELECTION OF CABLE HARVESTING MACHINES FOR VERMONT

INTRODUCTION

In the past two years there has been a large amount of interest in the use of cable harvesting systems in the State of Vermont. Initially this was brought about by many factors. Some of these are: declining timber supply, decreasing tolerance for environmental disturbance, increasing logging costs, and increasing demands on forests for lumber, fiber and fuel. This prompted the Vermont Department of Forests, Parks and Recreation to contract with E. Gerry Hawkes of Woodstock, Vermont, to research and write a book entitled, Introduction to Cable Harvesting Systems for Small Timber. Partial funding for this project was provided by the U.S. Forest Service. This publication was prepared as part of the effort of the Vermont Department of Forest, Parks and Recreation to upgrade forest management through improved harvesting methods.

Within the past year the interest in cable harvesting in Vermont has become very intense. This was brought about by the energy crunch. The energy situation has had a two-fold impact. First, it has created a market for fuel wood and in turn an interest in finding better methods of harvesting small wood.

Second, there is a great interest in reducing the amount of fuel required to bring the timber out of the woods. In a study done in Newfoundland by Colbert (1979), it was estimated that there could be a savings in the amount of fuel used of between 5 to 1 and

10 to 1 by using cable systems instead of the conventional tractors and skidders. (Presently, they are using 1 or 2 small tractors, 35 to 45 horsepower, to bunch with a medium skidder, 80 to 100 horsepower, for forwarding of distances of up to 1.5 miles.)

In February, 1979, the Advanced Logging Systems Group of the U.S. Forest Service received a request from the Green Mountain National Forest, Rutland, Vermont, for two students to study the feasibility of advanced logging systems in the Green Mountain National Forest. This paper will present a method to select a machine for cable logging in Vermont.

This paper is divided into three parts. Part one is a step-by-step explanation of the method used to make the selection of a machine. Part two is the testing of the model used in the selection process against a real situation. Part three is the actual application of this method in selecting a machine to cable log in Vermont.

STUDY OBJECTIVES

1. Determine the class of cable machine which appears to have application to the Green Mountain National Forest.
2. Determine the machine or machines that seem most suitable to the Green Mountain National Forest.
3. Carry out an economic evaluation and comparison of cable harvesting systems for the Green Mountain National Forest.

LITERATURE REVIEW

Most previous studies of production rates of skylines have been done in the West (Curtis, 1978, Hensel, 1977, Mann, 1979) and have been done under only one set of conditions. However, Peters and Kellogg (1978) did a summary of production data for the Trailer Alp which may have potential in yarding of small timber. This is a summary of work done in Norway, British Columbia and Oregon (Fjalestad, 1975, Kramer, 1978, McMorland, 1978, Maxwell, 1975, and Neilson, 1977). This paper does point out the difficulty of transferring technology from one geographical location to another.

Kramer (1978) looked at the performance of the Trailer Alp Yarder in clearcutting northwest hardwoods. Studies have been done in the northern hardwoods of West Virginia (Gibson and Biller, 1975, Gochenour, et. al., 1978). Because of the experimental nature of these last two studies, it would be hard to extract a

production equation that could be used in Vermont.

Perhaps the study that has terrain conditions closest to those in Vermont is a study done by the Department of Forestry and Agriculture, Newfoundland (Colbert, 1979). This study examined the potential of several skyline machines in Newfoundland.

Mifflin and Lysons (1978) present a breakdown of yarding costs and production elements for skyline yarding that allows a straightforward procedure for determining costs. Seabaugh and Yerkes (1979) present a method of small yarder comparison similar to Mifflin and Lysons (1978), but use "theoretical" data rather than time study data.

Since time study data is not available for all machines that will be examined in this paper, the method used by Seabaugh and Yerkes (1979) was selected.

METHOD

The method of achieving the goals can be broken down into four parts:

1. Use a decision table or matrix to decide what machine best meets requirements of the Green Mountain National Forest.
2. Use the Skyline Analysis Program (SAP) (Sessions, 1978) or Multispan Skyline Analysis Program (MSAP) (Sessions, 1978) designed for the Hewlett-Packard Model 9830 (HP 9830) desk top computer to arrive at the payload for a representative profile.
3. Use gross payload from (2), and individual machine characteristics and size of logging corridor to arrive at a "theoretical" production per day.
4. Construct yarding costs and combine this with the production from (3) to arrive at a cost per MBF.

USE OF THE DECISION TABLE

A decision table is a tabular display of all known factors considered significant in making a choice. The table provides an opportunity to quantify the real factors which affect selection, as well as to make a numerical comparison of the relationship between the various pieces of equipment.

A decision table was selected as part of the selection process

because it allows for adjustment as conditions and policies change. This method forces Green Mountain National Forest staff to decide just what attributes they want in a machine. This method provides documentation of the processes that were utilized in machine selection. When the information used in the process changes, a re-evaluation can be readily accomplished.

This procedure consists of the following steps:

1. Determine which factors are important in the selection of yarding equipment for a particular location. Gather information that will allow determination of the relative importance between these factors. At the same time, determine which factors absolutely must be met.
2. By use of the above "must" factors, determine which equipment will be feasible for the location, i.e., if intermediate supports are needed, machines such as running skylines will not be feasible.
3. Perform a comparative rating on each of the feasible pieces of equipment for each factor or group of factors considered important.
4. Combine the data developed thus far in a decision table and develop numerical rating for the machines.
5. Analyze results. Perform sensitivity tests on results.
6. Make selection.

Selection Of Key Factors For Cable Equipment

Key factors are anything that require a certain configuration of machine or that are important in selecting skyline equipment. For most applications, these factors can be segmented into five groups: 1) physical; 2) economic; 3) environmental considerations; 4) management implications; and 5) safety. When it comes to rating these factors, the factor as a whole can be rated or individual elements can each be rated.

1. Physical Considerations:

   A. Terrain--Terrain factors are slope, profile and drainage location. Information on terrain factors for a given area should be collected in the best method possible since these will be the factors which most likely will be "must" factors. Collecting data will entail the use of topographic maps, aerial photos and personal knowledge of the areas to be logged. Map profiles and, if possible, ground profiles should be run. These profiles should be used to determine the slope of the ground as well as give a good idea of intermediate supports which will be needed. Terrain factors may determine the necessity of downhill, as well as uphill, logging. Utilization of photos and topographic maps make it possible to estimate size and availability of landing sites. The person doing the selection should get a feel for maximum reach and average reach that will be required.

   B. Stand data--This data eminates from a variety of sources

ranging from personal knowledge to a complete cruise. Whatever the source of information, it will include largest piece, average piece size, variability of piece size, and volume per acre.

2. Economic

The economic comparison of different equipment includes all costs including road costs if additional roads must be built in order to use one type over another. Purchase price is not always the only consideration in making a selection. In fact, it could be argued that low cost per unit of production is a better criteria than low machine price. This does not mean that a detailed costing of each machine is necessary for initial selection. Instead, a relative comparison is made based on experience and judgment which ranks each machine according to cost. Later, a detailed costing is done on the two or three highest ranked machines.

3. Environmental Considerations

Several factors should normally be considered that may influence the decision of equipment purchase. The most commonly considered are stand damage and/or soil disturbance done by both logging and associated landing and road construction. These factors would usually indicate whether you would need full or partial suspension and if you want a short span or a long span machine.

4. Management Implications

Equipment selected on its physical and economic merits alone may adequately meet management requirements. Factors

that should be considered include: availability of parts and service, versatility, and expected life. If all other elements are equal, the equipment that is more versatile or gets better service may be the one selected. Readily available parts may even be a "must" factor.

5. Safety

   Almost any type of logging does produce some type of safety hazard. However, some equipment of newer design does give the operator better visability than others. Also, the use of a machine that will need to land logs on the slope rather than on the road prism could create a hazard. These things should be considered.

Factors presented here are not intended to be the only factors that should or would be considered. Factors will differ on a case-by-case basis. Nor are they intended to cover all cases. Those presented here give an idea of what key factors are, and how they are used.

Weighing Factors

After key factors have been selected they are listed and then weighed according to their importance. All "must" factors are separated from the other factors. Remaining factors can then be weighed from 1-5, with 1 being important and 5 being extremely important. These weighing factors will be multiplied by the ratings of each machine for each factor.

Determining Feasible Equipment

Once all "must" factors have been decided, all equipment that is being considered is examined to determine which equipment meets all of the "musts." Any piece of equipment that does not meet them all is no longer to be considered as feasible.

Comparative Ratings for Feasible Equipment for Factors

Now only equipment that can feasibly do the job remains. A comparative rating for each factor considered important is constructed. This is done on any scale as long as the higher the score, the better the equipment. For more information on rating, see Riggs (1977).

Construction of the Decision Table and Numerical Ratings

The table is constructed with the machines listed as columns and the factors as rows. For each piece of equipment the comparative rating for each factor is listed. The weighed rating is then developed by multiplying the rating by the weight of each factor. These weighed ratings are totaled up and each machine is given a rank by total weighed rating. An example of a decision table can be found in Table 5 on page 36 of this report.

Analyzing Results

Once an overall rank has been made it is advisable to cycle back through the process. Sometimes the ranking may point out the criticalness of some factors. If this happens, it is advisable to refine the data used in comparing the equipment.

In addition, some other elements can be considered that did not seem too important in the initial selection. If, after going through the process, the selection involves choosing between two equal machines, it must come down to a detailed economic analysis of each machine.

PAYLOAD ANALYSIS

In using the programs (SAP, MSAP), it is important to choose a representative profile to examine. In comparing one machine against another the same profile must be used for each to insure a fair comparison. A fixed set of operational conditions results.

ARRIVING AT A THEORETICAL PRODUCTION

Since time study data is generally from one set of operating conditions for one given machine, it would be impossible to apply this data to a different set of conditions. In addition, most of the data was not collected on a long term basis.

Seabaugh and Yerkes (1979) suggest that a better indication of comparative production potential of different machines is to use known machine characteristics, which govern or limit production potential, and calculate a "theoretical production" for each machine under a fixed set of operational conditions. This allows comparison of different machines using a common base where unknown factors are considered to be similar. This paper uses this method.

Mathematical Formulation for Determining Theoretical Production

Assumptions--Payload calculations were determined by using

the safe working load of the skyline or line pull of the yarder, whichever is less. Practical inhaul speed is 600 feet per minute (fpm) or the actual inhaul speed of the yarder at mid-drum, whichever is less. Analysis of several regression equations for skyline yarding with one end drag indicates that inhaul speeds are very close to 600 fpm. All settings are assumed to be rectangular.

FORMULAE FOR CALCULATION OF YARDING PRODUCTION[1/]

1. Average BF/turn = $\frac{\text{Gross Payload (lbs.) (HP 9830)}}{\text{11 pounds/BF} \div \text{\% Turn Making Efficiency}}$

2. Inhaul speed = the smaller of Average Inhaul Speed or 600 fpm

3. Inhaul Time Min/Turn = $\frac{\text{External Yarding Distance}}{2} \div$ Average Outhaul Speed (fpm)

4. Outhaul Time Minutes/Turn = $\frac{\text{External Yarding Distance}}{2} \div$ Average Outhaul Speed (fpm)

5. For mechanically operated slackpulling carriages: Lateral Min/Turn = (0.005) (Lateral Distance) + 0.37 minutes

5a. For manually operated slackpulling carriages: Lateral Time Min/Turn = (0.005 Lateral Distance) + 0.67[2/] minutes

6. Hook/Unhook Min/Turn = (0.0005) (Average BF/Turn) + 0.93 minutes[3a/]

7. Cycle Min/MBF = $\frac{\text{Inhaul Time + Outhaul Time + Lateral Time +}}{\text{BF/Turn}}$ $\text{Hook/Unhook Time} \times 1000$

8. MBF/Road = $\frac{\text{External Horizontal Yarding Distance) x (External}}{43560}$ $\text{Horizontal Lateral Distance) x (MBF/Acre)} \times 2$

9. Road Change Min/MBF = $\frac{\text{Road Change Time}}{\text{MBF Road}}$

10. Total Min/MBF = Cycle Min/MBF + Road Change Min/MBF

11. Production MBF/Day = $\frac{\text{Production Min/Day (excluding delays \&}}{\text{Total Min/MBF}}$ Maintenance)

[1/] This whole formulation from Yerkes and Seabaugh, 1979.

[2/] This is the same as #5 except that .3 min/turn were added on to account for manual operation.

[3a/] Dykstra, D.P., 1976.

This process was programmed on the HP 9830. The inputs needed are as follows:

1. Gross Payload - Obtained from the HP 9830 (SAP, MSAP) program.
2. Percent Turn Making Efficiency - Equal to allowable gross payload divided by the average actual payload per turn. For most machines this is between 40% and 75%. When this data is not available, assume the same value for all machines to be examined.
3. Inhaul Speed - Obtained from the yarder specifications. Most of the time the inhaul is given both for full and empty drum. The speed that most closely reflects the conditions of drum during inhaul can be used or a person can interpolate somewhere inbetween these two values.
4. Outhaul Speed - Obtained in a manner similar to inhaul speed.
5. External Yarding Distance - The horizontal distance from the yarder to the tailhold on the representative profile for which the payload was calculated.
6. Carriage Type - Types of carriages that was used in the payload calculation and slack is either "mechanically" or "manually" pulled in the skidding line. Since it is a must that we partial cut, this means that the carriage must be a slackpulling carriage.
7. Lateral Distance - The distance that the skidding line is pulled to the side of the skyline corridor. This varies, but is usually between 50 feet and 150 feet. This also varies with the amount of skidding line that can be

pulled through a given carriage.

8. Volume Per Acre - This should be the volume per acre that you wish to designate as a set operating condition and will be the same for all machines to be examined. This should also be representative of the area you are examining.
9. Road Change Time - The time in minutes that is required to move the lines and/or yarder from one skyline road to the next. In many cases, this can be obtained from time studies for given machines or personal knowledge.
10. Productive Minutes Per 8-Hour Day - The amount of time the machine is actually working excluding delays, maintenance and breakdowns.

CONSTRUCTING YARDING COSTS

Items included in cost construction are as follows:

1. Depreciation Cost - Calculated for all machines (yarder, tractor, etc.) that are needed to log. Also calculated for radio transmitters, carriage and rigging hardware. Depreciation per hour is equal to new cost plus the cost of freight, minus the residual value, all divided by life in hours.
2. Operating Costs -
   A. Maintenance and Repair - calculated as a percent of the depreciation.
   B. Fuel and Lubrication - cost for fuel and lubrication for all machines.

C. Labor - total cost to operator including fringe benefits.

3. Fixed Costs -

A. Move-in Costs - calculated by taking the hours to move in, times the sum of the cost for the side, plus the cost of the moving vehicle and driver.

B. Initial Rig Up - equals the hours to move in, times the cost per hour of the side.

C. Rig Down - found in the same manner as cost to initially rig up.

D. Move Out Costs - found in the same manner as move in costs.

E. Engineering Labor - cost to run skyline corridors.

F. Line and Choker Costs - for both line and chokers, cost is found by dividing the cost of each line by its life in MBF and multiplying the result by the sale volume in MBF.

G. Taxes, Interest and Insurance - calculated as a percent of average investment. Average investment is calculated as one half of the sum of the new cost, the salvage value and the depreciation for one year.

All costs except fixed costs are calculated in cost/hour. Fixed costs are first calculated as total costs. Then the volume of the sale is divided by the production per day and the result is divided into the total fixed costs to arrive at a fixed cost per day. Other costs are multiplied by 8 to arrive at a cost per day.

For an example of this calculation, see Appendix I and II.

TESTING OF THE MODEL

To test this system, data provided in a publication, "Cable Logging Trials in Newfoundland, 1978," by K.S. Colbert, was used. This study was done on the Smith Timbermaster yarder, manufactured by G.R. Smith (Engineers), Ltd., Aberfuldy, Scotland. Information needed, but not available in this publication, was obtained by personal communications with K.S. Colbert. A summary of the necessary facts follows:

A. Site Characteristics:

1. Concave slopes (25-40%)
2. External yarding distance - 920 ft.
3. Lateral yarding distance - Average 50 ft.
4. Average road change time - 45 min. (downhill)

B. Machine Characteristics:

1. 24 ft. spar
2.

Lines	Size	Length	Speed E.	Speed Full
Skyline	1/2" (Sweged)	1475 ft.	-	-
Mainline	3/8" (Sweged)	1475 ft.	492	885
Haulback	3/8" (Sweged)	3000 ft.	510	1770
Strawline	1/4" poly	4000 ft.	-	-

3. Manual Carriage (Wt. 80 lbs.)
4. 4-6 chokers

C. Stand Data

1. .10-0.15 m^3 per tree - (3.53 ft^3 - 5.30 ft^3)
2. Vol/Acre - 200 m^3/hour - (2859 ft^3/Ac.) ≈ (12,990 BF/Acre)

D. Crew - 1 operator

1 chokersetter

.5 feller to set chokers

Using site characteristics, a profile was created with a concave slope 925 feet long and a slope that ranged from 15% to 35%. Figure 1 on Page 21 is a graphical representation of this profile. This profile was analyzed using SAP for downhill logging with the Smith Timbermaster. Table 1 on Page 22 lists profile data and gives an example of the printout for the SAP program. Using a loaded carriage clearance of 6 feet, the result was a dragging load of 2009 lbs. (200 lbs. is used here).

THEORETICAL PRODUCTION FOR THE SMITH TIMBERMASTER

Inputs:

1. Gross payload - 2000 lbs.
2. Percent Turn Making Efficiency

Turn making efficiency is based on the fact that 4-6 chokers were used and the volume of each tree was between 3.53 ft^3 and 5.30 ft^3.

Largest Load:

5.3 ft^3 x 6 = (31.80 ft^3)

Weight of trees = 50 lbs./ft^3

Largest payload = 31.80 ft^3 x 50 lbs./ft^3 = 1590 lbs.

$\frac{1590 \text{ lbs.}}{2000 \text{ lbs.}}$ = 80% turn efficiency

It was assumed that with smaller trees, more chokers (6) would be used.

Therefore, 3.53 ft^3 x 6 = 21.18 ft^3

21.18 ft^3 x 50 lbs./ft^3 of wood = 1059 lbs.

$\frac{1059 \text{ lbs.}}{2000 \text{ lbs.}}$ = 53% turn making efficiency

Using this reasoning the turn making efficiency of between 53% and 80%. For this test 60% was used.

3. Inhaul Speed - Use mid-drum of 690 fpm.
4. Outhaul Speed - Use mid-drum of 1140 fpm.
5. External Yarding Distance - 925 ft.
6. Carriage - Manual (load locking).
7. Lateral Distance - 50 ft.
8. Road Change Time - 45 min. - based on 30-40 min. leaving haulback in place and 1 hour when haulback needed to be changed.
9. Volume Per Acre - 12.9 MBF.
10. Productive Minutes Per 8 Hour Day - 338 min. Based on 29.4% downtime from study.

Additional Assumption

One minute was added to the hook and unhook times/turn because this machine has no chaser while Seabaugh and Yerkes assumed there would be a chaser. The operator must lock yarder, walk out to chokers, unhook chokers, return to yarder and begin outhaul.

This one minute must account for only the additional time it takes without a chaser. This time can be broken down into 3 groups:

1. Time for yarder operator to leave the machine and walk to logs and back. This is estimated to be between .25 and

.35 minutes.

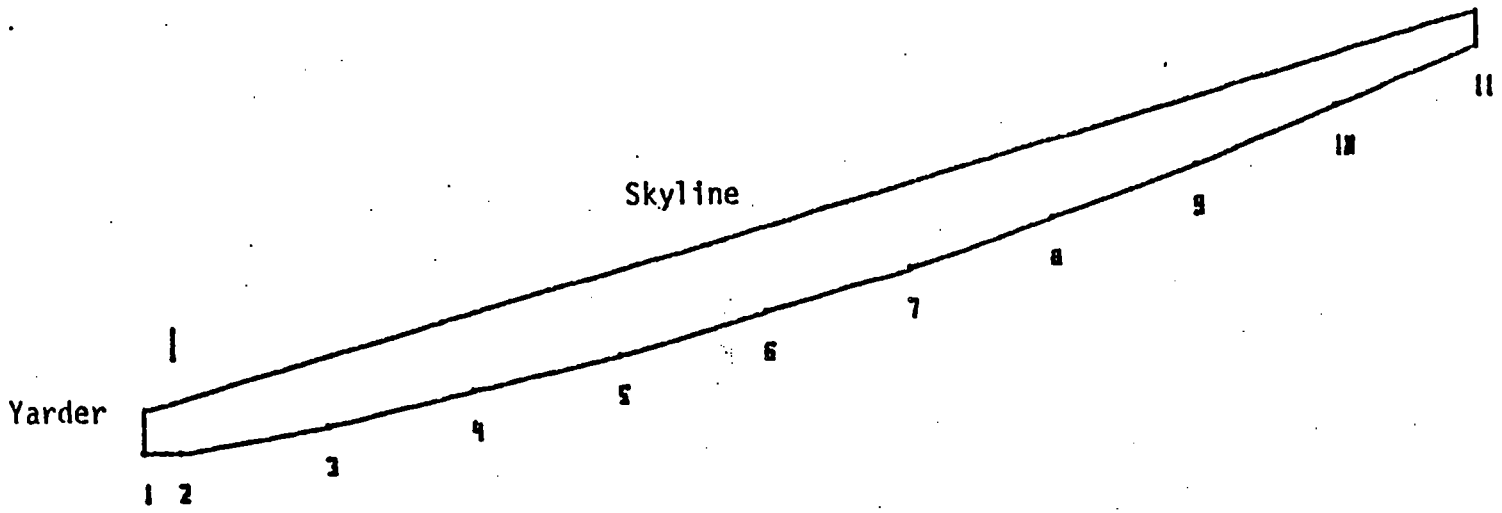
2. Time it takes the operator to sort the deck. This involves flattening the deck or moving logs so that further logs can be landed safely. This is necessary due to the short tower. A chaser would normally do this during the yarding cycle. This amounts to .36 minutes/turn (Neilson, 1977).
3. Time needed to correct decking problems. In Neilson's study this is classified as a delay. However, a chaser could prevent most of these delays. These delays account for 3% of total time (Kramer, 1978). For this study, this amounts to .18 minutes.

These three total .89 minutes (.35 + .36 + .18). This is only for the case where the operator only walks out to each turn once. If it is necessary to walk out to a turn twice due to something such as a pinched choker, then an additional .35 minutes must be added. This would then be 1.24 minutes. For these reasons, it was felt that one minute was a fair estimate of the additional time due to the lack of a chaser.

RESULTS

The stated values were input to the production program to arrive at a theoretical production of 8.65 MBF/day. The test study had an actual production of 8.67 MBF/day.

Figure 1 Timbermaster Profile



Scale 1 inch = 130 ft.

TABLE 1. PROFILE DATA AND SAP OUTPUT FOR TEST.

Profile Data

PROFILE 1

TERRAIN POINT	X COORD	Y COORD	SLOPE DIST	% SLOPE
1	1	20		
2	26	20	25	0
3	124.8936353	34.83404529	100	15
4	222.9517029	54.4456588	100	20
5	321.0097704	74.05727232	100	20
6	418.0240204	98.31083483	100	25
7	515.0382705	122.5643973	100	25
8	610.8208990	151.2991859	100	30
9	706.6035275	180.0339744	100	30
10	800.9893631	213.0690169	100	35
11	895.3751988	246.1040594	100	35

LIVE SKYLINE LOAD ANALYSIS (RIGID LINK ASSUMPTION)

Data Input

ALLOWABLE SKYLINE TENSION= 10630

SKYLINE WT= 0.54 MAINLINE WT= 0.35
HEADSPAR HT= 24 TAILSPAR HT= 20
HEADSPAR T. P. = 1 TAILSPAR T. P. = 11
INN YARD LIM= 1 OUT YARD LIM= 11

CARRIAGE WT= 80
LOADED CARRIAGE CLEARANCE= 8

TERRAIN POINT	LOG LOAD (FLY)	LOG LOAD (DRAG)	LINE LENGTH
2	7690	11535	931
3	2710	4065	926
4	1876	2815	925
5	1694	2540	925
6	1534	2300	925
7	1574	2361	925
8	1568	2352	925
9	1824	2736	924
10	2319	3478	924

NEW SPAR LOCATION = 0
NEW YARDER SPEC = 1
REQD RIGGING LENGTH = 2
STANDING SKYLINE PLOT= 3

LIVE SKYLINE LOAD ANALYSIS (RIGID LINK ASSUMPTION)

ALLOWABLE SKYLINE TENSION= 10620

SKYLINE WT=	0.54	MAINLINE WT=	0.35
HEADSPAR HT=	24	TAILSPAR HT=	20
HEADSPAR T.P.=	1	TAILSPAR T.P.=	11
INN YARD LIM=	1	OUT YARD LIM=	11

CARRIAGE WT= 30
LOADED CARRIAGE CLEARANCE= 6

TERRAIN POINT	LOG LOAD (FLY)	LOG LOAD (DRAG)	LINE LENGTH
2	8100	12150	933
3	2908	4361	927
4	2005	3007	926
5	1798	2697	926
6	1629	2444	925
7	1671	2507	925
8	1677	2516	925
9	1965	2947	925
10	2567	3850	924

NEW SPAR LOCATION = 0
NEW YARDER SPEC = 1
REQD RIGGING LENGTH = 2
STANDING SKYLINE PLOT= 3

STANDING SKYLINE PAYLOADS (BASED ON MIN LIVE SKYLINE LENGTH)

STATION	LOG LOAD (FLY)	LOG LOAD (DRAG)	CLEARANCE
90	2418	3628	15
180	1720	2580	13
269	1462	2192	13
359	1357	2035	13
448	1340	2009)	12
538	1396	2093	11
627	1541	2312	9
717	1849	2774	8
806	2641	3962	6

NEW SPAR LOCATION = 0
NEW YARDER SPEC = 1
REQD RIGGING LENGTH = 2
STANDING SKYLINE PLOT= 3

COSTS

An explanation of costs used in this analysis is presented in Table 2. These costs should be for the most part self-explanatory.

Depreciations

In Table 2, yarder cost includes carriage. Tractor cost is for a tractor delivered at the site.

Operating Cost

Information for maintenance, repair, fuel, and lube were taken from U.S. Forest Service Timber Appraisal Handbook, Sec. 2409.22 of the Forest Service Handbook.

Labor cost were extracted from Table 3, page 26 of this paper. Labor cost include $1.39/hour for fringe benefits. Labor cost shown for the hooktender is actually one-half the rate of a feller. This was done because in the study one feller worked part-time as a chokersetter. The feller does not make the same as a chokersetter so he is represented as a hooktender.

Fixed Costs

The study started at the site so there was no move in and move out figured. All cost of lines were as per a letter from Wire Rope Industries Ltd., of Vancouver, B.C., dated May 18, 1977. The machine was purchased in the fall of 1977.

Insurance and Taxes

Found as a percent of average investment.

TABLE 2. EXPLANATION OF COST FOR THE SMITH TIMBERMASTER.

A. DEPRECIATION COSTS

EQUIPMENT	NEW	RESIDUAL	FREIGHT	LIFE YRS	LIFE HRS	$/HR
YARDER	33000.00	3300.00	0.00	7	7163	4.14
RADIO/TRANS	0.00	0.00	0000000	4	6400	0.00
CARRIAGE	0.00	0.00	0000000	4	6400	0.00
TRACTOR	0.00	0.00	0.00	6	9600	0.00
RIG. MOV. TT	0.00	0.00	0000000	4	6400	0.00

	SIZE	NUMBER	LENGTH	COST/FT	TOT. COST	LIFE/HRS	COST/H
GUYLINES	0.00	0.00	0.00	0.00	0.00	6400	0.00

TOTAL DEPRECIATON COSTS = 4.14 /HR

B. OPERATING COSTS

MAINTENANCE AND REPAIR

EQUIPMENT	%OF DEP.	$/HOUR
YARDER	50	2.07
RADIO	60	0.00
CARRIAGE	50	0.00
TRACTOR	50	0.00
RADIO CONT.	60	0.00

SUBTOTAL 2.07

FUEL AND LUBRICATION

EQUIPMENT	$/HR
YARDER	1.90
TRACTOR	0.00

SUBTOTAL 1.90

YARDING LABOR(TITLE)	HOURLY RATE	NUMBER	TOTAL COST/HR
HOOK TENDER	3.48	1	3.48
CHOKER SETTER	7.30	1.00	7.30
CHASER	0.00	1	0.00
YARDING ENGINEER	7.67	1	7.67
SKIDDER OPERATOR	0.00	1	0.00

SUBTOTAL 18.45

C. FIXED COSTS

MOVE IN 0.00 HOURS FOR SIDE, VEHICLE AND DRIVER
26.57 + 0.00 * 0.00 = 0.00

INITIAL RIG UP 2.00 HOURS FOR SIDE = 53.13

RIG DOWN SAME AS RIG UP 53.13

MOVE OUT SAME AS MOVE IN 0.00

ENGINEERING LABOR = 0.00

CHOKERS 14.00 EACH

COST OF CHOKERS = (SALE VOL) * (COST EACH)/LIFE MBF

COST OF CHOKERS = 65.52

OPERATING LINES(EPS)

LINE	#1/FT	SIZE(IN)	LENGTH(FT)	TOTAL	LIFE(MM)	($/M)
MAINLINE	0.50	0.38	1500.00	750.00	8.00	0.09
HAULBACK	0.50	0.38	3000.00	1500.00	4.00	0.38
SKYLINE	0.67	0.50	2000.00	1340.00	8.00	0.17
SKIDDING	0.00	0.00	0.00	0.00	0.00	0.00
STRAWLINE	0.07	0.25	4000.00	280.00	6.00	0.05
SLACK PULLING	0.00	0.00	0.00	0.00	0.00	0.00
OTHER LINE	0.00	0.00	0.00	0.00	0.00	0.00

SUBTOTAL: 0.68 /M * 468.00 = 319.61

TOTAL FIXED COSTS = 491.39

D. INSURANCE AND TAXES

AVERAGE INVESTMENT = (NEW COST + RESID. + DEPR.)/2
INSURANCE AND TAXES = 0.12 % * AVE. INVEST. (20271.43)

INSURANCE AND TAXES = 2.38 $/HR

YARDING COST SUMMARY

CALCULATED MBF/DAY	8.65
DEPRECIATION/8 HR. DAY	33.15
OPERATING COST/8 HR. DAY	179.37
FIXED COST /8 HR. DAY	9.08
INSURANCE AND TAXES/8 HR. DAY	19.00
TOTAL COST/8 HR. DAY	240.61
COST/MBF	27.82

TABLE 3. COST FOR SMITH TIMBERMASTER FROM TEST CASE (Colbert, 1979).

AVERAGE DAILY PRODUCTION - 54 m^3 (stacked)

Operator	$ 6.28/h x 8 x 1	$ 50.24
Chokerman	5.91/h x 8 x 1	47.28
Fellers	5.56/h x 8 x 2	88.96
C.O.L.A.	0.87/h x 32	27.84
Fringe Benefits	11.10/day x 4	44.40
Camp Cost	6.00/day x 4	24.00
Chain Saws	7.50/day x 2	15.00
Equipment Rental	12.25/h x 8	98.00
Supervision, foreman, and assistant Based on 12 machine operation including transportation		27.00
	TOTAL Daily Cost	$422.72

The cost per MBF from the printout is $27.82.

Cost from Study

To arrive at the cost from the study, the information from Table 3 was used as a basis and adjusted as follows:

Cost which should not be included in yarding cost

1.	1.5 Fellers salary at $44.48/day	$ 66.72
2.	C.I.A./day	27.84
3.	1.5 Fringe Benefits at $11.10/day	16.65
4.	Camp Cost/day	24.00
5.	Chain Saws	15.00
6.	Supervision	27.00
		$177.21

Total Daily Cost (Preceding Page, Table 3) $422.72

Adjusted Daily Cost = $422.72 - $177.21 = $245.51

$$\text{Adjusted cost/M}^3 = \frac{\$245.51}{54\text{M}^3} = \$4.55/\text{M}^3$$

Adjusted Cost = $28.35/MBF

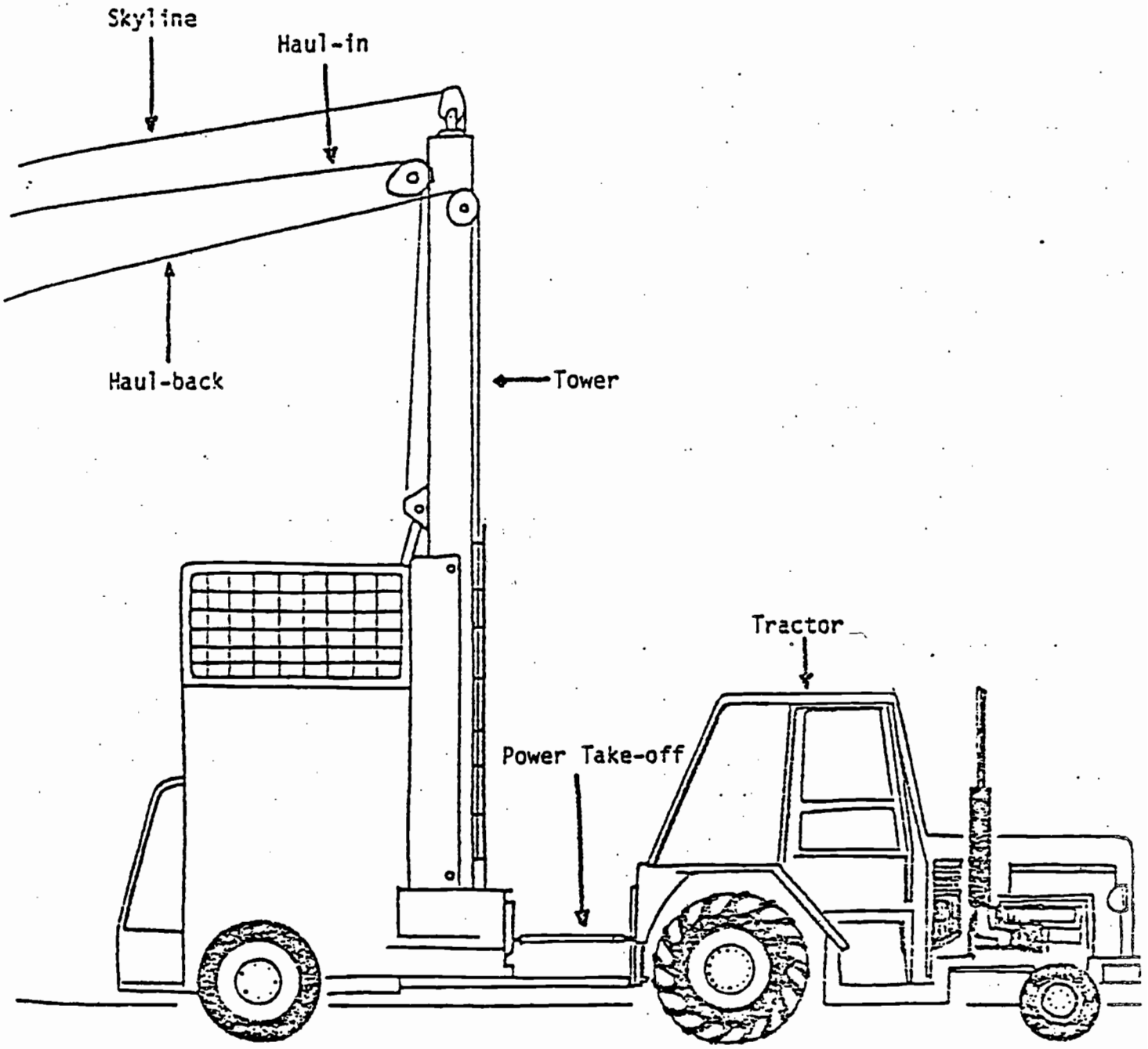
Summary of Test Case

The model came remarkedly close to study data. It had been intended to use the turn making efficiency to calibrate the model, however, there was no need. Turn-making-efficiency, hook and unhook time were the only inputs that the study did not actually state.

TABLE 4. RESULTS FOR TEST OF MODEL.

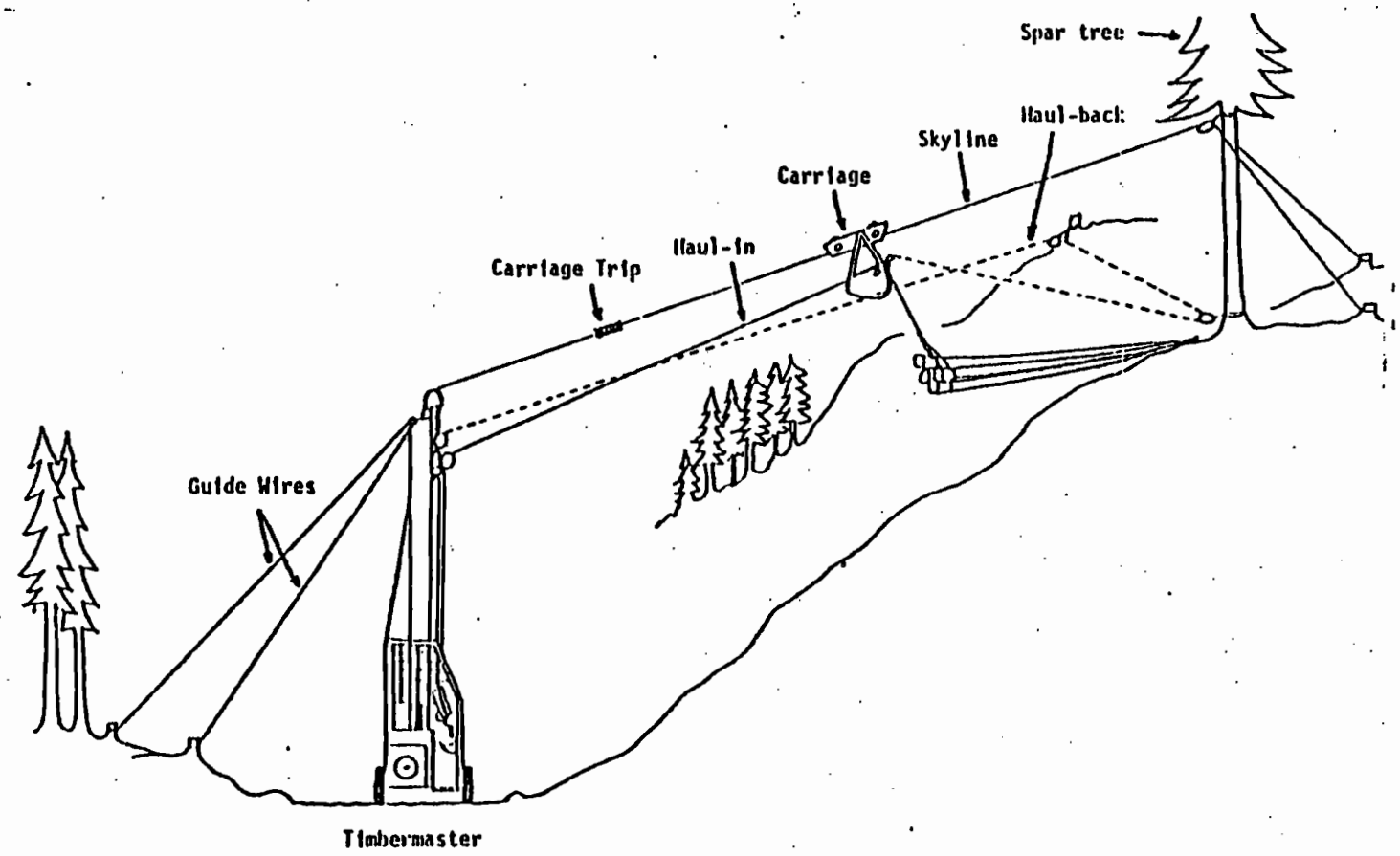
SOURCE	PROD. PER DAY	COST/MBF
Newfoundland Study	8.67 MBF	$28.35
HP 9830 Model	8.65 MBF	$27.82

Figure 2. Smith Timbermaster Cable Logging Machine.



Source, (Colbert 1978)

Figure 3. Timbermaster in Operation.



Source, (Colbert 1978)

Assumptions that were made worked well. Although the closeness of the model to actual test data may be due to compensating errors, this means that if data used in this model is good, it will predict production in an acceptable model. This model should serve as a good basis for comparing different yarders under similar conditions. Once the test was complete, the next step is to apply the model to the study area.

SELECTION OF A YARDER FOR VERMONT

CONSTRUCTION OF DECISION TABLE

Data to build the decision table was obtained from two sources:

1. The Green Mountain National Forest (in particular the Rochester Ranger District) was sent a copy of how to do a decision table and asked to decide on what was needed in their area. They replied as follows:
   - A. Must Factors
     1. Capable of multispan
     2. At least a 1000 foot reach
     3. Capable of logging both uphill and downhill
     4. Capable of partial cut for shelterwood harvesting
   - B. Key Factors
     1. Capable of partial suspension
   - C. Weighing Factors for Key Factors
     1. Highest for partial suspension
   - D. Other Important Data
     1. Minimum log length - 8 feet
     2. Maximum diameter of log - 30" small end
     3. Average saw log diameter - 14" - 16" small end
2. Personal contact with loggers both during a one month stay in Vermont during the summer of 1979, and while attending a meeting on Cable Logging Systems for New England held on the University of Massachusetts during January of 1980. The major concerns voiced were as follows:

1. Low initial cost
2. Easy to repair
3. Easy to use

All of these factors must be considered in the decision table to assure that both the Forest Service Requirements are met and that it will have a chance of being accepted by the industry.

First, the cable machines that meet all of the must factors were selected. Since, for all intents and purposes, running skyline systems cannot be used with an intermediate support, these systems were disregarded. In addition, the requirement of downhill logging means that a machine must have at least 3 working drums, and last, the machine must have a 1000 foot reach. There are many machines that meet these requirements. Since it has been accepted that it is not economical to log small timber with large standing skylines in the West, it is safe to assume that it would not be economical to do so in Vermont. For this reason they will not be considered. The following is a list that meet the "musts:"

A. Standing Skyline Yarders

1. Smith Timbermaster
2. Rosedale Timbermaster
3. Highland Trailer Alp
4. Mini Urus - Class I
5. Urus Yarders - Class II, III and IV
6. Koller 800
7. Ecologger II

8. Timber Tower

B. Skyline Cranes

1. Wyssen Skyline Crane
2. Baco Skyline Crane
3. Jobv Combi Cat C-1000/52
4. Vinje K-1200

C. Running Skylines with Optional Skyline Drum

1. Washington 78SL
2. Skagit - 717
3. M.A.C. Thunderbird

In order to simplify the decision table, the yarders with similar characteristics are grouped.

Group 1 - European Trailer Mounted (Smith Timbermaster, Igland Jones Trailer Alp)

Group 2 - Small European Trailer Mounted (Mini Urus)

Group 3 - Medium European Truck Mounted Yarders (Urus Yarders - Class II, III, IV and Koller 800)

Group 4 - Rosedale Timbermaster (Skidder mounted with a knuckleboom loader)

Group 5 - North American Skidder Mounted Yarders (Ecologger II, Timber Tower)

Group 6 - Skyline Cranes (Wyssen, Baco, Jobu and Vinje)

Group 7 - Running Skylines with Optional Skyline Drum (Washington 78SL, Skagit 717)

Group 8 - M.A.C. Thunderbird (four drum yarder)

TABLE 5. DECISION TABLE FOR VERMONT.

	1		2		3		4		5		6		7		8	
	R**	WR*	R	WR	R	WR	R	WR	R	WR	R	WR	R	WR	R	WR
5* - Economics (Init. Cost)	80	400	90	450	60	300	70	350	60	300	40	200	30	150	40	200
5 - Environmental (Par. Susp.)	60	300	30	150	80	400	60	300	70	350	60	300	70	350	80	400
5 - Payload (at least 2050 lbs)	50	250	30	150	70	350	70	350	70	350	90	450	80	400	90	450
3 - Ease of Repair	70	210	50	150	50	150	70	210	80	240	60	180	50	150	60	180
3 - Parts Availability	70	210	50	150	50	150	70	210	80	240	60	180	60	180	60	180
3 - Ease of Use	70	210	50	150	40	120	70	210	70	210	40	120	60	180	60	180
1 - Safety	80	80	60	60	70	70	70	70	70	70	60	60	90	90	90	90
WT RATINGS	1660		1260		1540		1700		1760		1490		1500		1680	
Rank	4		8		5		2		1		7		6		3	

*5 = Weighting Factor
**R = Rating
*WR = Weighted Rating

Rating Values: 100 = Excellent
80 = Good
60 = Fair
40 = Poor
20-0 = Critical

Weighing Factors

Economics, environmental and payload were given most weight since they are most nearly "must" factors. Ease of repair, parts availability and ease of use are given the next highest weighing since they are not necessary, but still affect the choice of a machine. Safety, although important, is given the lowest weighing since the difference between machines is very small.

A decision table was then constructed (see Table 5, page 36). Only 100 points separated the top four groups. It was, therefore, decided to look at all four. The machines that will be considered further are as follows:

1. Group 5 - Ecologger II (the timber tower will not be evaluated because it is no longer in production)
2. Group 4 - Rosedale Timbermaster
3. Group 8 - M.A.C. Thunderbird
4. Group 1 - Smith Timbermaster and the Igland-Jones Trailer Alp

A brief description of these five machines can be found in Appendix V.

PAYLOAD ANALYSIS

Downhill profiles were examined since Vermont timber staff expressed this as a main interest. Ten downhill profiles in the area of interest that could be logged from the current road system were analyzed, using the SAP program for the HP 9830. For the analysis the Smith Timbermaster was used. The average payload for a dragging load for this machine in the standing skyline

configuration was about 2000 lbs., which also corresponded to the load used in the test case. A profile was then selected that gave about this payload and seemed to be representative of the profiles examined. The data for this profile and a plot of this profile can be found on pages 37 and 38. The plot also contains a graphical representation of the Timbermaster tower and skyline.

Using the Skyline Analysis Program, payloads for all remaining four yarders were calculated. The computer printout for the analysis of the five machines on the representative profile is presented in Appendix III. Analysis was done using a safety factor of three and the safe working loads for Extra Improved Plow Steel Lines, except for the Smith Timbermaster for which sweged rope was recommended. The results are as follows:

	Payload in Pounds
Thunderbird	6878
Ecologger II	5146
Rosedale Timbermaster	2694
Smith Timbermaster	1964
Igland-Jones Trailer Alp	2615

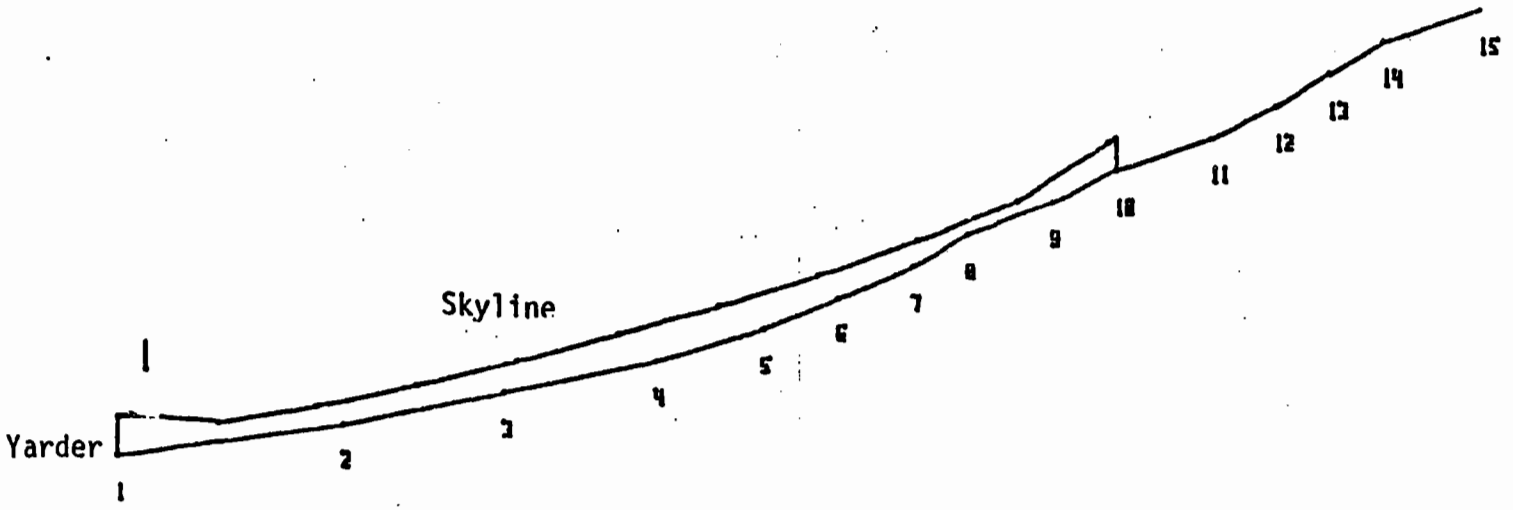
THEORETICAL PRODUCTION

To determine theoretical production of the machines that were selected it was decided to use a turn making efficiency of .6. From the best case and other literature this seemed to be a reasonable estimate. Although turn making efficiency probably does vary for different machines under similar conditions, at present there is no way to predict what that difference may be.

TABLE 6. PROFILE DATA FOR REPRESENTATIVE PROFILE.

```
C                    SKYLINE ANALYSIS PROGRAM (SAP)
          ***PROGRAM TO ENTER, PLOT, AND ANALYZE PROFILE***

     THE FOLLOWING PROFILE DATA INPUT MODES ARE AVAILABLE

               INPUT MODE 0 - DIGITIZER
               INPUT MODE 1 - (X,Y) COORDINATES
               INPUT MODE 2 - SLOPE DIST. % SLOPE
               INPUT MODE 3 - TAPE FILE

PROFILE DATA RETRIEVAL
----------------------
FPROFILE,  1     (FILE    2)

T P #          X COORD        Y COORD
 1               0              5000
 2               198            5020
 3               338            5040
 4               470            5060
 5               564            5080
 6               630            5100
 7               696            5120
 8               743            5140
 9               818            5160
 10              874            5180
 11              958            5200
 12              1014           5220
 13              1062           5240
 14              1110           5260
 15              1194           5280
```

Figure 4. Representative profile for Vermont.



Scale 1 inch = 175 ft.

Therefore, to avoid biasing the results, it was decided to assume the same factor for all the yarders.

Inhaul and outhaul speeds were found for individual machines from the specification sheets (see Appendix VI).

Length of the skyline road was taken from profile data for yarding between terrain points 1 and 10. Horizontal distance of the skyline road came out to 874 feet.

Lateral yarding distance was set at 50 feet and was chosen because this is a common distance that one could expect the chokersetter or hooktender to pull slack in the line.

A road change time of 90 minutes was used for two larger machines (Thunderbird and Ecologger II) while 60 minutes was used for the three smaller machines. Although this also varies from machine to machine and the figures that were chosen may not be exact, it does recognize that there is a difference in time required for different size machines. The 60 minutes for the smaller machines seems to be reasonable based on several studies for various machines (Kramer, 1978 and Colbert, 1978) for other than clearcuts which would require shorter times since in many cases the haulback could be left in place for at least some of the raod changes.

A productive minutes per 8-hour day of 330 was used for all calculations. This was based on the studies of Colbert, 1979, and Seabaugh and Yerkes, 1979. Although some machines have less downtime than others, unless there is data to back up a decision to vary the productive time per day for different yarders, it would be unwise to do so and could add bias to the results.

For the two machines (Smith Timbermaster and Igland-Jones Trailer Alp) for which the yarder operator acts as chaser, one minute per turn was added to the unhooking time.

The above mentioned data was combined with the payloads of each machine to arrive at their theoretical production. A copy of the program used to arrive at theoretical production and printout of the results and inputs are found in Appendix IV. The results of these calculations are as follows:

Yarder	Production Per 8 Hour Day
Thunderbird	22.22 MBF
Ecologger II	17.70 MBF
Rosedale Timbermaster	12.94 MBF
Igland-Jones Trailer Alp	9.81 MBF
Smith Timbermaster	7.77 MBF

CONSTRUCTION OF YARDING COSTS

Yarding cost was constructed to try to represent, as nearly as possible, the conditions found in Vermont. Six MBF/Acre and 750 MBF total sales volume are used in the calculations. With 6 MBF/Acre on an 874 foot skyline road with lateral yarding 50 feet on either side of the corridor, a volume of about 12 MBF will be brought into each landing. Since many of the profiles previously examined started out fairly flat, it may be possible to deck the wood on the side slope and not require a skidder to swing the wood out from under the skyline. For this reason both cases (with and without a skidder) were computed. Since the volume per landing would be quite low, a used skidder was

allowed for at a cost of $10,000.

For both the Igland-Jones Trailer Alp and the Smith Timbermaster, the cost used for the yarder included a John Deere 2640 farm tractor. Since all of the other cost of yarders were for new costs, it was important to use new costs for the yarder and the tractor in order not to bias the results.

It is very difficult to decide how much should be allowed for interest, taxes and insurance. This is usually expressed as a percent of average investment. Since this could have a large impact on the outcome of the comparison, two cases were examined; one using 16% and the other 20%. Under current conditions it is probably closer to 20%. By doing both cases, it gives the reader an idea of the sensitivity of the cost per MBF for each machine to a change in interest and can be used to adjust the cost to each individual case.

Almost all costs used were from the Forest Service Handbook, section 2409.22 R6, entitled, "Timber Appraisal Handbook, Siuslaw Supplement No. 99 of February, 1980." There were three exceptions: 1) labor costs used were estimated from data gathered in Vermont; 2) new cost for the Smith Timbermaster and the Rosedale were arrived at using cost from 1978 and multiplying by 1.14. This factor was arrived at by using other cost that were available for both times (1978 and 1980); and 3) shipping costs were estimated using information obtained from the Southern Pacific Transportation Company. All costs quoted are as of March 1, 1980.

In the cases without the use of a skidder, a crew of two was considered for the Trailer Alp and the Smith Timbermaster while a

crew of three was considered for the Rosedale Timbermaster and the Ecologger II. The Thunderbird was examined using a crew of four. When considering the cases using a skidder, one person was added to each crew.

Cost computations for each case was accomplished using the HP 9830 program found in Appendix VII. Printouts of the yarding cost computations without a skidder is found in Appendix I, while those for the cases using a skidder are found in Appendix II. A summary of these results were found in Table 7.

COST/MBF

TABLE 7. SUMMARY OF COSTS.

	WITHOUT SKIDDER		WITH SKIDDER		
	Taxes of Interest & Ins. 16%	20%	16%	20%	Initial Cost
Ecologger II	31.80	33.15	38.03	39.38	$182,390
Rosedale Timbermaster	31.54	32.38	*	*	$ 82,000
Thunderbird	36.49	37.87	42.75	41.37	$235,000
Smith Timbermaster	38.04	39.17	51.98	53.11	$ 66,000
Trailer Alp	37.00	38.04	48.02	49.06	$ 73,000

* Same as without skidder. Loader can deck so skidder is not necessary.

DISCUSSION AND SUMMARY

From the table for cost without skidder, it seems that within the accuracy of this study there is virtually a tie for lowest cost between the Ecologger II and the Rosedale Timbermaster. The remaining three machines are tied for third. In the case where the skidder is used to clear the landing, the Rosedale Timbermaster came out by far the best since by using the knuckleboom loader mounted on it, it becomes the only machine that does not require a skidder. It should also be noted that the increase that is realized by adding a skidder to the two larger machines (Ecologger II, Thunderbird), is only about one-half of the increase realized with the other two machines. This is mainly due to the fact that the production per day for the larger machines is considerably greater and thus the increased costs are spread over a larger volume. The Smith Timbermaster seems to come out worst for several reasons. First, it has the smallest skyline size of all the machines, and second, it is tied with the Igland-Jones Trailer Alp for the shortest tower. Both of these add up to a smaller payload for this machine, and therefore, less production. However, the Smith Timbermaster has the lowest initial cost. At times, initial investment on equipment may dictate use of equipment that may not give the lowest cost per MBF at the landing. The Smith and the Igland-Jones Trailer Alp also have the advantage that the purchaser may have a new or used skidder or tractor already and need only to purchase the yarder. Also, it may be possible to use a skidder to power these yarders and disconnect it and use it

to clear the landing at the end of the day. This could be possible since they would be accumulating less than 10 MBF per day on the landing.

As pointed out, Smith Timbermaster was shown to have the smallest payload due to its small skyline (1/2 inch). However, it is capable of holding 2000 feet of line on the skyline drum. This indicates that it could hold slightly over 1300 feet of 5/8 inch skyline. This would be adequate for most cases we would be considering. A recommendation for this change of line size was not found in the literature search. For this reason, it was not examined using this line size, but may be possible since the Rosedale Timbermaster is quite similar and does use 5/8 inch line. If line size change would turn out to be feasible, indications are that the Timbermaster would fall between the Rosedale Timbermaster cost and the Thunderbird. This is because it would have the payload of the Trailer Alp, with faster line speeds and also be the lowest in initial costs. Since this depends on the strength of the tower and guylines, this procedure cannot be recommended without an approval of the manufacturer. This may be taken into account when the purchase of a Smith Timbermaster is considered.

I would like to emphasize that these conclusions are only for the given set of conditions and may not be true for other conditions.

NOTE: Commercial trade names of yarders have been used so that the reader can readily identify machines with known characteristics. The mention of trade names does not constitute endorsement or recommendation for use.

In addition, it should be noted that Forest Service skidding costs do not contain interest, taxes and insurance. Interest in Forest Service appraisals is accounted for under profit and risk. Taxes and insurance are accounted for under overhead. Anyone wishing to compare the yarding cost in this study with skidding cost from the Forest Service appraisal must adjust the appraisal cost accordingly.

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APPENDIX 1

YARDING COST COMPUTATIONS
(without skidder)

Igland Jones Trailer Alp

EXPLANATION OF COST

A DEPRECIATION COSTS

EQUIPMENT	NEW	RESIDUAL	FREIGHT	LIFE YRS	HRS	$/HR
YARDER	72000.00	14600.00	1460.00	4	6400	9.35
RADIO/TRANS	4809.00	480.90	0000000	4	6400	0.68
CARRIAGE	2300.00	460.00	0000000	3	12800	0.14
TRACTOR	0.00	0.00	0.00	5	8000	0.00
RIG HOW TT	8000.00	800.00	0000000	4	6400	1.13

	SIZE	NUMBER	LENGTH	COST/FT	TOT COST	LIFE/HRS	COST/H
SUYLINES	0.75	3.00	100.00	1.33	199.50	12800	0.03

TOTAL DEPRECIATON COSTS = 11.33 /HR

B OPERATING COSTS

MAINTENANCE AND REPAIR

EQUIPMENT	%OF DEP	$/HOUR
YARDER	50	4.68
RADIO	60	0.41
CARRIAGE	20	0.03
TRACTOR	50	0.00
RADIO CONT.	60	0.00

SUBTOTAL 5.11

FUEL AND LUBRICATION

EQUIPMENT	$/HR
YARDER	3.84
TRACTOR	0.00

SUBTOTAL 3.84

YARDING LABOR(TITLE)	HOURLY RATE	NUMBER	TOTAL COST/HR
HOOK TENDER	0.00	1	0.00
CHOKER SETTER	8.50	1.00	8.50
CHASER	0.00	1	0.00
YARDING ENGINEER	8.50	1	8.50
SKIDDER OPERATOR	0.00	1	0.00

SUBTOTAL 17.00

C. FIXED COSTS

MOVE IN 6.00 HOURS FOR SIDE, VEHICLE AND DRIVER
37.28 + 35.00 * 6.00 = 433.68

INITIAL RIG UP 2.00 HOURS FOR SIDE = 74.56

RIG DOWN SAME AS RIG UP 74.56

MOVE OUT SAME AS MOVE IN 433.68

ENGINEERING LABOR = 0.00

CHOKERS 15.85 EACH

COST OF CHOKERS = (SALE VOL) * (COST EACH)/LIFE MBF

COST OF CHOKERS = 113.98

OPERATING LINES(EPS)

LINE	$1/FT	SIZE(IN)	LENGTH(FT)	TOTAL	LIFE(MM)	($/M)
MAINLINE	0.50	0.38	2100.00	1050.00	6.00	0.18
HAULBACK	0.50	0.38	2100.00	1050.00	6.00	0.18
SKYLINE	0.90	0.63	3300.00	2970.00	8.00	0.37
SKIDDING	0.00	0.00	0.00	0.00	0.00	0.00
STRAWLINE	0.21	0.12	4250.00	892.50	5.00	0.13
SLACK PULLING	0.00	0.00	0.00	0.00	0.00	0.00
OTHER LINE	0.00	0.00	0.00	0.00	0.00	0.00

SUBTOTAL: 0.90 /M * 750.00 = 674.81

TOTAL FIXED COSTS = 1810.17

D. INSURANCE AND TAXES

AVERAGE INVESTMENT = (NEW COST + RESID + DEPR.)/2
INSURANCE AND TAXES = 0.16 % * AVE. INVEST. (51282.50)

INSURANCE AND TAXES = 5.13 $/HR

YARDING COST SUMMARY

CALCULATED MBF/DAY	9.81
DEPRECIATION/8 HR. DAY	90.63
OPERATING COST/8 HR. DAY	207.61
FIXED COST /8 HR. DAY	23.68
INSURANCE AND TAXES/8 HR. DAY	41.03
TOTAL COST/8 HR. DAY	362.95
COST/MBF	37.00

Igland Jones Trailer Alp

EXPLANATION OF COST

A DEPRECIATION COSTS

EQUIPMENT	NEW	RESIDUAL	FREIGHT	LIFE YRS	LIFE HRS	$/HR
YARDER	73000.00	14600.00	1460.00	4	6400	9.35
RADIO/TRANS	4803.00	480.30	0000000	4	6400	0.68
CARRIAGE	2300.00	460.00	0000000	8	12800	0.14
TRACTOR	0.00	0.00	0.00	5	9000	0.00
PIG. HDW. TT	9000.00	800.00	0000000	4	6400	1.13

	SIZE	NUMBER	LENGTH	COST/FT	TOT. COST	LIFE/HRS	COST/H
GUYLINES	0.75	3.00	100.00	1.33	199.50	12800	0.03

TOTAL DEPRECIATON COSTS = 11.33 /HR

B. OPERATING COSTS

MAINTENANCE AND REPAIR

EQUIPMENT	%OF DEP.	$/HOUR
YARDER	50	4.68
RADIO	60	0.41
CARRIAGE	20	0.03
TRACTOR	50	0.00
RADIO CONT.	60	0.00

SUBTOTAL 5.11

FUEL AND LUBRICATION

EQUIPMENT	$/HR
YARDER	3.84
TRACTOR	0.00

SUBTOTAL 3.84

YARDING LABOR(TITLE)	HOURLY RATE	NUMBER	TOTAL COST/HR
HOOK TENDER	0.00	1	0.00
CHOKER SETTER	8.50	1.00	8.50
CHASER	0.00	1	0.00
YARDING ENGINEER	8.50	1	8.50
SKIDDER OPERATOR	0.00	1	0.00

SUBTOTAL 17.00

C. FIXED COSTS

MOVE IN 6.00 HOURS FOR SIDE, VEHICLE AND DRIVER
37.28 + 35.00 * 6.00 = 433.68

INITIAL RIG UP 2.00 HOURS FOR SIDE = 74.56

RIG DOWN SAME AS RIG UP 74.56

MOVE OUT SAME AS MOVE IN 433.68

ENGINFERING LABOR = 0.00

CHOKERS 15.85 EACH

COST OF CHOKERS = (SALE VOL) * (COST EACH)/LIFE MBF

COST OF CHOKERS = 118.88

OPERATING LINES(EPS)

LINE	$1/FT	SIZE(IN)	LENGTH(FT)	TOTAL	LIFE(MM)	($/M)
MAINLINE	0.50	0.38	2100.00	1050.00	6.00	0.18
HAULBACK	0.50	0.38	2100.00	1050.00	6.00	0.18
SKYLINE	0.90	0.62	3300.00	2970.00	8.00	0.27
SKIDDING	0.00	0.00	0.00	0.00	0.00	0.00
STRAWLINE	0.21	0.12	4250.00	892.50	5.00	0.18
SLACK PULLING	0.00	0.00	0.00	0.00	0.00	0.00
OTHER LINE	0.00	0.00	0.00	0.00	0.00	0.00

SUBTOTAL: 0.90 /M * 750.00 = 674.81

TOTAL FIXED COSTS = 1910.17

D. INSURANCE AND TAXES

AVERAGE INVESTMENT = (NEW COST + RESID. + DEPR.)/2
INSURANCE AND TAXES = 0.20 % * AVE. INVEST.(51232.50)

INSURANCE AND TAXES = 6.41 $/HR

YARDING COST SUMMARY

CALCULATED MBF/DAY	9.81
DEPRECIATION/8 HR. DAY	90.63
OPERATING COST/8 HR. DAY	207.61
FIXED COST /8 HR. DAY	22.68
INSURANCE AND TAXES/8 HR. DAY	51.28
TOTAL COST/8 HR. DAY	372.20
COST/MBF	38.04

Smith Timbermaster

EXPLANATION OF COST

A DEPRECIATION COSTS

EQUIPMENT	NEW	RESIDUAL	FREIGHT	LIFE YRS	LIFE HRS	$/HR
YARDER	66000.00	13200.00	1000.00	7	11200	4.80
RADIO/TRANS	4809.00	480.90	0000000	4	6400	0.68
CARRIAGE	0.00	0.00	0000000	9	12800	0.00
TRACTOR	0.00	0.00	0.00	5	8000	0.00
RIG. MDW. TT	8000.00	800.00	0000000	4	6400	1.13

	SIZE	NUMBER	LENGTH	COST/FT	TOT. COST	LIFE/HRS	COST/H
GUYLINES	0.50	3.00	200.00	0.70	210.00	12800	0.03

TOTAL DEPRECIATON COSTS = 6.64 /HR

B OPERATING COSTS

	EQUIPMENT	%OF DEP.	$/HOUR
MAINTENANCE AND REPAIR	YARDER	50	2.40
	RADIO	60	0.41
	CARRIAGE	20	0.00
	TRACTOR	50	0.00
	RADIO CONT	60	0.00

SUBTOTAL 2.81

	EQUIPMENT	$/HR
FUEL AND LUBRICATION	YARDER	3.84
	TRACTOR	0.00

SUBTOTAL 3.84

YARDING LABOR(TITLE)	HOURLY RATE	NUMBER	TOTAL COST/HR
HOOK TENDER	0.00	1	0.00
CHOKER SETTER	8.50	1.00	8.50
CHASER	0.00	1	0.00
YARDING ENGINEER	8.50	1	8.50
SKIDDER OPERATOR	0.00	1	0.00

SUBTOTAL 17.00

C. FIXED COSTS

MOVE IN 6.00 HOURS FOR SIDE, VEHICLE AND DRIVER
30.29 + 35.00 * 6.00 = 391.71

INITIAL RIG UP 2.00 HOURS FOR SIDE = 60.57

RIG DOWN SAME AS RIG UP 60.57

MOVE OUT SAME AS MOVE IN 391.71

ENGINEERING LABOR = 0.00

CHOKERS 15.35 EACH

COST OF CHOKERS = (SALE VOL) * (COST EACH)/LIFE MBF

COST OF CHOKERS = 118.58

OPERATING LINES(EPS)

LINE	$1/FT	SIZE(IN)	LENGTH(FT)	TOTAL	LIFE(MM)	($/M)
MAINLINE	0.50	0.38	1500.00	750.00	6.00	0.13
HAULBACK	0.50	0.38	3000.00	1500.00	6.00	0.25
SKYLINE	0.80	0.50	2000.00	1600.00	8.00	0.20
SKIDDING	0.00	0.00	0.00	0.00	0.00	0.00
STRAWLINE	0.21	0.25	4000.00	840.00	5.00	0.17
SLACK PULLING	0.00	0.00	0.00	0.00	0.00	0.00
OTHER LINE	0.00	0.00	0.00	0.00	0.00	0.00

SUBTOTAL: 0.74 /M * 750.00 = 557.25

TOTAL FIXED COSTS = 1580.69

D. INSURANCE AND TAXES

AVERAGE INVESTMENT = (NEW COST + RESID. + DEPR.)/2
INSURANCE AND TAXES = 0.16 % * AVE. INVEST (43442.86)

INSURANCE AND TAXES = 4.34 $/HR

YARDING COST SUMMARY

CALCULATED MBF/DAY	7.71
DEPRECIATION/8 HR. DAY	53.10
OPERATING COST/8 HR. DAY	189.18
FIXED COST /8 HR. DAY	16.25
INSURANCE AND TAXES/8 HR. DAY	34.75
TOTAL COST/8 HR. DAY	293.29
COST/MBF	38.04

Smith Timbermaster

EXPLANATION OF COST

A DEPPECIATION COSTS

EQUIPMENT	NEW	RESIDUAL	FREIGHT	LIFE YRS	HRS	$/HR
YARDER	66000.00	13200.00	1000.00	7	11200	4.80
RADIO/TPANS	4809.00	480.90	0000000	4	6400	0.68
CARRIAGE	0.00	0.00	0000000	8	12800	0.00
TRACTOR	0.00	0.00	0.00	5	8000	0.00
RIG. HDW. TT	8000.00	800.00	0000000	4	6400	1.13

	SIZE	NUMBER	LENGTH	COST/FT	TOT COST	LIFE/HRS	COST/H
GUYLINES	0.50	3.00	200.00	0.70	210.00	12800	0.03

TOTAL DEPRECIATON COSTS = 6.64 /HR

B OPERATING COSTS

MAINTENANCE AND REPAIR

EQUIPMENT	%OF DEP.	$/HOUR
YARDER	50	2.40
RADIO	60	0.41
CARRIAGE	20	0.00
TRACTOR	50	0.00
RADIO CONT.	60	0.00

SUBTOTAL 2.81

FUEL AND LUBRICATION

EQUIPMENT	$/HR
YARDER	3.84
TRACTOR	0.00

SUBTOTAL 3.84

YARDING LABOR(TITLE)	HOURLY RATE	NUMBER	TOTAL COST/HR
HOOK TENDER	0.00	1	0.00
CHOKER SETTER	8.50	1.00	8.50
CHASER	0.00	1	0.00
YARDING ENGINEER	8.50	1	8.50
SKIDDER OPEPATOR	0.00	1	0.00

SUBTOTAL 17.00

C. FIXED COSTS

MOVE IN 6.00 HOURS FOR SIDE, VEHICLE AND DRIVER
30.29 + 35.00 * 6.00 = 391.71

INITIAL RIG UP 2.00 HOURS FOR SIDE = 60.57

RIG DOWN SAME AS RIG UP 60.57

MOVE OUT SAME AS MOVE IN 391.71

ENGINEERING LABOR = 0.00

CHOKERS 15 $5 EACH

COST OF CHOKERS = (SALE VOL) * (COST EACH)/LIFE MBF

COST OF CHOKERS = 118.88

OPERATING LINES(EPS)

LINE	$1/FT	SIZE(IN)	LENGTH(FT)	TOTAL	LIFE(MM)	($/M)
MAINLINE	0.50	0.38	1500.00	750.00	6.00	0.13
HAULBACK	0.50	0.38	3000.00	1500.00	6.00	0.25
SKYLINE	0.80	0.50	2000.00	1600.00	8.00	0.20
SKIDDING	0.00	0.00	0.00	0.00	0.00	0.00
STRAWLINE	0.21	0.25	4000.00	840.00	5.00	0.17
SLACK PULLING	0.00	0.00	0.00	0.00	0.00	0.00
OTHER LINE	0.00	0.00	0.00	0.00	0.00	0.00

SUBTOTAL: 0.74 /M * 750.00 = 557.25

TOTAL FIXED COSTS = 1590.69

D. INSURANCE AND TAXES

AVERAGE INVESTMENT = (NEW COST + RESID. + DEPR.)/2
INSURANCE AND TAXES = 0.20 % * AVE. INVEST (43442.86)

INSURANCE AND TAXES = 5.43 $/HR

YARDING COST SUMMARY

CALCULATED MBF/DAY	7.71
DEPRECIATION/8 HR. DAY	53.10
OPERATING COST/8 HR. DAY	189.13
FIXED COST /8 HR. DAY	16.25
INSURANCE AND TAXES/8 HR. DAY	43.44
TOTAL COST/8 HR. DAY	301.97
COST/MBF	39.17

Thunderbird

EXPLANATION OF COST

A. DEPRECIATION COSTS

EQUIPMENT	NEW	RESIDUAL	FREIGHT	LIFE YRS	LIFE HRS	$/HR
YARDER	235000.00	47000.00	9000.00	8	12800	15.39
RADIO/TRANS	4809.00	480.90	0000000	4	6400	0.68
CARRIAGE	4300.00	860.00	0000000	4	6400	0.54
TRACTOR	0.00	0.00	0.00	6	9600	0.00
RIG. HDW. TT	9000.00	800.00	0000000	4	6400	1.13

	SIZE	NUMBER	LENGTH	COST/FT	TOT. COST	LIFE/HRS	COST/H
GUYLINES	1.12	3.00	200.00	2.57	771.00	12800	0.12

TOTAL DEPRECIATON COSTS = 17.85 /HR

B. OPERATING COSTS

MAINTENANCE AND REPAIR

EQUIPMENT	%OF DEP.	$/HOUR
YARDER	50	7.70
RADIO	60	0.41
CARRIAGE	50	0.27
TRACTOR	50	0.00
RADIO CONT.	60	0.00

SUBTOTAL 8.37

FUEL AND LUBRICATION

EQUIPMENT	$/HR
YARDER	13.51
TRACTOR	0.00

SUBTOTAL 13.51

YARDING LABOR(TITLE)	HOURLY RATE	NUMBER	TOTAL COST/HR
HOOK TENDER	8.50	1	8.50
CHOKER SETTER	8.50	1.00	8.50
CHASER	8.50	1	8.50
YARDING ENGINEER	8.50	1	8.50
SKIDDER OPERATOR	0.00	1	0.00

SUBTOTAL 34.00

C. FIXED COSTS

MOVE IN 6.00 HOURS FOR SIDE, VEHICLE AND DRIVER
73.73 + 45.00 * 6.00 = 712.38

INITIAL RIG UP 2.00 HOURS FOR SIDE = 147.46

RIG DOWN SAME AS RIG UP 147.46

MOVE OUT SAME AS MOVE IN 712.38

ENGINEERING LABOR = 0.00

CHOKERS 34.45 EACH

COST OF CHOKERS = (SALE VOL) * (COST EACH)/LIFE MBF

COST OF CHOKERS = 258.38

OPERATING LINES(EPS)

LINE	$1/FT	SIZE(IN)	LENGTH(FT)	TOTAL	LIFE(MM)	($/M)
MAINLINE	1.33	0.75	1500.00	1995.00	12.00	0.17
HAULBACK	1.33	0.75	3500.00	4655.00	12.00	0.39
SKYLINE	2.10	1.00	1800.00	3780.00	10.00	0.38
SKIDDING	0.00	0.00	0.00	0.00	0.00	0.00
STRAWLINE	0.45	0.38	4000.00	1800.00	5.00	0.36
SLACK PULLING	1.33	0.75	1500.00	1995.00	12.00	0.17
OTHER LINE	1.33	0.75	125.00	166.25	0.50	0.33

SUBTOTAL: 1.79 /M * 750.00 = 1343.19

TOTAL FIXED COSTS = 3321.24

D. INSURANCE AND TAXES

AVERAGE INVESTMENT = (NEW COST + RESID. + DEPR.)/2
INSURANCE AND TAXES = 0.16 % * AVE. INVEST. (153312.50)

INSURANCE AND TAXES = 15.33 $/HR

YARDING COST SUMMARY

CALCULATED MBF/DAY	22.22
DEPRECIATION/8 HR. DAY	142.80
OPERATING COST/8 HR. DAY	447.04
FIXED COST /8 HR. DAY	98.40
INSURANCE AND TAXES/8 HR. DAY	122.65
TOTAL COST/8 HR. DAY	810.88
COST/MBF	36.49

Thunderbird

EXPLANATION OF COST

A. DEPRECIATION COSTS

EQUIPMENT	NEW	RESIDUAL	FREIGHT	LIFE YRS	LIFE HRS	$/HR
YARDER	235000.00	47000.00	9000.00	9	12300	15.39
RADIO/TPANS	4809.00	480.90	0000000	4	6400	0.68
CARRIAGE	4300.00	860.00	0000000	4	6400	0.54
TRACTOR	0.00	0.00	0.00	5	9600	0.00
RIG. HDW. TT	8000.00	800.00	0000000	4	6400	1.13

	SIZE	NUMBER	LENGTH	COST/FT	TOT COST	LIFE/HRS	COST/H
GUYLINES	1.12	3.00	200.00	2.57	771.00	12800	0.12

TOTAL DEPRECIATON COSTS = 17.85 /HR

B. OPERATING COSTS

MAINTENANCE AND REPAIR

EQUIPMENT	%OF DEP.	$/HOUR
YARDER	50	7.70
RADIO	60	0.41
CARRIAGE	50	0.27
TRACTOR	50	0.00
RADIO CONT.	60	0.00

SUBTOTAL 8.37

FUEL AND LUBRICATION

EQUIPMENT	$/HP
YARDER	13.51
TRACTOR	0.00

SUBTOTAL 13.51

YARDING LABOR(TITLE)	HOURLY RATE	NUMBER	TOTAL COST/HR
HOOK TENDER	8.50	1	8.50
CHOKER SETTER	8.50	1.00	8.50
CHASER	8.50	1	8.50
YARDING ENGINEER	8.50	1	8.50
SKIDDER OPERATOR	0.00	1	0.00

SUBTOTAL 34.00

C. FIXED COSTS

MOVE IN 6.00 HOURS FOR SIDE, VEHICLE AND DRIVER
73.73 + 45.00 * 6.00 = 712.38

INITIAL RIG UP 2.00 HOURS FOR SIDE = 147.46

RIG DOWN SAME AS RIG UP 147.46

MOVE OUT SAME AS MOVE IN 712.38

ENGINFERING LABOR = 0.00

CHOKERS 34 45 EACH

COST OF CHOKERS = (SALE VOL) * (COST EACH)/LIFE MBF

COST OF CHOKERS = 258.38

OPERATING LINES(EPS)

LINE	$1/FT	SIZE(IN)	LENGTH(FT) TOTAL	LIFE(MM)	($/M)
MAINLINE	1.33	0.75	1500.00	1995.00	12.00	0.17
HAULBACK	1.33	0.75	3500.00	4655.00	12.00	0.39
SKYLINE	2.10	1.00	1800.00	3780.00	10.00	0.38
SKIDDING	0.00	0.00	0.00	0.00	0.00	0.00
STRAWLINE	0.45	0.38	4000.00	1800.00	5.00	0.36
SLACK PULLING	1.33	0.75	1500.00	1995.00	12.00	0.17
OTHER LINE	1.33	0.75	125.00	166.25	0.50	0.33

SUBTOTAL: 1.79 /M * 750.00 = 1343.19

TOTAL FIXED COSTS = 3321.24

D. INSURANCE AND TAXES

AVERAGE INVESTMENT = (NEW COST + RESID. + DEPR.)/2
INSURANCE AND TAXES = 0.20 % * AVE. INVEST.(153312.50)

INSURANCE AND TAXES = 19.16 $/HR

YARDING COST SUMMARY

CALCULATED MBF/DAY	22.22
DEPRECIATION/8 HR. DAY	142.80
OPERATING COST/8 HR. DAY	447.04
FIXED COST /8 HR. DAY	98.40
INSURANCE AND TAXES/8 HR. DAY	153.31
TOTAL COST/8 HR. DAY	841.55
COST/MBF	37.87

Rosedale Timbermaster

EXPLANATION OF COST

A DEPRECIATION COSTS

EQUIPMENT	NEW	RESIDUAL	FREIGHT	LIFE YRS	LIFE HRS	$/HR
YARDER	82000.00	16400.00	7500 00	7	11200	6.53
RADIO/TRANS	4809 00	480.90	0000000	4	6400	0.68
CARRIAGE	3400.00	680.00	0000000	8	12800	0.21
TRACTOR	0.00	0.00	0 00	5	9000	0.00
RIG. HDW TT	8000.00	800.00	0000000	4	6400	1.13

	SIZE	NUMBER	LENGTH	COST/FT	TOT COST	LIFE/HRS	COST/H
GUYLINES	0.75	2.00	100.00	1.33	133.00	12800	0.02

TOTAL DEPRECIATON COSTS = 8.56 /HR

B OPERATING COSTS

MAINTENANCE AND REPAIR

EQUIPMENT	%OF DEP.	$/HOUR
YARDER	50	3.26
RADIO	60	0.41
CARRIAGE	20	0.04
TRACTOR	50	0.00
RADIO CONT.	60	0.00

SUBTOTAL 3.71

FUEL AND LUBRICATION

EQUIPMENT	$/HR
YARDER	3.84
TRACTOR	0.00

SUBTOTAL 3.84

YARDING LABOR(TITLE)	HOURLY RATE	NUMBER	TOTAL COST/HR
HOOK TENDER	0.00	1	0.00
CHOKER SETTER	8.50	1 00	8 50
CHASER	8.50	1	8.50
YARDING ENGINEER	8.50	1	8.50
SKIDDER OPERATOR	0.00	1	0 00

SUBTOTAL 25.50

C. FIXED COSTS

MOVE IN 6.00 HOURS FOR SIDE, VEHICLE AND DRIVER
41.61 + 50.00 * 6.00 = 549.68

INITIAL RIG UP 2.00 HOURS FOR SIDE = 83.23

RIG DOWN SAME AS RIG UP 83.23

MOVE OUT SAME AS MOVE IN 549.68

ENGINEERING LABOR = 0.00

CHOKERS 15.85 EACH

COST OF CHOKERS = (SALE VOL) * (COST EACH)/LIFE MBF

COST OF CHOKERS = 118.88

OPERATING LINES(EPS)

LINE	$1/FT	SIZE(IN)	LENGTH(FT)	TOTAL	LIFE(MM)	($/M)
MAINLINE	0.50	0.38	1050.00	525.00	6.00	0.09
HAULBACK	0.50	0.39	1950.00	975.00	6.00	0.16
SKYLINE	0.90	0.63	1350.00	1215.00	8.00	0.15
SKIDDING	0.00	0.00	0.00	0.00	0.00	0.00
STRAWLINE	0.40	0.25	2600.00	1040.00	6.00	0.17
SLACK PULLING	0.00	0.00	0.00	0.00	0.00	0.00
OTHER LINE	0.00	0.00	0.00	0.00	0.00	0.00

SUBTOTAL: 0.58 /M * 750.00 = 431.41

TOTAL FIXED COSTS = 1816.09

D. INSURANCE AND TAXES

AVERAGE INVESTMENT = (NEW COST + RESID. + DEPR)/2
INSURANCE AND TAXES = 0.16 % * AVE. INVEST (54421.43)

INSURANCE AND TAXES = 5.44 $/HR

YARDING COST SUMMARY

CALCULATED MBF/DAY	12.93
DEPRECIATION/8 HR. DAY	68.49
OPERATING COST/8 HR. DAY	264.41
FIXED COST /8 HR. DAY	31.31
INSURANCE AND TAXES/8 HR. DAY	43.54
TOTAL COST/8 HR. DAY	407.75
COST/MBF	31.54

Rosedale TimBermaster

EXPLANATION OF COST

A DEPRECIATION COSTS

EQUIPMENT	NEW	RESIDUAL	FREIGHT	LIFE YRS	LIFE HRS	$/HR
YARDER	82000.00	16400.00	7500.00	7	11200	6.53
RADIO/TRANS	4809.00	480.90	0000000	4	6400	0.68
CARRIAGE	3400.00	660.00	0000000	8	12300	0.21
TRACTOR	0.00	0.00	0.00	5	8000	0.00
RIG. HDW. TT	8000.00	800.00	0000000	4	6400	1.13

	SIZE	NUMBER	LENGTH	COST/FT	TOT COST	LIFE/HRS	COST/H
GUYLINES	0.75	2.00	100.00	1.33	133.00	12800	0.02

TOTAL DEPRECIATON COSTS = $ 56 /HR

B. OPERATING COSTS

MAINTENANCE AND REPAIR

EQUIPMENT	%OF DEP.	$/HOUR
YARDER	50	3.26
RADIO	60	0.41
CARRIAGE	20	0.04
TRACTOR	50	0.00
RADIO CONT.	60	0.00

SUBTOTAL 3.71

FUEL AND LUBRICATION

EQUIPMENT	$/HR
YARDER	3.94
TRACTOR	0.00

SUBTOTAL 3.94

YARDING LABOR(TITLE)	HOURLY RATE	NUMBER	TOTAL COST/HR
HOOK TENDER	0.00	1	0.00
CHOKER SETTER	8.50	1.00	8 50
CHASER	8.50	1	8 50
YARDING ENGINEER	8.50	1	8 50
SKIDDER OPERATOR	0.00	1	0.00

SUBTOTAL 25 50

C. FIXED COSTS

MOVE IN 6.00 HOURS FOR SIDE, VEHICLE AND OPIVER
41.61 + 50.00 * 6.00 = 549.68

INITIAL RIG UP 2.00 HOURS FOR SIDE = 83.23

RIG DOWN SAME AS RIG UP 83.23

MOVE OUT SAME AS MOVE IN 549 68

ENGINEFRING LABOR = 0.00

CHOKEPS 15 35 EACH

COST OF CHOKERS = (SALE VOL) * (COST EACH)/LIFE MEF

COST OF CHOKERS = 118.88

OPERATING LINES(EPS)

LINE	$1/FT	SIZE(IN)	LENGTH(FT)	TOTAL	LIFE(MM)	($/M)
MAINI INE	0 50	0.33	1050.00	525 00	6.00	0.09
HAULBACK	0.50	0.33	1950.00	975.00	6.00	0.16
SKYLINE	0.90	0.63	1350.00	1215.00	8.00	0.15
SKIDDING	0.00	0.00	0.00	0.00	0.00	0.00
STRAWLINE	0.40	0.25	2600.00	1040.00	6.00	0.17
SLACK PULLING	0.00	0.00	0.00	0.00	0.00	0.00
OTHER LINE	0.00	0.00	0.00	0.00	0.00	0.00

SUBTOTAL: 0.58 /M * 750.00 = 431.41

TOTAL FIXED COSTS = 1816.09

D. INSURANCE AND TAXES

AVERAGE INVESTMENT = (NEW COST + RESID. + DEPR.)/2
INSURANCE AND TAXES = 0.20 % * AVE. INVEST (54421.43)

INSURANCE AND TAXES = 6.80 $/HR

YARDING COST SUMMARY

CALCULATED MBF/DAY	12.93
DEPPECIATION/8 HR. DAY	68.49
OPERATING COST/8 HR. DAY	264 41
FIXED COST /8 HR. DAY	31.31
INSURANCE AND TAXES/8 HR. DAY	54.42
TOTAL COST/8 HR. DAY	418.63
COST/MBF	32 38

Ecologger II

EXPLANATION OF COST

A DEPRECIATION COSTS

EQUIPMENT	NEW	RESIDUAL	FREIGHT	LIFE YRS	LIFE HRS	$/HR
YARDER	182390.00	36478.00	7500.00	8	12800	11.99
RADIO/TRANS	4800.00	480.00	0000000	4	6400	0.68
CARRIAGE	2800.00	560.00	0000000	8	12800	0.18
TRACTOR	0.00	0.00	0.00	5	8000	0.00
PTG HDW TT	8000.00	800.00	0000000	4	6400	1.13

	SIZE	NUMBER	LENGTH	COST/FT	TOT COST	LIFE/HRS	COST/H
GUYLINES	0.88	4.00	225.00	1.66	747.00	12800	0.12

TOTAL DEPRECIATON COSTS = 14.00 /HR

B OPERATING COSTS

MAINTENANCE AND REPAIR

EQUIPMENT	%OF DEP	$/HOUR
YARDER	50	5.99
RADIO	60	0.41
CARRIAGE	20	0.04
TRACTOR	50	0.00
RADIO CONT	60	0.00

SUBTOTAL 6.43

FUEL AND LUBRICATION

EQUIPMENT	$/HR
YARDER	5.92
TRACTOR	0.00

SUBTOTAL 5.92

YARDING LABOR(TITLE)	HOURLY RATE	NUMBER	TOTAL COST/HR
HOOK TENDER	8.50	1	8.50
CHOKER SETTER	8.50	1.00	8.50
CHASER	0.00	1	0.00
YARDING ENGINEER	8.50	1	8.50
SKIDDER OPERATOR	0.00	1	0.00

SUBTOTAL 25.50

C. FIXED COSTS

MOVE IN 6.00 HOURS FOR SIDE, VEHICLE AND DRIVER
51.93 + 40.00 * 6.00 = 551.59

INITIAL RIG UP 2.00 HOURS FOR SIDE = 103.86

RIG DOWN SAME AS RIG UP 103.86

MOVE OUT SAME AS MOVE IN 551.59

ENGINEERING LABOR = 0.00

CHOKERS 34.45 EACH

COST OF CHOKERS = (SALE VOL) * (COST EACH)/LIFE MBF

COST OF CHOKERS = 258.38

OPERATING LINES(EPS).

LINE	$1/FT	SIZE(IN)	LENGTH(FT)	TOTAL	LIFE(MM)	($/M)
MAINLINE	1.27	0.75	2100.00	2667.00	10.00	0.27
HAULBACK	0.86	0.63	1900.00	1634.00	8.00	0.20
SKYLINE	1.66	0.88	1500.00	2490.00	10.00	0.25
SKIDDING	0.00	0.00	0.00	0.00	0.00	0.00
STRAWLINE	0.45	0.38	2500.00	1125.00	8.00	0.14
SLACK PULLING	0.00	0.00	0.00	0.00	0.00	0.00
OTHER LINE	0.00	0.00	0.00	0.00	0.00	0.00

SUBTOTAL: 0.86 /M * 750.00 = 645.43

TOTAL FIXED COSTS = 2214.71

D INSURANCE AND TAXES

AVERAGE INVESTMENT = (NEW COST + RESID + DEPR)/2
INSURANCE AND TAXES = 0.16 % * AVE INVEST (119022.25)

INSURANCE AND TAXES = 11.90 $/HR

YARDING COST SUMMARY

CALCULATED MBF/DAY	17.70
DEPRECIATION/8 HR DAY	112.63
OPERATING COST/8 HR DAY	392.87
FIXED COST /8 HR DAY	52.27
INSURANCE AND TAXES/8 HR DAY	95.20
TOTAL COST/8 HR DAY	562.94
COST/MBF	31.80

Ecologger II

EXPLANATION OF COST

A DEPRECIATION COSTS

EQUIPMENT	NEW	RESIDUAL	FREIGHT	LIFE YRS	LIFE HRS	$/HR
YARDER	182390 00	36478 00	7500 00	8	12800	11.99
RADIO/TRANS	4800 00	480 00	0000000	4	6400	0 68
CARRIAGE	2800 00	560 00	0000000	8	12800	0.18
TRACTOR	0 00	0 00	0 00	5	8000	0.00
RIG HOW TT	8000 00	800 00	0000000	4	6400	1.13

	SIZE	NUMBER	LENGTH	COST/FT	TOT COST	LIFE/HRS	COST/H
GUYLINES	0 88	4 00	225 00	1 66	747 00	12800	0 12

TOTAL DEPRECIATON COSTS = 14 98 /HR

B OPERATING COSTS

MAINTENANCE AND REPAIR

EQUIPMENT	%OF DEP.	$/HOUR
YARDER	50	5 99
RADIO	60	0 41
CARRIAGE	20	0 04
TRACTOR	50	0 00
RADIO CONT	60	0 00

SUBTOTAL 6.43

FUEL AND LUBRICATION

EQUIPMENT	$/HR
YARDER	5 92
TRACTOR	0 00

SUBTOTAL 5 92

YARDING LABOR(TITLE)	HOURLY RATE	NUMBER	TOTAL COST/HR
HOOK TENDER	8 50	1	8 50
CHOKER SETTER	8 50	1 00	8 50
CHASER	0 00	1	0 00
YARDING ENGINEER	8 50	1	8 50
SKIDDER OPERATOR	0 00	1	0 00

SUBTOTAL 25 50

C. FIXED COSTS

MOVE IN 6.00 HOURS FOR SIDE, VEHICLE AND DRIVER
51.93 + 40.00 * 6.00 = 551.59

INITIAL RIG UP 2.00 HOURS FOR SIDE = 103.86

RIG DOWN SAME AS RIG UP 103.86

MOVE OUT SAME AS MOVE IN 551.59

ENGINEERING LABOR = 0.00

CHOKERS 34.45 EACH

COST OF CHOKERS = (SALE VOL) * (COST EACH)/LIFE MBF

COST OF CHOKERS = 259.38

OPERATING LINES(EPS)

LINE	$1/FT	SIZE(IN)	LENGTH(FT)	TOTAL LIFE(MM)	($/M)	
MAINLINE	1.27	0.75	2100.00	2667.00	10.00	0.27
HAULBACK	0.86	0.63	1900.00	1634.00	8.00	0.20
SKYLINE	1.66	0.88	1500.00	2490.00	10.00	0.25
SKIDDING	0.00	0.00	0.00	0.00	0.00	0.00
STRAWLINE	0.45	0.38	2500.00	1125.00	8.00	0.14
SLACK PULLING	0.00	0.00	0.00	0.00	0.00	0.00
OTHER LINE	0.00	0.00	0.00	0.00	0.00	0.00

SUBTOTAL: 0.86 /M * 750.00 = 645.43

TOTAL FIXED COSTS = 2214.71

D. INSURANCE AND TAXES

AVERAGE INVESTMENT = (NEW COST + RESID. + DEPR.)/2
INSURANCE AND TAXES = 0.20 % * AVE. INVEST (119022.25)

INSURANCE AND TAXES = 14.88 $/HR

YARDING COST SUMMARY

CALCULATED MBF/DAY	17.70
DEPRECIATION/8 HR. DAY	112.63
OPERATING COST/8 HR. DAY	302.82
FIXED COST /8 HR. DAY	52.27
INSURANCE AND TAXES/8 HR. DAY	119.02
TOTAL COST/8 HR. DAY	586.74
COST/MBF	33.15

APPENDIX II

YARDING COST COMPUTATIONS
(with skidder)

Igland Jones Trailer Alp

EXPLANATION OF COST

A DEPRECIATION COSTS

EQUIPMENT	NEW	RESIDUAL	FREIGHT	LIFE YRS	LIFE HRS	$/HR
YARDER	73000.00	14600.00	1460.00	4	6400	9.35
RADIO/TRANS	4809.00	480.90	0000000	4	6400	0.68
CARRIAGE	2200.00	460.00	0000000	8	12800	0.14
TRACTOR	10000.00	1000.00	0.00	5	8000	1.12
RIG. HDW TT	8000.00	800.00	0000000	4	6400	1.13

	SIZE	NUMBER	LENGTH	COST/FT	TOT COST	LIFE/HRS	COST/H
GUYLINES	0.75	3.00	100.00	1.33	199.50	12800	0.03

TOTAL DEPRECIATON COSTS = 12.45 /HP

B OPERATING COSTS

MAINTENANCE AND REPAIR

EQUIPMENT	%OF DEP.	$/HOUR
YARDER	50	4.68
RADIO	60	0 41
CARRIAGE	20	0 03
TRACTOR	50	0.56
RADIO CONT.	60	0.00

SUBTOTAL 5.67

FUEL AND LUBRICATION

EQUIPMENT	$/HR
YARDER	3 94
TRACTOR	2.98

SUBTOTAL 6.92

YARDING LABOR(TITLE)	HOURLY RATE	NUMBER	TOTAL COST/HR
HOOK TENDER	0.00	1	0.00
CHOKER SETTER	8.50	1.00	8 50
CHASER	0.00	1	0.00
YARDING ENGINEER	8 50	1	8 50
SKIDDER OPERATOR	8.50	1	8 50

SUBTOTAL 25.50

C. FIXED COSTS

MOVE IN 6.00 HOURS FOR SIDE, VEHICLE AND DRIVER
50.45 + 35.00 * 6.00 = 512.69

INITIAL RIG UP 2.00 HOURS FOR SIDE = 100.90

RIG DOWN SAME AS RIG UP 100.90

MOVE OUT SAME AS MOVE IN 512.69

ENGINFERING LABOR = 0.00

CHOKERS 15.85 EACH

COST OF CHOKERS = (SALE VOL) * (COST EACH)/LIFE MBF

COST OF CHOKERS = 118.88

OPERATING LINES(EPS)

LINE	$1/FT	SIZE(IN)	LENGTH(FT)	TOTAL	LIFE(MM)	($/M)
MAINLINE	0.50	0.38	2100.00	1050.00	6.00	0.18
HAULBACK	0.50	0.38	2100.00	1050.00	6.00	0.18
SKYLINE	0.90	0.63	3300.00	2970.00	8.00	0.37
SKIDDING	0.00	0.00	0.00	0.00	0.00	0.00
STRAWLINE	0.21	0.12	4250.00	892.50	5.00	0.13
SLACK PULLING	0.00	0.00	0.00	0.00	0.00	0.00
OTHER LINE	0.00	0.00	0.00	0.00	0.00	0.00

SUBTOTAL 0.90 /M * 750.00 = 674.81

TOTAL FIXED COSTS = 2020.85

D. INSURANCE AND TAXES

AVERAGE INVESTMENT = (NEW COST + RESID. + DEPR.)/2
INSURANCE AND TAXES = 0.16 % * AVE. INVEST.(51232.50)

INSURANCE AND TAXES = 5.13 $/HR

YARDING COST SUMMARY

CALCULATED MBF/DAY	9.81
DEPRECIATION/8 HR. DAY	99.62
OPERATING COST/8 HR. DAY	303.95
FIXED COST /8 HR. DAY	26.43
INSURANCE AND TAXES/8 HR. DAY	41.03
TOTAL COST/8 HR. DAY	471.04
COST/MBF	48.02

Igland Jones Trailer Alp

EXPLANATION OF COST

A DEPRECIATION COSTS

EQUIPMENT	NEW	RESIDUAL	FREIGHT	LIFE YRS	LIFE HRS	$/HR
YARDER	73000.00	14600.00	1460.00	4	6400	9.35
RADIO/TRANS	4309.00	430.90	0000000	4	6400	0.68
CARRIAGE	2300.00	460.00	0000000	3	12800	0.14
TRACTOR	10000.00	1000.00	0.00	5	9000	1.13
RIG. HDW TT	9000.00	900.00	0000000	4	6400	1.13

	SIZE	NUMBER	LENGTH	COST/FT	TOT. COST	LIFE/HRS	COST/H
GUYLINES	0.75	3.00	100.00	1.33	199.50	12800	0.03

TOTAL DEPRECIATON COSTS = 12.45 /HR

B OPERATING COSTS

MAINTENANCE AND REPAIR

EQUIPMENT	%OF DEP.	$/HOUR
YARDER	50	4.68
RADIO	60	0.41
CARRIAGE	20	0.03
TRACTOR	50	0.56
RADIO CONT.	60	0.00

SUBTOTAL 5.67

FUEL AND LUBRICATION

EQUIPMENT	$/HR
YARDER	3.84
TRACTOR	2.98

SUBTOTAL 6.82

YARDING LABOR(TITLE)	HOURLY RATE	NUMBER	TOTAL COST/HR
HOOK TENDER	0.00	1	0.00
CHOKER SETTER	8.50	1.00	8.50
CHASER	0.00	1	0.00
YARDING ENGINEER	8.50	1	8.50
SKIDDER OPERATOR	8.50	1	8.50

SUBTOTAL 25.50

C. FIXED COSTS

MOVE IN 6.00 HOURS FOR SIDE, VEHICLE AND DRIVER
50.45 + 35.00 * 6.00 = 512.69

INITIAL RIG UP 2.00 HOURS FOR SIDE = 100.90

RIG DOWN SAME AS RIG UP 100.90

MOVE OUT SAME AS MOVE IN 512.69

ENGINEERING LABOR = 0.00

CHOKERS 15.85 EACH

COST OF CHOKERS = (SALE VOL) * (COST EACH)/LIFE MBF

COST OF CHOKERS = 118.88

OPERATING LINES(EPS)

LINE	$1/FT	SIZE(IN)	LENGTH(FT) TOTAL	LIFE(MM)	($/M)
MAINLINE	0.50	0.38	2100.00	1050.00	6.00	0.18
HAULBACK	0.50	0.38	2100.00	1050.00	6.00	0.18
SKYLINE	0.90	0.63	3300.00	2970.00	8.00	0.37
SKIDDING	0.00	0.00	0.00	0.00	0.00	0.00
STRAWLINE	0.21	0.12	4250.00	892.50	5.00	0.18
SLACK PULLING	0.00	0.00	0.00	0.00	0.00	0.00
OTHER LINE	0.00	0.00	0.00	0.00	0.00	0.00

SUBTOTAL: 0.90 /M * 750.00 = 674.81

TOTAL FIXED COSTS = 2020.85

D. INSURANCE AND TAXES

AVERAGE INVESTMENT = (NEW COST + RESID. + DEPR.)/2
INSURANCE AND TAXES = 0.20 % * AVE. INVEST. (51282.50)

INSURANCE AND TAXES = 6.41 $/HR

YARDING COST SUMMARY

CALCULATED MBF/DAY	9.91
DEPRECIATION/8 HR. DAY	99.62
OPERATING COST/8 HR. DAY	303.95
FIXED COST /8 HR. DAY	26.43
INSURANCE AND TAXES/8 HR. DAY	51.28
TOTAL COST/8 HR DAY	481.30
COST/MBF	49.06

Smith Timbermaster

EXPLANATION OF COST

A DEPRECIATION COSTS

EQUIPMENT	NEW	RESIDUAL	FREIGHT	LIFE YRS	LIFE HRS	$/HR
YARDER	66000.00	13200.00	1000.00	7	11200	4.80
RADIO/TRANS	4803.00	480.90	0000000	4	6400	0.68
CARRIAGE	0.00	0.00	0000000	8	12800	0.00
TRACTOR	10000.00	1000.00	0.00	5	8000	1.13
RIG. HDW. TT	8000.00	800.00	0000000	4	6400	1.13

	SIZE	NUMBER	LENGTH	COST/FT	TOT. COST	LIFE/HRS	COST/H
GUYLINES	0.50	3.00	200.00	0.70	210.00	12800	0.03

TOTAL DEPRECIATON COSTS = 7.76 /HR

B OPERATING COSTS

MAINTENANCE AND REPAIR

EQUIPMENT	%OF DEP.	$/HOUR
YARDER	50	2.40
RADIO	60	0.41
CARRIAGE	20	0.00
TRACTOR	50	0.56
RADIO CONT.	60	0.00

SUBTOTAL 3.37

FUEL AND LUBRICATION

EQUIPMENT	$/HR
YARDER	3.84
TRACTOR	2.98

SUBTOTAL 6.82

YARDING LABOR(TITLE)	HOURLY RATE	NUMBER	TOTAL COST/HR
HOOK TENDER	0.00	1	0.00
CHOKER SETTER	8.50	1.00	8.50
CHASER	0.00	1	0.00
YARDING ENGINEER	8.50	1	8.50
SKIDDER OPERATOR	8.50	1	8.50

SUBTOTAL 25.50

C. FIXED COSTS

MOVE IN 6.00 HOURS FOR SIDE, VEHICLE AND DRIVER
43.45 + 35.00 * 6.00 = 470.72

INITIAL RIG UP 2.00 HOURS FOR SIDE = 86.91

RIG DOWN SAME AS RIG UP 86.91

MOVE OUT SAME AS MOVE IN 470.72

ENGINEERING LABOR = 0.00

CHOKERS 15.85 EACH

COST OF CHOKERS = (SALE VOL) * (COST EACH)/LIFE MBF

COST OF CHOKERS = 118.88

OPERATING LINES(EPS)

LINE	$1/FT	SIZE(IN)	LENGTH(FT)	TOTAL	LIFE(MM)	($/M)
MAINLINE	0.50	0.38	1500.00	750.00	6.00	0.13
HAULBACK	0.50	0.38	3000.00	1500.00	6.00	0.25
SKYLINE	0.80	0.50	2000.00	1600.00	8.00	0.20
SKIDDING	0.00	0.00	0.00	0.00	0.00	0.00
STRAWLINE	0.21	0.25	4000.00	840.00	5.00	0.17
SLACK PULLING	0.00	0.00	0.00	0.00	0.00	0.00
OTHER LINE	0.00	0.00	0.00	0.00	0.00	0.00

SUBTOTAL: 0.74 /M * 750.00 = 557.25

TOTAL FIXED COSTS = 1791.37

D. INSURANCE AND TAXES

AVERAGE INVESTMENT = (NEW COST + RESID. + DEPR.)/2
INSURANCE AND TAXES = 0.20 % * AVE. INVEST. (43442.86)

INSURANCE AND TAXES = 5.43 $/HR

YARDING COST SUMMARY

CALCULATED MBF/DAY	7.71
DEPRECIATION/8 HR. DAY	62.10
OPERATING COST/8 HR. DAY	235.52
FIXED COST /8 HR. DAY	19.42
INSURANCE AND TAXES/8 HR. DAY	43.44
TOTAL COST/8 HR. DAY	409.48
COST/MBF	53.11

Smith Timbermaster

EXPLANATION OF COST

A. DEPRECIATION COSTS

EQUIPMENT	NEW	RESIDUAL	FREIGHT	LIFE YRS	HPS	$/HR
YARDER	66000.00	13200.00	1000.00	7	11200	4.80
RADIO/TRANS	4809.00	480.90	0000000	4	6400	0.68
CARRIAGE	0.00	0.00	0000000	8	12800	0.00
TRACTOR	10000.00	1000.00	0.00	5	8000	1.13
RIG. HDW. TT	8000.00	800.00	0000000	4	6400	1.13

	SIZE	NUMBER	LENGTH	COST/FT	TOT. COST	LIFE/HRS	COST/H
GUYLINES	0.50	3.00	200.00	0.70	210.00	12800	0.03

TOTAL DEPRECIATON COSTS = 7.76 /HR

B OPERATING COSTS

MAINTENANCE AND REPAIR

EQUIPMENT	%OF DEP.	$/HOUR
YARDER	50	2.40
RADIO	60	0.41
CARRIAGE	20	0.00
TRACTOR	50	0.56
RADIO CONT.	60	0.00

SUBTOTAL 3.37

FUEL AND LUBRICATION

EQUIPMENT	$/HR
YARDER	3.84
TRACTOR	2.98

SUBTOTAL 6.82

YARDING LABOR(TITLE)	HOURLY RATE	NUMBER	TOTAL COST/HR
HOOK TENDER	0.00	1	0.00
CHOKER SETTER	8.50	1.00	8.50
CHASER	0.00	1	0.00
YARDING ENGINEER	8.50	1	8.50
SKIDDER OPERATOR	8.50	1	8.50

SUBTOTAL 25.50

C. FIXED COSTS

MOVE IN 6.00 HOURS FOR SIDE, VEHICLE AND DRIVER
43.45 + 35.00 * 6.00 = 470.72

INITIAL RIG UP 2.00 HOURS FOR SIDE = 86.91

RIG DOWN SAME AS RIG UP 86.91

MOVE OUT SAME AS MOVE IN 470.72

ENGINEERING LABOR = 0.00

CHOKERS 15.85 EACH

COST OF CHOKERS = (SALE VOL) * (COST EACH)/LIFE MBF

COST OF CHOKERS = 113.88

OPERATING LINES(EPS)

LINE	$1/FT	SIZE(IN)	LENGTH(FT)	TOTAL	LIFE(MM)	($/M)
MAINLINE	0.50	0.38	1500.00	750.00	6.00	0.13
HAULBACK	0.50	0.38	3000.00	1500.00	6.00	0.25
SKYLINE	0.80	0.50	2000.00	1600.00	8.00	0.20
SKIDDING	0.00	0.00	0.00	0.00	0.00	0.00
STRAW LINE	0.21	0.25	4000.00	840.00	5.00	0.17
SLACK PULLING	0.00	0.00	0.00	0.00	0.00	0.00
OTHER LINE	0.00	0.00	0.00	0.00	0.00	0.00

SUBTOTAL: 0.74 /M * 750.00 = 557.25

TOTAL FIXED COSTS = 1791.37

D. INSURANCE AND TAXES

AVERAGE INVESTMENT = (NEW COST + RESID. + DEPR.)/2
INSURANCE AND TAXES = 0.16 % * AVE. INVEST (43442.86)

INSUPANCE AND TAXES = 4.34 $/HR

YARDING COST SUMMARY

CALCULATED MBF/DAY	7.71
DEPRECIATION/8 HR. DAY	62.10
OPERATING COST/8 HR. DAY	285.52
FIXED COST /8 HR. DAY	18.42
INSURANCE AND TAXES/8 HR. DAY	34.75
TOTAL COST/8 HR. DAY	400.79
COST/MBF	51.98

ThunderBird

EXPLANATION OF COST

A DEPRECIATION COSTS

EQUIPMENT	NEW	RESIDUAL	FREIGHT	LIFE YRS	LIFE HRS	$/HR
YARDER	235000.00	47000.00	9000.00	8	12800	15.39
RADIO/TRANS	4809.00	480.90	0000000	4	6400	0.68
CARRIAGE	4300.00	860.00	0000000	4	6400	0.54
TRACTOR	10000.00	1000.00	0.00	5	8000	1.13
RIG. HDW. TT	8000.00	800.00	0000000	4	6400	1.13

	SIZE	NUMBER	LENGTH	COST/FT	TOT. COST	LIFE/HRS	COST/H
GUYLINES	1.12	3.00	200.00	2.57	771.00	12800	0.12

TOTAL DEPRECIATON COSTS = 13.97 /HR

B OPERATING COSTS

MAINTENANCE AND REPAIR

EQUIPMENT	%OF DEP.	$/HOUR
YARDER	50	7.70
RADIO	60	0.41
CARRIAGE	50	0.27
TRACTOR	50	0.56
RADIO CONT.	60	0.00

SUBTOTAL 8.93

FUEL AND LUBRICATION

EQUIPMENT	$/HR
YARDER	13.15
TRACTOR	2.97

SUBTOTAL 16.12

YARDING LABOR(TITLE)	HOURLY RATE	NUMBER	TOTAL COST/HR
HOOK TENDER	8.50	1	8.50
CHOKER SETTER	8.50	1.00	8.50
CHASER	8.50	1	8.50
YARDING ENGINEER	8.50	1	8.50
SKIDDER OPERATOR	8.50	1	8.50

SUBTOTAL 42.50

C. FIXED COSTS

MOVE IN 6.00 HOURS FOR SIDE, VEHICLE AND DRIVER
86.53 + 45.00 * 6.00 = 789.16

INITIAL RIG UP 2.00 HOURS FOR SIDE = 173.05

RIG DOWN SAME AS RIG UP 173.05

MOVE OUT SAME AS MOVE IN 789.16

ENGINEERING LABOR = 0.00

CHOKERS 34.45 EACH

COST OF CHOKERS = (SALE VOL) * (COST EACH)/LIFE MBF

COST OF CHOKERS = 258.38

OPERATING LINES(EPS)

LINE	$1/FT	SIZE(IN)	LENGTH(FT)	TOTAL	LIFE(MM)	($/M)
MAINLINE	1.33	0.75	1500.00	1995.00	12.00	0.17
HAULBACK	1.33	0.75	3500.00	4655.00	12.00	0.39
SKYLINE	2.10	1.00	1800.00	3780.00	10.00	0.38
SKIDDING	0.00	0.00	0.00	0.00	0.00	0.00
STRAWLINE	0.45	0.38	4000.00	1800.00	5.00	0.36
SLACK PULLING	1.33	0.75	1500.00	1995.00	12.00	0.17
OTHER LINE	1.33	0.75	125.00	166.25	0.50	0.33

SUBTOTAL: 1.79 /M * 750.00 =. 1343.19

TOTAL FIXED COSTS = 3526.00

D. INSURANCE AND TAXES

AVERAGE INVESTMENT = (NEW COST + RESID. + DEPR.)/2
INSURANCE AND TAXES = 0.16 % * AVE. INVEST. (153312.50)

INSURANCE AND TAXES = 15.33 $/HR

YARDING COST SUMMARY

CALCULATED MBF/DAY	22.22
DEPRECIATION/8 HR. DAY	151.80
OPERATING COST/8 HR. DAY	540.42
FIXED COST /8 HR. DAY	104.46
INSURANCE AND TAXES/8 HR. DAY	122.65
TOTAL COST/8 HR. DAY	919.33
COST/MBF	41.37

Thunderbird

EXPLANATION OF COST

A DEPRECIATION COSTS

EQUIPMENT	NEW	RESIDUAL	FREIGHT	LIFE YRS	LIFE HRS	$/HR
YARDER	235000.00	47000.00	9000.00	8	12800	15.39
RADIO/TRANS	4809.00	480.90	0000000	4	6400	0.68
CARRIAGE	4300.00	860.00	0000000	4	6400	0.54
TRACTOR	10000.00	1000.00	0.00	5	8000	1.13
RIG HDW TT	8000.00	800.00	0000000	4	6400	1.13

	SIZE	NUMBER	LENGTH	COST/FT	TOT. COST	LIFE/HRS	COST/H
GUYLINES	1.12	3.00	200.00	2.57	771.00	12800	0.12

TOTAL DEPRECIATON COSTS = 18.97 /HR

B OPERATING COSTS

MAINTENANCE AND REPAIR

EQUIPMENT	%OF DEP.	$/HOUR
YARDER	50	7.70
RADIO	60	0.41
CARRIAGE	50	0.27
TRACTOR	50	0.56
RADIO CONT.	60	0.00

SUBTOTAL 8.93

FUEL AND LUBRICATION

EQUIPMENT	$/HR
YARDER	13.15
TRACTOR	2.97

SUBTOTAL 16.12

YARDING LABOR(TITLE)	HOURLY RATE	NUMBER	TOTAL COST/HR
HOOK TENDER	8.50	1	8.50
CHOKER SETTER	8.50	1.00	8.50
CHASER	8.50	1	8.50
YARDING ENGINEER	8.50	1	8.50
SKIDDER OPERATOR	8.50	1	8.50

SUBTOTAL 42.50

C. FIXED COSTS

MOVE IN 6.00 HOURS FOR SIDE, VEHICLE AND DRIVER
86.53 + 45.00 * 6.00 = 789.16

INITIAL RIG UP 2.00 HOURS FOR SIDE = 173.05

RIG DOWN SAME AS RIG UP 173.05

MOVE OUT SAME AS MOVE IN 789.16

ENGINEERING LABOR = 0.00

CHOKERS 34.45 EACH

COST OF CHOKERS = (SALE VOL) * (COST EACH)/LIFE MBF

COST OF CHOKERS = 258.38

OPERATING LINES(EPS)

LINE	$1/FT	SIZE(IN)	LENGTH(FT)	TOTAL	LIFE(MM)	($/M)
MAINLINE	1.33	0.75	1500.00	1995.00	12.00	0.17
HAULBACK	1.33	0.75	2500.00	4655.00	12.00	0.39
SKYLINE	2.10	1.00	1800.00	3780.00	10.00	0.38
SKIDDING	0.00	0.00	0.00	0.00	0.00	0.00
STRAWLINE	0.45	0.38	4000.00	1800.00	5.00	0.36
SLACK PULLING	1.33	0.75	1500.00	1995.00	12.00	0.17
OTHER LINE	1.33	0.75	125.00	166.25	0.50	0.33

SUBTOTAL: 1.79 /M * 750.00 = 1343.19

TOTAL FIXED COSTS = 3526.00

D. INSURANCE AND TAXES

AVERAGE INVESTMENT = (NEW COST + RESID. + DEPR.)/2
INSURANCE AND TAXES = 0.20 % * AVE. INVEST. (153312.50)

INSURANCE AND TAXES = 19.16 $/HR

YARDING COST SUMMARY

CALCULATED MBF/DAY	22.22
DEPRECIATION/8 HR. DAY	151.80
OPERATING COST/8 HR. DAY	540.42
FIXED COST /8 HR. DAY	104.46
INSURANCE AND TAXES/8 HR. DAY	152.31
TOTAL COST/8 HR. DAY	949.99
COST/MBF	42.75

Ecologger II

EXPLANATION OF COST

A DEPRECIATION COSTS

EQUIPMENT	NEW	RESIDUAL	FREIGHT	LIFE YRS	LIFE HRS	$/HR
YARDER	182390.00	36479.00	7500.00	8	12800	11.99
RADIO/TRANS	4809.00	480.90	00000000	4	6400	0.68
CARRIAGE	2800.00	560.00	00000000	8	12800	0.19
TRACTOR	10000.00	1000.00	0.00	5	8000	1.13
RIG HOW TT	8000.00	800.00	00000000	4	6400	1.13

	SIZE	NUMBER	LENGTH	COST/FT	TOT COST	LIFE/HRS	COST/H
GUYLINES	0.88	4.00	225.00	1.66	747.00	12800	0.12

TOTAL DEPRECIATON COSTS = 15.20 /HR

B OPERATING COSTS

	EQUIPMENT	%OF DEP	$/HOUR
MAINTENANCE AND REPAIR	YARDER	50	5.99
	RADIO	60	0.41
	CARRIAGE	20	0.04
	TRACTOR	50	0.56
	RADIO CONT.	60	0.00

SUBTOTAL 7.00

	EQUIPMENT	$/HR
FUEL AND LUBRICATION	YARDER	5.92
	TRACTOR	2.97

SUBTOTAL 8.89

YARDING LABOR(TITLE)	HOURLY RATE	NUMBER	TOTAL COST/HR
HOOK TENDER	8.50	1	8.50
CHOKER SETTER	8.50	1.00	8.50
CHASER	0.00	1	0.00
YARDING ENGINEER	8.50	1	8.50
SKIDDER OPERATOR	8.50	1	8.50

SUBTOTAL 34.00

C FIXED COSTS

MOVE IN 6.00 HOURS FOR SIDE, VEHICLE AND DRIVER
65.09 + 40.00 * 6.00 = 630.54

INITIAL RIG UP 2.00 HOURS FOR SIDE = 130.18

RIG DOWN SAME AS RIG UP 130.18

MOVE OUT SAME AS MOVE IN 630.54

ENGINEERING LABOR = 0.00

CHOKERS 24.45 EACH

COST OF CHOKERS = (SALE VOL) * (COST EACH)/LIFE MBF

COST OF CHOKERS = 258.38

OPERATING LINES(EPS)

LINE	$1/FT	SIZE(IN)	LENGTH(FT)	TOTAL LIFE(MM)	($/M)	
MAIN LINE	1.27	0.75	2100.00	2667.00	10.00	0.27
HAULBACK	0.86	0.63	1900.00	1634.00	8.00	0.20
SKYLINE	1.66	0.88	1500.00	2490.00	10.00	0.25
SKIDDING	0.00	0.00	0.00	0.00	0.00	0.00
STRAWLINE	0.45	0.38	2500.00	1125.00	8.00	0.14
SLACK PULLING	0.00	0.00	0.00	0.00	0.00	0.00
OTHER LINE	0.00	0.00	0.00	0.00	0.00	0.00

SUBTOTAL 0.86 /M * 750.00 = 645.43

TOTAL FIXED COSTS = 2425.23

D INSURANCE AND TAXES

AVERAGE INVESTMENT = (NEW COST + RESID + DEPR)/2
INSURANCE AND TAXES = 0.20 % * AVE INVEST (119022.25)

INSURANCE AND TAXES = 14.88 $/HR

YARDING COST SUMMARY

CALCULATED MBF/DAY	17.70
DEPRECIATION/8 HR DAY	121.63
OPERATING COST/8 HR DAY	399.09
FIXED COST /8 HR DAY	57.24
INSURANCE AND TAXES/8 HR DAY	119.02
TOTAL COST/8 HR DAY	696.97
COST/MBF	39.38

Ecologger II

EXPLANATION OF COST

A. DEPRECIATION COSTS

EQUIPMENT	NEW	RESIDUAL	FREIGHT	LIFE YRS	LIFE HRS	$/HR
YARDER	182390.00	36478.00	7500.00	8	12800	11.99
RADIO/TRANS	4809.00	480.90	0000000	4	6400	0.68
CARRIAGE	2800.00	560.00	0000000	8	12800	0.18
TRACTOR	100000.00	1000.00	0.00	5	8000	1.13
RIG HDW TT	8000.00	800.00	0000000	4	6400	1.13

	SIZE	NUMBER	LENGTH	COST/FT	TOT COST	LIFE/HRS	COST/H
GUYLINES	0.88	4.00	225.00	1.66	747.00	12800	0.12

TOTAL DEPRECIATON COSTS = 15.20 /HR

B. OPERATING COSTS

MAINTENANCE AND REPAIR

EQUIPMENT	%OF DEP	$/HOUR
YARDER	50	5.99
RADIO	60	0.41
CARRIAGE	20	0.04
TRACTOR	50	0.56
RADIO CONT	60	0.00

SUBTOTAL 7.00

FUEL AND LUBRICATION

EQUIPMENT	$/HR
YARDER	5.92
TRACTOR	2.97

SUBTOTAL 8.89

YARDING LABOR(TITLE)	HOURLY RATE	NUMBER	TOTAL COST/HR
HOOK TENDER	8.50	1	8.50
CHOKER SETTER	8.50	1.00	8.50
CHASER	0.00	1	0.00
YARDING ENGINEER	8.50	1	8.50
SKIDDER OPERATOR	8.50	1	8.50

SUBTOTAL 34.00

C. FIXED COSTS

MOVE IN 6.00 HOURS FOR SIDE, VEHICLE AND DRIVER
65.09 + 40.00 * 6.00 = 630.54

INITIAL RIG UP 2.00 HOURS FOR SIDE = 130 18

RIG DOWN SAME AS RIG UP 130.18

MOVE OUT SAME AS MOVE IN 630 54

ENGINEERING LABOR = 0.00

CHOKERS 34 45 EACH

COST OF CHOKERS = (SALE VOL) * (COST EACH)/LIFE MBF

COST OF CHOKERS = 258.38

OPERATING LINES(EPS)

LINE	$1/FT	SIZE(IN)	LENGTH(FT)	TOTAL	LIFE(MM)	($/M)
MAINLINE	1.27	0.75	2100 00	2667 00	10.00	0.27
HAULBACK	0 86	0.63	1900 00	1634 00	8.00	0.20
SKYLINE	1.65	0 88	1500 00	2490 00	10.00	0.25
SKIDDING	0 00	0.00	0 00	0.00	0 00	0.00
STRAWLINE	0.45	0.38	2500.00	1125 00	8.00	0.14
SLACK PULLING	0 00	0.00	0.00	0.00	0.00	0.00
OTHER LINE	0 00	0.00	0 00	0 00	0.00	0.00

SUBTOTAL 0.86 /M * 750 00 = 645 43

TOTAL FIXED COSTS = 2425.23

D. INSURANCE AND TAXES

AVERAGE INVESTMENT = (NEW COST + RESID + DEPR)/2
INSURANCE AND TAXES = 0 1.6 % * AVE INVEST (119022.25)

INSURANCE AND TAXES = 11 90 $/HR

YARDING COST SUMMARY

CALCULATED MBF/DAY	17 70
DEPRECIATION/8 HR DAY	121.63
OPERATING COST/8 HR DAY	399 09
FIXED COST /8 HR DAY	57 24
INSURANCE AND TAXES/8 HR DAY	95 22
TOTAL COST/8 HR DAY	673 17
COST/MBF	38 03

APPENDIX III

PAYLOAD COMPUTATIONS

SKYLINE ANALYSIS PROGRAM (SAP)

Smith Timbermaster

LIVE SKYLINE LOAD ANALYSIS (RIGID LINK ASSUMPTION)

ALLOWABLE SKYLINE TENSION= 10630

SKYLINE WT=	0.54	MAINLINE WT=	0.35
HEADSPAR HT=	24	TAILSPAR HT=	20
HEADSPAR T.P =	1	TAILSPAR T.P =	10
INN YARD LIM=	1	OUT YARD LIM=	10

CARRIAGE WT= 80
LOADED CARRIAGE CLEARANCE= 8

TERRAIN POINT	LOG LOAD (FLY)	LOG LOAD (DRAG)	LINE LENGTH
2	2046	3069	896
3	1839	2758	896
4	2077	3116	897
5	2237	3356	897
6	2200	3300	896
7	2326	3488	896
8	2084	3126	894
9	3820	5730	895

NEW SPAR LOCATION = 0
NEW YARDER SPEC = 1
REQD RIGGING LENGTH = 2
STANDING SKYLINE PLOT= 3

STANDING SKYLINE PAYLOADS (BASED ON MIN LIVE SKYLINE LENGTH)

STATION	LOG LOAD (FLY)	LOG LOAD (DRAG)	CLEARANCE
87	2359	3539	12
175	1681	2521	14
262	1429	2143	15
350	1327	1990	18
437	1310	1964	22
524	1364	2046	23
612	1505	2258	20
699	1804	2706	15
787	2571	3856	9

NEW SPAR LOCATION = 0
NEW YARDER SPEC = 1
REQD RIGGING LENGTH = 2
STANDING SKYLINE PLOT= 3

Rosedale Timbermaster

LIVE SKYLINE LOAD ANALYSIS (RIGID LINK ASSUMPTION)

ALLOWABLE SKYLINE TENSION= 13700

SKYLINE WT=	0 72	MAINLINE WT=	0 26
HEADSPAR HT=	28	TAILSPAR HT=	20
HEADSPAR T.P =	1	TAILSPAR T.P =	10
INN YARD LIM=	1	OUT YARD LIM=	10

CARRIAGE WT= 80
LOADED CARRIAGE CLEARANCE= 8

TERRAIN POINT	LOG LOAD (FLY)	LOG LOAD (DRAG)	LINE LENGTH
2	2993	4490	895
3	2599	3899	896
4	2849	4273	897
5	3027	4540	897
6	2962	4443	896
7	3109	4664	895
8	2788	4182	894
9	5013	7519	894

NEW SPAR LOCATION = 0
NEW YARDER SPEC = 1
REQD RIGGING LENGTH = 2
STANDING SKYLINE PLOT= 3

STANDING SKYLINE PAYLOADS (BASED ON MIN LIVE SKYLINE LENGTH)

STATION	LOG LOAD (FLY)	LOG LOAD (DRAG)	CLEARANCE
87	3214	4820	15
175	2312	3468	16
262	1971	2957	17
350	1828	2742	20
437	1796	2694	23
524	1859	2788	24
612	2037	3055	20
699	2422	3633	15
787	3426	5139	9

NEW SPAR LOCATION = 0
NEW YARDER SPEC = 1
REQD RIGGING LENGTH = 2
STANDING SKYLINE PLOT= 3

Thunderbird

C----------

LIVE SKYLINE LOAD ANALYSIS (RIGID LINK ASSUMPTION)

ALLOWABLE SKYLINE TENSION= 34500

SKYLINE WT=	1.85	MAINLINE WT=	1.04
HEADSPAR HT=	45	TAILSPAR HT=	20
HEADSPAR T P =	1	TAILSPAR T P =	10
INN YARD LIM=	1	OUT YARD LIM=	10

CARRIAGE WT= 600
LOADED CARRIAGE CLEARANCE= 8

TERRAIN POINT	LOG LOAD (FLY)	LOG LOAD (DRAG)	LINE LENGTH
2	9901	14852	896
3	7767	11651	895
4	7941	11911	896
5	8204	12306	895
6	7947	11920	894
7	8243	12364	893
8	7389	11083	891
9	12949	19424	892

NEW SPAR LOCATION = 0
NEW YARDER SPEC = 1
REQD RIGGING LENGTH = 2
STANDING SKYLINE PLOT= 3

STANDING SKYLINE PAYLOADS (BASED ON MIN LIVE SKYLINE LENGTH)

STATION	LOG LOAD (FLY)	LOG LOAD (DRAG)	CLEARANCE
87	9409	12613	28
175	5958	8937	27
262	5037	7556	26
350	4657	6985	27
437	4586	6879	28
524	4774	7162	27
612	5282	7923	22
699	6366	9549	15
787	9170	13754	8

NEW SPAR LOCATION = 0
NEW YARDER SPEC = 1
REQD RIGGING LENGTH = 2
STANDING SKYLINE PLOT= 3

Igland Jones Trailer Alp

LIVE SKYLINE LOAD ANALYSIS (RIGID LINK ASSUMPTION)

ALLOWABLE SKYLINE TENSION= 13700

SKYLINE WT=	0.72	MAINLINE WT=	0.26
HEADSPAR HT=	24	TAILSPAR HT=	20
HEADSPAR T P =	1	TAILSPAR T P =	10
INN YARD LIM=	1	OUT YARD LIM=	10

CARRIAGE WT= 80
LOADED CARRIAGE CLEARANCE= 8

TERRAIN POINT	LOG LOAD (FLY)	LOG LOAD (DRAG)	LINE LENGTH
2	2716	4074	896
3	2436	3653	896
4	2730	4096	897
5	2928	4392	897
6	2873	4310	896
7	3028	4542	896
8	2712	4069	894
9	4943	7414	895

NEW SPAR LOCATION = 0
NEW YARDER SPEC = 1
REQD RIGGING LENGTH = 2
STANDING SKYLINE PLOT= 3

STANDING SKYLINE PAYLOADS (BASED ON MIN LIVE SKYLINE LENGTH)

STATION	LOG LOAD (FLY)	LOG LOAD (DRAG)	CLEARANCE
87	3130	4695	12
175	2247	3371	14
262	1914	2872	15
350	1774	2661	13
437	1744	2615	22
524	1805	2707	23
612	1979	2968	20
699	2355	3533	15
787	3335	5003	9

NEW SPAR LOCATION = 0
NEW YARDER SPEC = 1
REQD RIGGING LENGTH = 2
STANDING SKYLINE PLOT= 3

RIGGING LENGTH REQUIRED FOR SKYLINE= 984

LIVE SKYLINE LOAD ANALYSIS (RIGID LINK ASSUMPTION)

ALLOWABLE SKYLINE TENSION= 26500

SKYLINE WT=	1.42	MAINLINE WT=	1.04
HEADSPAR HT=	49	TAILSPAR HT=	20
HEADSPAR T P =	1	TAILSPAR T P =	10
INN YARD LIM=	1	OUT YARD LIM=	10

CARRIAGE WT= 600
LOADED CARRIAGE CLEARANCE= 8

TERRAIN POINT	LOG LOAD (FLY)	LOG LOAD (DRAG)	LINE LENGTH
2	7896	11844	897
3	6073	9110	895
4	6137	9205	895
5	6314	9471	895
6	6106	9159	893
7	5326	9489	892
8	5666	8499	890
9	9936	14904	891

NEW SPAR LOCATION = 0
NEW YARDER SPEC = 1
REQD RIGGING LENGTH = 2
STANDING SKYLINE PLOT= 3

STANDING SKYLINE PAYLOADS (BASED ON MIN LIVE SKYLINE LENGTH)

STATION	LOG LOAD (FLY)	LOG LOAD (DRAG)	CLEARANCE
87	6382	9573	31
175	4475	6713	29
262	3765	5647	28
350	3477	5215	28
437	3431	5146	29
524	3589	5384	28
612	3998	5997	23
699	4858	7287	16
787	7069	10604	8

NEW SPAR LOCATION = 0
NEW YARDER SPEC = 1
REQD RIGGING LENGTH = 2
STANDING SKYLINE PLOT= 3

APPENDIX IV

THEORETICAL DAILY PRODUCTION

```
 C10 DISP "PAYLOAD(FROM SAP OR MEAS)":
20 INPUT A
30 DISP "% TURN MAKING EFFICIENCY":
40 INPUT A1
50 DISP "INHAUL SPEED (FPM.MID DRUM)":
60 INPUT A2
70 DISP "OUTHAUL SPEED (FPM MID DRUM)":
80 INPUT A3
90 DISP "LENGTH OF SKYLINE ROAD":
100 INPUT A4
110 DISP "LATERAL YARDING DISTANCE":
120 INPUT A5
130 DISP "ROAD CHANGE TIME (MIN)":
140 INPUT A6
150 DISP "PRODUCTIVE MINUTES PER 8HR DAY":
160 INPUT A7
170 DISP "CARRIAGE (1) MECH. (2) MANUAL":
180 INPUT A8
190 DISP "MBF/ACRE":
200 INPUT A9.
210 B1=(A*A1)/11
220 IF A2>600 THEN 240
230 GOTO 250
240 A2=600
250 B2=A4/2/A2
260 B3=A4/2/A3
270 GOTO A8 OF 280,300
280 B4=(0.005*A5)+0.37
290 GOTO 310
300 B4=(0.005*A5)+0.67
310 B5=(0.0005*B1)+0.93
320 B6=(B2+B3+B4+B5)*1000/B1
330 B7=(A4*A5*A9*2)/43560
340 B8=B6/B7
350 B9=B6+B8
360 C=A7/B9
370 PRINT ""C""
380 END
```

Ecologger II

```
RUN
PAYLOAD(FROM SAP OR MSAP)?5146
% TURN MAKING EFFICIENCY? 6
INHAUL SPEED (FPM.MID DRUM)?1050
OUTHAUL SPEED (FPM MID DRUM)?1050
LENGTH OF SKYLINE ROAD?874
LATERAL YARDING DISTANCE?50
ROAD CHANGE TIME (MIN)?90
PRODUCTIVE MINUTES PER 8HR DAY?330
CARRIAGE (1) MECH. (2) MANUAL?2
MBF/ACRE?6
 17.69970769
```

Rosedale Timbermaster

```
RUN
PAYLOAD(FROM SAP OR MSAP)?2694
% TURN MAKING EFFICIENCY? 6
INHAUL SPEED (FPM.MID DRUM)?750
OUTHAUL SPEED (FPM MID DRUM)?1200
LENGTH OF SKYLINE ROAD?874
LATERAL YARDING DISTANCE?50
ROAD CHANGE TIME (MIN)?60
PRODUCTIVE MINUTES PER 8HR DAY?330
CARRIAGE (1) MECH. (2) MANUAL?2
MBF/ACRE?6
 1.2 9369054
```

Thunderbird

```
RUN
PAYLOAD(FROM SAP OR MSAP)?6878
% TURN MAKING EFFICIENCY? 6
INHAUL SPEED (FPM.MID DRUM)?1454
OUTHAUL SPEED (FPM MID DRUM)?1454
LENGTH OF SKYLINE ROAD?874
LATERAL YARDING DISTANCE?50
ROAD CHANGE TIME (MIN)?90
PRODUCTIVE MINUTES PER 8HR DAY?330
CARRIAGE (1) MECH. (2) MANUAL?1
MBF/ACRE?6
 22.2222868
RUN
```

Smith Timbermaster

```
RUN
PAYLOAD(FROM SAP OR MSAP)?1954
% TURN MAKING EFFICIENCY? 6
INHAUL SPEED (FPM.MID DRUM)?690
OUTHAUL SPEED (FPM MID DRUM)?1140
LENGTH OF SKYLINE ROAD?874
LATERAL YARDING DISTANCE?50
ROAD CHANGE TIME (MIN)?60
PRODUCTIVE MINUTES PER SHR DAY?330
CARRIAGE (1) MECH. (2) MANUAL?2
MBF/ACRE?6
 7.771120935
RUN
```

Igland Jones Trailer Alp

```
PAYLOAD(FROM SAP OR MSAP)?2615
% TURN MAKING EFFICIENCY? 6
INHAUL SPEED (FPM.MID DRUM)?1000
OUTHAUL SPEED (FPM MID DRUM)?1000
LENGTH OF SKYLINE ROAD?874
LATERAL YARDING DISTANCE?50
ROAD CHANGE TIME (MIN)?60
PRODUCTIVE MINUTES PER SHR DAY?330
CARRIAGE (1) MECH. (2) MANUAL?2
MBF/ACRE?6
 9.811260815
```

APPENDIX V

YARDER DESCRIPTIONS

SMITH TIMBERMASTER

The "Timbermaster," designed and manufacturered by a small agricultural engineering firm in Scotland, is a well engineered machine of rugged yet compact design. The unit is trailer mounted for ease of movement and is powered by a standard farm tractor.

Two operators are required for the "Timbermaster," one to run the yarder and one to set chokers. The yarder operator runs the system with two hand levers, one for the mainline winch and one for the haulback winch. Throttle speed is controlled by a foot pedal with a control cable leading to the farm tractor power unit. If a self-releasing choker hook is used, the yarder operator does not have to double as chaser and the turns can be quickly dropped at the landing allowing the skyline carriage to return to the woods without delay. Communications between the chokersetter and yarder operator are by radio.

ROSEDALE TIMBERMASTER

The Timbermaster is a truck mounted yarder-loader. The drumset includes three operating drums (skyline, mainline and haulback). Self-releasing chokers and a knuckleboom grapple permit the yarder engineer to land and deck logs without assistance provided the log slip is flat and volume per skyline road is low enough to be decked within reach of the knuckleboom. The machine should be capable of performing all the typical three drum live skyline operations described under Ecologger II.

The knuckleboom was assumed to be capable of keeping the

log slip clear in case 1, permitting the exclusion of skidder + skidder operator costs.

The Rosedale Timbermaster is actually the same as the Timbermaster Skyline Hauler which is manufactured in Australia and New Zealand.

*NOTE: All descriptions of Yarders from Seabaugh and Yerkes, 1979, except for the Smith Timbermaster which is from Hawkes, 1979.

ECOLOGGER II

The Ecologger II is a three drum (skyline, mainline, haulback) drumset and steel tower mounted on a rubber tired skidder. The machine is capable of yarding in live skyline, highlead, Grabinsky and (with proper carriage and intermediate support equipment) multispan configurations.

In live skyline configuration, operation of a variety of slackpulling carriages is feasible with or without use of the haulback line as chordslope dictates. The yarder can be radio controlled, permitting the yarder operator to also act as chaser when other conditions permit.

The Ecologger II is capable of yarding uphill or downhill and in partial cuts or clearcuts. The christy lightweight yarder-controlled carriage for downhill partial cutting has been developed for this cable configuration.

Costs for a three man crew, including one hooktender, one

chokersetter, one yarder engineer-chaser, and one skidder operator were computed for all logging.

THUNDERBIRD

The Thunderbird is a four drum and fixed boom steel tower available on crawler, rubber tired trailer or self propelled rubber mounted undercarriages. The skidder system (skyline, mainline, slackpuller, haulback, and skidder carriage) is standard logging configuration for the machine. The Thunderbird is also capable of yarding in highlead, Grabinsky, standing skyline, northbend, southbend, block in the bite, Tyler, and multispan configurations.

IGLAND-JONES MINI ALP

The mini alp is a small trailer mounted drumset (skyline, mainline and haulback) and tower. Power is applied from a farm tractor via the power takeoff. The machine is capable of operating in standing skyline, restricted live skyline, and multispan configurations, all with various slackpulling carriages and all with or without the haulback as chordslope dictates.

APPENDIX VI

	Ecologger II	Rosedale Timbermaster	Igland-Jones Alp	Thunderbird	Smith Timbermaster
Drum Capacities					
Skyline	1500	1350	3300	1700	2000
Mainline	2100	1050	2100	1500	1500
Slackpulling				1500	
Haulback	1900	1950	2100	3100	3000
Line Size					
Skyline	7/8	5/8	5/8	1	1/2
Mainline	3/4	3/8	3/8	3/4	3/8
Slackpulling				3/4	
Haulback	5/8	3/8	3/8	3/4	3/8
Line Speeds					
Mainline (fpm)	1050	750	1000	1454	690
Slackpulling				1454	
Haulback	1050	1200	1000	3700	1140
Tower Height	49'	28'	24'	45'	24'
Engine HP	160-200	80	65	320	65
Price (1980)	$182,000	$ 82,000	$ 73,000	$235,000	$ 66,000

APPENDIX VII

CONSTRUCTED COST PROGRAM

FOR THE HP 9830

```
<@
5 FIXED 2
6 DISP "LIFE OF YARDER IN YEARS":
7 INPUT I
8 I1=I*1600
10 DISP "NEW COST OF YARDER":
20 INPUT X
30 DISP "FREIGHT COST FOR YARDED";
40 INPUT X1
50 DISP "TOTAL COST OF RADIO TRANSM.";
60 INPUT X3
70 DISP "NEW COST OF CARRIAGE":
80 INPUT X4
90 DISP "NEW COST OF LANDING TRACTOR":
100 INPUT Y
110 DISP "FREIGHT FOR TRACTOR":
120 INPUT Y1
130 DISP "COST OF RIGGING HDWR";
140 INPUT Y2
150 DISP "COST OF RADIO CONTROL":
160 INPUT Y7
170 DISP "DIAMETER,COST/FT OF GUYLINES";
180 INPUT Y4,Y5
190 DISP "NUMBER,LENGTH IN FT OF GUYLINES";
200 INPUT Y3,Y6
210 Z=0.2*X
220 Z1=X-Z+X1
230 A=Z1/I1
240 Z2=0.1*X3
250 Z3=X3-Z2
260 B=Z3/6400
270 Z4=0.2*X4
280 Z6=X4-Z4
300 C=Z6/12800
310 Z7=0.1*Y
320 Z8=Y-Z7+Y1
330 D=Z8/8000
340 Z9=0.1*Y2
350 W1=Y2-Z9
360 E=W1/6400
370 F=(Y3*Y6*Y5)/12800
380 W2=0.1*Y7
390 W3=Y7-W2
400 G=W3/6400
410 S1=(A+B+C+D+E+F+G)
420 DISP "OPERATING COSTS"
430 WAIT 4000
440 DISP "FUEL AND LUBE FOR YARDER":
450 INPUT A1
460 DISP "FUEL AND LUBE FOR TRACTOR $/HR":
470 INPUT A2
```

```
490 DISP "HOOKTENDER WAGES $/HR":
500 INPUT B1
510 DISP " NUMBER OF CHOKER SET, WAGES $/HR":
520 INPUT B2,B3
530 DISP "CHASER WAGES $/HR":
540 INPUT B4
550 DISP "YARD ENG. WAGES $/HR":
560 INPUT B5
570 DISP "SKIDDER OPER. WAGES $/HR":
580 INPUT B6
590 DISP "FIXED COSTS"
600 WAIT 4000
610 DISP "HRS TO MOVE IN, COST OF VEHICLE":
620 INPUT C1,C2
630 DISP "INITIAL RIG UP IN HRS":
640 INPUT C3
650 DISP "ENGINEERING COSTS":
660 INPUT C4
670 DISP "COST PER CHOKER $":
680 INPUT C5
690 D1=D2=D3=D4=D5=D6=D7=0
700 DISP "MAINLINE COST/FT. DIAMETER":
710 INPUT L1,L2
720 DISP "MAINLINE LENGTH, LIFE MM":
730 INPUT L3,L4
740 DISP "HAULBACK COST/FT.SIZE":
750 INPUT L5,L6
760 DISP "HAULBACK LENGTH, LIFE MM":
770 INPUT L7,L8
780 DISP "SKYLINE COST/FT, SIZE":
790 INPUT M1,M2
800 DISP "SKYLINE LENGTH, LIFE MM":
810 INPUT M3,M4
820 DISP "SKIDDING LINE COST/FT,SIZE":
830 INPUT M5,M6
840 DISP "SKIDDING LINE LENGHT,LIFE MM":
850 INPUT M7,M8
860 DISP "STRAWLINE COST/FT.SIZE":
870 INPUT N1,N2
880 DISP "STRAWLINE LENGTH, LIFE MM":
890 INPUT N3,N4
900 DISP "SLACK PULLING LINE COST/FT.SIZE":
910 INPUT N5,N6
920 DISP "SLACK PULLING LINE LENGTH,LIFE MM":
930 INPUT N7,N8
940 DISP "OTHER LINES COST/FT. SIZE":
950 INPUT P1,P2
960 DISP "OTHER LINE LENGTH,LIFE MM":
970 INPUT P3,P4
971 I2=Z1/I
972 I3=(X+Z+I2)/2
973 DISP "INSURANCE AND TAXES AS %OF A.I.":
974 INPUT I4
975 I5=(I3/1600)*I4
980 IF L4=0 THEN 1000
990 D1=(L1*L3)/L4/1000
1000 IF L8=0 THEN 1020
1010 D2=(L5*L7)/L8/1000
```

```
1020 IF M4=0 THEN 1040
1030 Q3=(M1*M3)/M4/1000
1040 IF M8=0 THEN 1060
1050 Q4=(M5*M7)/M8/1000
1060 IF N4=0 THEN 1080
1070 Q5=(N1*N3)/N4/1000
1080 IF N8=0 THEN 1100
1090 Q6=(N5*N7)/N8/1000
1100 IF P4=0 THEN 1120
1110 Q7=(P1*P3)/P4/1000
1120 DISP "TOTAL SALE VOL. MBF";
1130 INPUT Q8
1140 Q9=(Q1+Q2+Q3+Q4+Q5+Q6+Q7)*Q8
1150 P5=(C5*Q8)/100
1160 S2=0.5*A+0.6*B+0.2*C+0.5*D+0.6*G
1170 S3=A1+A2
1180 S4=B1+(B2*B3)+B4+B5+B6
1190 S5=S2+S3+S4
1200 S6=S1+S5
1210 P6=(C2+S6)*C1
1220 P7=S6*C3
1230 S7=(2*P6)+(2*P7)+C4+P5+Q9
1240 DISP "PRINTOUT SHORT(1), LONG(2)";
1250 INPUT D1
1260 GOTO D1 OF 1265,1306
1265 PRINT "TOTAL TAXES & INSURANCE ="I5"      $"
1270 PRINT "TOTAL DEPRECIATION = "S1"       $/HR"
1280 PRINT "TOTAL OPERATING COST = "S5"       $/HR"
1290 PRINT "TOTAL FIXED COST = "S7"          $   "
1291 DISP "LONG PRINTOUT YES(1) NO(2)";
1292 INPUT D2
1293 GOTO D2 OF 1306,1294
1294 STOP
1300 FIXED 2
1301 PRINT "*****************************************************************************"
1306 PRINT "                    EXPLANATION OF COST"
1307 PRINT "*****************************************************************************"
1308 PRINT "A. DEPRECIATION COSTS"
1310 PRINT "                                                              LIFE"
1320 PRINT "EQUIPMENT     NEW        RESIDUAL       FREIGHT   YRS     HRS   $/HR"
1330 PRINT
1339 FIXED 2
1340 PRINT "YARDER     "X""Z"   "X1"4      6400 "A""
1341 F1=F*6400
1350 PRINT "RADIO/TRANS "X3" "Z2"      0000000    4      6400 "B""
1360 PRINT "CARRIAGE    "X4" "Z4"      0000000    8     12800 "C""
1370 PRINT "TRACTOR        "Y"   "Z7"      "Y1"5       8000 "D""
1380 PRINT "RIG. HDW. TT  "Y2" "Z9"      0000000    4      6400 "E""
1400 PRINT
1410 PRINT
1420 PRINT "          SIZE    NUMBER    LENGTH  COST/FT TOT. COST LIFE/HRS COST/H"
1430 PRINT "GUYLINES"Y4""Y3""Y6""Y5""F1"12800    "F"       "
1440 PRINT
1441 PRINT
1444 PRINT
1450 PRINT "                TOTAL DEPRECIATON COSTS = "S1"/HR"
1460 PRINT
1470 PRINT "*****************************************************************************"
1480 PRINT " B. OPERATING COSTS"
1481 PRINT
```

```
1482 PRINT
1490 PRINT "MAINTENANCE"
1500 PRINT "AND REPAIR    EQUIPMENT  %OF DEP   $/HOUR"
1501 A4=0.5*A
1502 A5=0.6*B
1503 A6=0.2*C
1504 A7=0.5*D
1505 A8=0.6*G
1510 PRINT "               YARDER          50      "A4" "
1520 PRINT "               RADIO           60      "A5" "
1520 PRINT "               CARRIAGE        20      "A6" "
1540 PRINT "               TRACTOR         50      "A7" "
1550 PRINT "               RADIO CONT      60      "A8" "
1560 PRINT
1570 PRINT "                      SUBTOTAL "S2"    "
1580 PRINT
1590 PRINT
1600 PRINT "FUEL AND"
1610 PRINT "LUBRICATION        EQUIPMENT          $/HR     "
1620 PRINT
1625 PRINT "                   YARDER             "A1""
1630 PRINT "                   TRACTOR            "A2""
1640 PRINT
1645 PRINT
1650 PRINT "                     SUBTOTAL  "A3" "
1660 PRINT
1670 PRINT
1680 PRINT "YARDING LABOR(TITLE)  HOURLY RATE   NUMBER  TOTAL COST/HR"
1690 PRINT "-------------------------------------------------------------------------"
1700 PRINT                                    .
1710 PRINT "HOOK TENDER              "B1"      1       "B1""
1712 T1=A2*B3
1720 PRINT "CHOKER SETTER            "B3"     "B2""T1""
1730 PRINT "CHASER                   "B4"      1       "B4""
1740 PRINT "YARDING ENGINEER         "B5"      1       "B5""
1750 PRINT "SKIDDER OPERATOR         "B6"      1       "B6""
1760 PRINT
1765 PRINT
1770 PRINT "                    SUBTOTAL "S4""
1780 PRINT
1790 PRINT "-------------------------------------------------------------------------"
1791 PRINT
1792 PRINT
1793 PRINT
1794 PRINT
1795 PRINT
1796 PRINT
1797 PRINT
1798 PRINT
1800 PRINT "*************************************************************************"
1810 PRINT "C.  FIXED COSTS"
1820 PRINT
1830 PRINT "MOVE IN      "C1"HOURS FOR SIDE, VEHICLE AND DRIVER"
1840 PRINT "             "S6" + "C2" * "C1" = "P6""
1850 PRINT
1859 PRINT
1860 PRINT "INITIAL RIG UP  "C3" HOURS FOR SIDE  =  "P7""
1870 PRINT
1880 PRINT
1890 PRINT "RIG DOWN    SAME AS RIG UP."P7""
```

```
1900 PRINT
1910 PRINT
1920 PRINT "MOVE OUT   SAME AS MOVE IN  "P6""
1930 PRINT
1940 PRINT
1950 PRINT "ENGINEERING LABOR  = "C4""
1960 PRINT
1970 PRINT
1980 PRINT "CHOKERS  "C5"EACH"
1990 PRINT
2000 PRINT "COST OF CHOKERS = (SALE VOL) * (COST EACH)/LIFE MBF"
2010 PRINT
2020 PRINT "COST OF CHOKERS = "P5""
2030 PRINT
2040 PRINT
2050 PRINT "OPERATING LINES(EPS)"
2060 PRINT "-------------------------------------------------------------------------"
2070 PRINT "LINE          $1/FT   SIZE(IN) LENGTH(FT) TOTAL  LIFE(MM) ($/M)"
2079 PRINT "-------------------------------------------------------------------------"
2080 PRINT
2081 T2=L1*L2
2082 T2=L5*L7
2083 T4=M1*M2
2084 T5=M5*M7
2085 T6=N1*N3
2086 T7=N5*N7
2087 T8=P1*P3
2088 T9=Q9/Q8
2090 PRINT "MAINLINE      "L1""L2""L3""T2" "L4""Q1
2100 PRINT "HAULBACK      "L5""L6""L7""T3" "L8""Q2
2110 PRINT "SKYLINE       "M1""M2""M3""T4" "M4""Q3
2120 PRINT "SKIDDING      "M5""M6"   "M7"   "T5" "M8""Q4
2130 PRINT "STRAWLINE     "N1""N2""N3" "T6"   "N4""Q5
2140 PRINT "SLACK PULLING"N5""N6"   "N7"   "T7" "N8""Q6
2150 PRINT "OTHER LINE    "P1""P2"   "P3"   "T8" "P4""Q7
2160 PRINT
2170 PRINT
2180 PRINT "   SUBTOTAL:  "T9"/M * "Q8" = "Q9""
2190 PRINT
2200 PRINT
2210 PRINT "-------------------------------------------------------------------------"
2220 PRINT "TOTAL FIXED COSTS = "S7""
2230 PRINT "-------------------------------------------------------------------------"
2240 PRINT "D.   INSURANCE AND TAXES"
2241 PRINT
2242 PRINT "AVERAGE INVESTMENT = (NEW COST + RESID.  + DEPR.)/2"
2243 PRINT "INSURANCE AND TAXES = "I4"%  * AVE.  INVEST.("I3")"
2244 PRINT
2245 PRINT "INSURANCE AND TAXES = "I5"   $/HR"
2246 PRINT
2247 PRINT "*************************************************************************"
2250 DISP "COST SUMMARY (1) YES, (2)NO";
2260 INPUT J5
2270 GOTO J5 OF 2290, 2280
2280 END
2290 PRINT "*************************************************************************"
2300 PRINT "            YARDING COST SUMMARY"
2310 PRINT "*************************************************************************"
2311 I9=I5*8
2320 DISP "MBF PER DAY";
```

```
2320 INPUT J6
2331 J1=S1*8
2332 J2=S5*8
2333 J3=(S7/98)*J6
2334 J4=J1+J2+J3+I9
2335 J9=I4/J6
2340 PRINT "CALCULATED MBF/DAY            "J6
2350 PRINT "DEPRECIATION/8 HR. DAY        "J1
2360 PRINT "OPERATING COST/8 HR. DAY      "J2
2370 PRINT "FIXED COST /8 HR. DAY         "J3
2371 PRINT "INSURANCE AND TAXES/8 HR  DAY"I9
2380 PRINT "TOTAL COST/8 HR. DAY          "J4
2390 PRINT "COST/MBF                      "J9
2400 PRINT "*************************************************************************"
2410 END
```