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INSTITUT CANADIEN DE RECHERCHES EN GÉNIE FORESTIER

T.N. # 32

FUEL AND ENERGY USE IN A COASTAL LOGGING OPERATION

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Technical Note No. TN-32
December 1979

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ACKNOWLEDGEMENT

This study could not have been done without the willing cooperation of B.C. Forest Products and the employees and staff at Pitt Lake Camp. Special thanks are given to Harry Erickson for help in assembling the data and reviewing the draft report.

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SUMMARY

The consumption of fuel and energy in logging operations has not been a major concern in the past. Recent price increases for petroleum fuels have changed this attitude, however, and loggers are becoming more concerned about energy conservation. This report describes the energy consumption patterns in fuels, lubricants and electricity at a typical British Columbia coastal logging operation during two periods, a full calendar year (1977) and a 4-month period of peak activity (April - July 1979). A broad breakdown of this consumption is expressed in diesel fuel energy equivalents* in the following table.

	FULL YEAR (1977)	PEAK PERIOD April-July 1979
Logging - Stump to Dump	2.31 gal d.e./cunit (3.70 ℓ d.e/m^3)	2.12 gal d.e./cunit (3.41 ℓ d.e./m^3)
Road Construction and Maintenance	1.26 gal d.e./cunit (2.02 ℓ d.e./m^3)	1.10 gal d.e./cunit (1.77 ℓ d.e./m^3)
Camp Operation (Heat, Crew Transport & Service)	2.46 gal d.e./cunit (3.96 ℓ d.e./m^3)	1.08 gal d.e./cunit (1.72 ℓ d.e./m^3)
TOTAL (includes unallocated miscellaneous energy usage)	6.33 gal d.e./cunit (10.17 ℓ d.e./m^3)	4.78 gal d.e./cunit (7.67 ℓ d.e./m^3)

This energy cost \$3.95/cunit (\$1.40/m^3) in 1977 (\$4.62/ cunit (\$1.63/m^3) at 1979 costs), and \$3.47/ cunit (\$1.23/m^3) for the peak period April to July 1979.

(Note that 1977 figures are for a full year and 1979 figures represent a partial year.)

*gallons in diesel equivalent = gal d.e.
litres in diesel equivalent = ℓ d.e.

A more detailed breakdown of the energy requirements in each phase of the operation is given in this report. Seasonal changes in fuel use are described and fuel consumption rates of individual machines are compared.

The report identifies unexpectedly high consumption in two phases which are not linked to direct production. The two phases, BUILDINGS (heat and light) and CREW TRANSPORTATION, together consumed 36% of the energy used by the operation in 1977.

The information in this report was compiled to help logging companies develop effective conservation programs at the greatest cost savings.

INTRODUCTION

One of the most important requirements in logging is the supply of fuel and energy. The efficient use of energy was not a major concern in the past when there were abundant supplies and relatively low prices. Petroleum price increases in the last decade have affected all consumers, including loggers, and the need to conserve supplies and to economize has been recognized. Developing a conservation program is difficult due to the nature of most logging operations. Most machines and other consumers use only a relatively small amount of energy and it is difficult to relate that use to the work being done. In addition, there is little published information concerning the consumption pattern within the total logging operation or concerning the relative energy efficiency of various logging systems. An effective energy conservation program needs this information as a basis for comparison.

FERIC studied fuel and energy consumption patterns at one typical British Columbia coastal logging operation during two periods: January through December 1977 and April through July 1979. The purposes of the study were

1. To document the types and quantities of energy used in the total operation and in each phase.
2. To compare the fuel use of individual machines.
3. To identify areas where a conservation program would have the most effect.

The concern over energy costs in logging will probably continue to increase. Studies of consumption patterns in other operations are needed as well as studies of the costs and benefits of various conservation strategies.

DESCRIPTION OF OPERATION

British Columbia Forest Products' Pitt Lake camp was used as a case study for this report. It is typical of many coastal logging operations. The camp is located five miles (8 km) north of Pitt Lake. Access is by water taxi from Pitt Polder, 16 miles (28 km) south.

The annual production of roughly 35,000 cunits (99 100 m^3) is achieved from three logging sides using conventional falling, high lead and grapple yarders, front-end and boom-type loaders and off-highway log trucks. Logs are unloaded, sorted, and bundled on land, then watered and boomed to the Fraser River for delivery to various destinations.

An average of eight miles (13 km) of new road is built each year on steep, rocky terrain. Road equipment used includes bulldozers, backhoes, rock drills, gravel trucks, a front-end loader and a grader. Most ballast and surfacing material is developed on-site.

A camp has existed at the present site since the 1930's although most buildings were built after 1954. A distinctive feature of the camp is its company-owned hydro-electric generator. It produces most of the electricity required; the standby diesel generator is needed only during periods of low water. There are 79 regular employees.

A more complete description of the operation is found in Appendix B.

METHOD OF ANALYSIS

The operation used different products in meeting its energy needs--various fuels, lubricants, electricity. The basis for comparison between these products is their net heating value, although this method is artificial in the case of lubricants. Product quantities are expressed as diesel fuel volumes of equivalent heating value (Imperial gallons or litres diesel equivalent, gal d.e., ℓ d.e.). The heating value of each product and its diesel equivalent volume is given in Appendix A. The total volumes consumed were obtained from the company's purchase and inventory records in most cases.

The energy demands of the various phases of the total logging operation are given in this report. The phases recognized are

Logging:
- Falling and Bucking (F&B)
- Yarding (YDG)
- Loading (LD)
- Hauling (HL)
- Sort Dump and Boom (SDB)

Roadwork:
- Road Maintenance (RM)
- Road Construction (RC)
- Rock Drilling and Blasting (RK)
- Ballast and Gravel (GVL)

Camp:
- Service (SER)
- Buildings - Heat and Light (BLD)
- Crew Transportation (CRT)

Usually several activities contributed to the total energy use in each phase. For example, the energy used in the Road Maintenance phase would include the fuel and lubricants used in maintenance work by gravel trucks and bulldozers as well as by the grader, but when the same equipment worked in the sort yard the fuel and lubricants used would be part of the energy needs in the Sort, Dump, and Boom phase. Some other examples are as follows:

Fuel and Lubricants used by	Phase used for
Logtruck Lowbedding a Yarder	Yarding
Logtruck Lowbedding a Bulldozer	Road Construction
Cherrypicking	½ Yarding; ½ Loading
Bulldozer in Landing Construction	Road Construction
Rock Drill in Landing Construction	Rock
Gravel Truck in Road Maintenance	Road Maintenance
Gravel Truck Landfilling Sortyard Debris	Sort, Dump and Boom

Fuel and Lubricants used by	Phase used for
Bridge Building	Road Construction
Miscellaneous	Service

The energy used in some extraordinary activities has not been included in the calculations. In 1977, a dry-land sort yard was built during the off-season (Jan-Mar). The fuel and lubricants used in its construction (7733 gal d.e., 35 154 ℓ d.e.) were not included in the total. Although this work probably increased Camp requirements (heating fuel and gasoline (crew transportation)) the totals were not changed since the effect of the work on them is unknown.

In 1979 the camp acquired a lake tug which was used for towing booms and freight. Its fuel requirements were also not included (2886 gal d.e., 13 120 ℓ d.e.). The actual amount of gasoline and lubricants used in the water taxi service is not known. The camp staff estimate that 1350 gallons of gasoline (1248 gal d.e., 5 676 ℓ d.e.) are used by the taxi fleet during each peak operating month. This estimate was not included in the calculations.

Company cost records using estimates of fuel consumption were the main sources of data used to determine the fuel and lubricant distribution in 1977. In 1979, machine time summaries and fueling records were used. A comparison of the 1977 consumption data and the 1979 fueling records showed that the estimates were fair and accurate for the purposes of this report.

Information involving wood volumes is based on load averages used by the camp. Each truckload yarded, loaded and hauled to the lake was considered to be 22 cunits (62 cubic metres) in 1977 and 23 cunits (65 cubic metres) in 1979.

ENERGY CONSUMPTION BY PRODUCT

A. Total Consumption

Figure 1 shows the proportions of all energy products consumed (diesel heating equivalent) that contributed to the production of logs at Pitt Lake camp during all of 1977 and in the April-through-July peak production period in 1979. The relative importance of each product in all phases combined can be seen. Table 1 gives the volume (d.e.) of each product for 1977. Table 2 gives the same information for April through July 1979.

TABLE 1. Total Energy by Type - 1977

1977	gal d.e.	ℓ d.e.	gal/cunit	ℓ/m^3	%
Diesel motive fuel	117625	534 723	3.74	6.00	58.9
Heating fuel	36279	164 925	1.15	1.85	18.2
Gasoline	28912	131 434	.92	1.48	14.5
Diesel electricity	7667	34 854	.24	.39	3.8
Lubricants	6011	27 326	.19	.31	3.0
Propane	1995	9 069	.06	.10	1.0
Hydro electricity	1155	5 251	.03	.06	0.6
	199644	907 582	6.35	10.19	100.0

TABLE 2. Total Energy by Type - April-July 1979

1979	gal d.e.	ℓ d.e.	gal/cunit	ℓ/m^3	%
Diesel motive fuel	63745	289 785	3.39	5.44	71.0
Gasoline	11442	52 015	.61	.97	12.7
Heating fuel	8631	39 237	.46	.74	9.6
Lubricants	3925	17 843	.21	.34	4.4
Hydro electricity	903	4 105	.05	.08	1.0
Propane	603	2 741	.03	.05	0.7
Diesel electricity	544	2 473	.03	.05	0.6
	89793	408 199	4.78	7.67	100.0

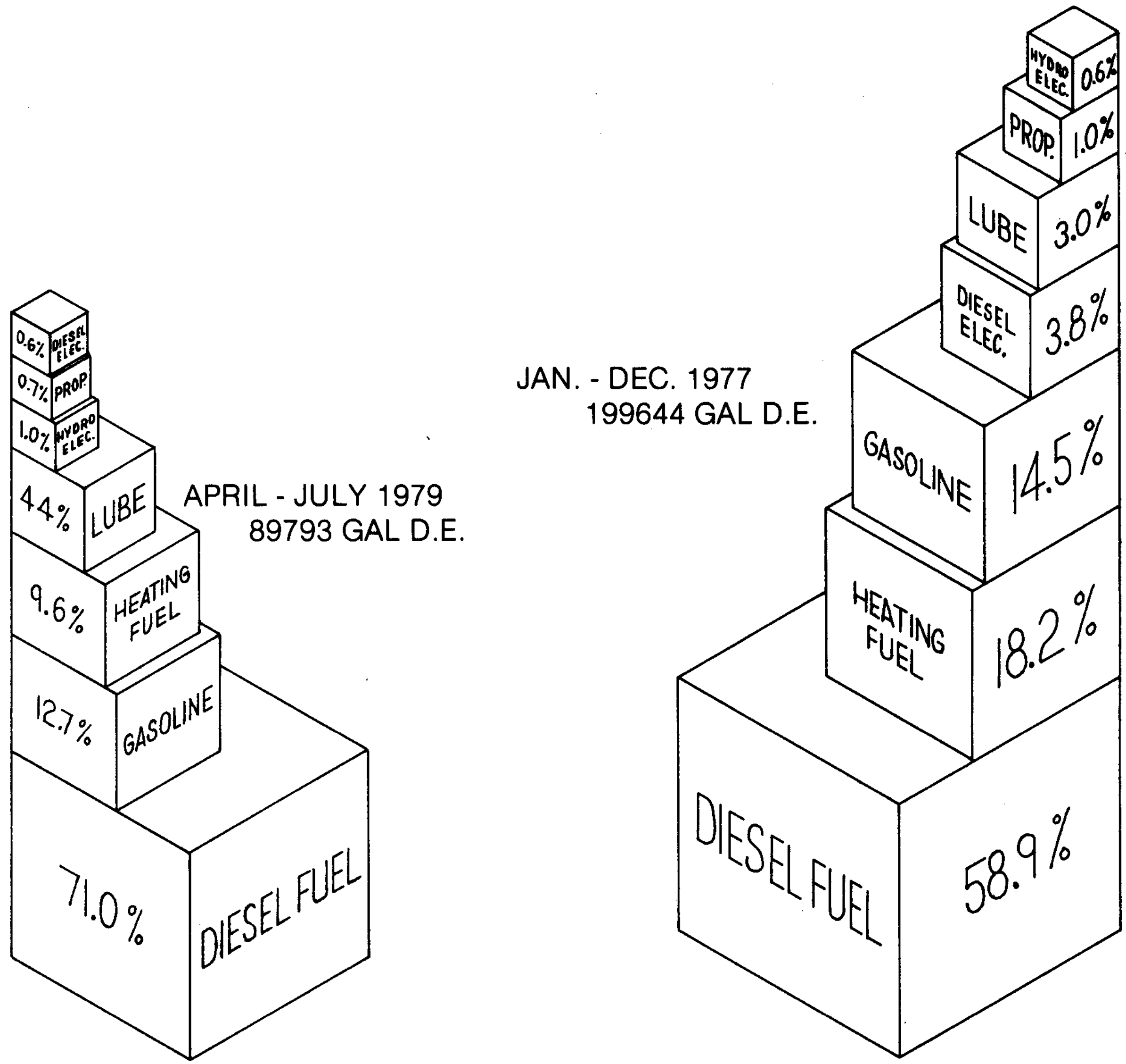

FIGURE 1. Total energy by type

The total cost of this energy:

Period	$/cunit ($/m^3)		Total Cost
all 1977	$3.95	($1.40)	$124,353
(all 1977 at 1979 cost)	$4.62	($1.63)	$145,389
April-July 1979	$3.47	($1.23)	$65,284

The consumption and cost figures cannot be directly compared. The 1977 data represent an entire year, including three non-operating periods--two winter shutdowns (Jan-Mar, Dec) and a fire season shutdown (August). During these periods, the camp was heated and some road work occurred but no logs were produced. The 1979 data represent only four months of peak activity. The differences in the per-unit wood volume values between the two years illustrate the importance of non-operating periods in the annual energy consumption.

Diesel fuel was, as expected, the largest component of the total but the significance of heating fuel and gasoline (used mainly for crew transportation) was unexpected. In 1977 these two products made up over 30% of total consumption and in 1979 they made up over 20%.

B. Fuel

Tables 3 and 4 show in more detail the fuels consumed and their cost during the two periods.

TABLE 3. Fuels Purchased - 1977

Fuel	Actual Volume (Imp.gal)	Cost	Diesel Equivalent Volume (gal d.e.)
Marked Diesel		$74,257	147875
Clear Diesel		7,803	11244
Clear Gasoline	24308	17,593	22480
Marked Gasoline	6955	4,200	6432
Stove Oil	2532	1,193	2452
Propane	2830	1,453	1995
TOTALS		$106,499 ($126,506 - 79 cost)	192478 gal d.e. (875 005 ℓ d.e.)

S U M M A R Y

Wood Volume Logged cunit (m^3)	$/cunit ($/m^3)	$/gal d.e. ($/ℓ d.e.)	gal d.e./cunit (ℓ d.e./m^3)
31,444 (89 049)	$3.39 ($1.20)	$0.53 ($0.12)	6.12 (9.83)

TABLE 4. Fuels Consumed - April to July 1979

Fuel	Actual Volume (Imp. gal)	Cost	Diesel Equivalent Volume (gal d.e.)
Marked Diesel		$35,986	59565
Clear Diesel		2,062	2713
Marked Gas	12373	8,511	11442
*Stove Oil (Diesel)		6,035	10039
Propane	856	510	603
TOTALS		$53,104	84362 gal d.e. (383 345 ℓ d.e.)

S U M M A R Y

Wood Volume Logged cunit (m^3)	$/cunit ($/m^3)	$/gal d.e. ($/ℓ d.e.)	gal d.e./cunit (ℓ d.e./m^3)
18,791 (53 216)	$2.83 ($1.00)	$0.63 ($0.14)	4.49 (7.20)

The values are based on purchases for 1977 and on inventory statements for 1979.

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*The camp is actually heated with diesel fuel but the supplier charges the stove oil price.

C. Lubricants

Exact inventory data were not available for lubricants. Purchases are shown in Tables 5 and 6.

TABLE 5. Lubricants Purchased - 1977

Product	Actual Volume	Cost	Diesel Equivalent Volume (gal d.e.)
Hydraulic & Lubricating Oils	1760 Imp. gal	$4,231	1848
Motor Oils	3518 Imp. gal	8,425	3694
Greases	1605 lb	953	111
Varsol	380 Imp. gal	345	358
TOTALS		$13,954 ($14,937 - 79 cost)	6011 gal d.e. (27 326 ℓ d.e.)

S U M M A R Y

Wood Volume Logged cunit (m^3)	$/cunit ($/m^3)	$/gal d.e. ($/ℓ d.e.)	gal d.e./cunit (ℓ d.e./m^3)
31,444 (89 049)	$0.44 ($0.16)	$2.32 ($0.51)	0.20 (0.31)

TABLE 6. Lubricants Purchased - April to July 1979

Product	Actual Volume	Cost	Diesel Equivalent Volume (gal d.e.)
Hydraulic & Lubricating Oils	1267 Imp. gal	$3,578	1331
Motor Oils	2296 Imp. gal	5,546	2411
Greases	1358 lb	1,249	141
Varsol	44 Imp. gal	57	41
TOTALS		$10,430	3924 gal d.e. (17 839 ℓ d.e.)

SUMMARY

Wood Volume Logged cunit (m^3)	\$/cunit (\$/m^3)	\$/gal d.e. (\$/ℓ d.e.)	gal d.e./cunit (ℓ d.e./m^3)
18,791 (53 216)	\$0.56 (\$0.20)	\$2.66 (0.58)	0.21 (0.34)

A given quantity of lubricants costs more than the same quantity of fuel. Although lubricant consumption in 1977 was only 3.0% of total energy volume (d.e.), it made up 11.1% of the total energy cost. In 1979 it represented 4.3% of volume but 16.1% of cost.

The camp usually assigns the cost of lubricants in the following manner: Yarding - 10%; Loading - 10%; Hauling - 20%; Sort Dump and Boom - 15%; Road Construction - 20%; Rock - 10%; Crew Transport - 15%. Lubricant volumes have been distributed in the same way for this study.

D. ELECTRICITY

The amount of electricity consumed was not monitored, but based on a load survey and estimates of demand, the camp's electricity consumption might be reasonably estimated as follows:

Peak operating periods	530 kWh/day (11.6 gal d.e., 52.6 ℓ d.e.)
Partial operating periods	360 kWh/day (7.9 gal d.e., 35.7 ℓ d.e.)
Annual (1977)	88 000 kWh (1925 gal d.e., 8 750 ℓ d.e.)
April-July 1979	43 900 kWh (958 gal d.e., 4 355 ℓ d.e.)

A company-owned 75 kW hydro-powered generator provides 60% of the camp's electricity. If the backup diesel-powered generator provided all the electricity, its fuel consumption could have been about 19000 gal (87 000 ℓ) in 1977.

The following is a comparison of electricity costs in 1977, given three options.

"As-is" (60% hydro, 40% diesel)	$3850
All B.C. Hydro (if hookup at property)	$3900
All diesel generator	$9540

Distribution of electricity is about 70% to kitchen, office and bunkhouses and 30% to the shop.

ENERGY CONSUMPTION BY PHASE

Figure 2 shows energy use (d.e.) for all 1977 per unit of wood volume by phase and Figure 3 represents the four-month peak period in 1979. On the right side of each Figure is a scale showing percentage of the total energy consumption in the operation.

The energy consumption in the BUILDINGS and CREW TRANSPORTATION phases was unexpectedly large. In 1977 BUILDINGS used over 22% of the total energy volume and CREW TRANSPORTATION used 14% and the next largest consumer, HAULING, used slightly over 11%. All LOGGING phases together consumed 41% of the total. During the 1979 peak production period, the consumption of the BUILDINGS phase was 12% of the total and that for CREW TRANSPORTATION 8% of the total. HAULING used 15% and all LOGGING phases together used 44%.

FUEL CONSUMPTION BY SEASON

The seasonal changes in fuel demand are shown in Figures 4 and 5. Figure 4 shows total fuel consumption in each process for four seasons in 1977. Superimposed on the figure is a broken line showing volume of wood produced in each

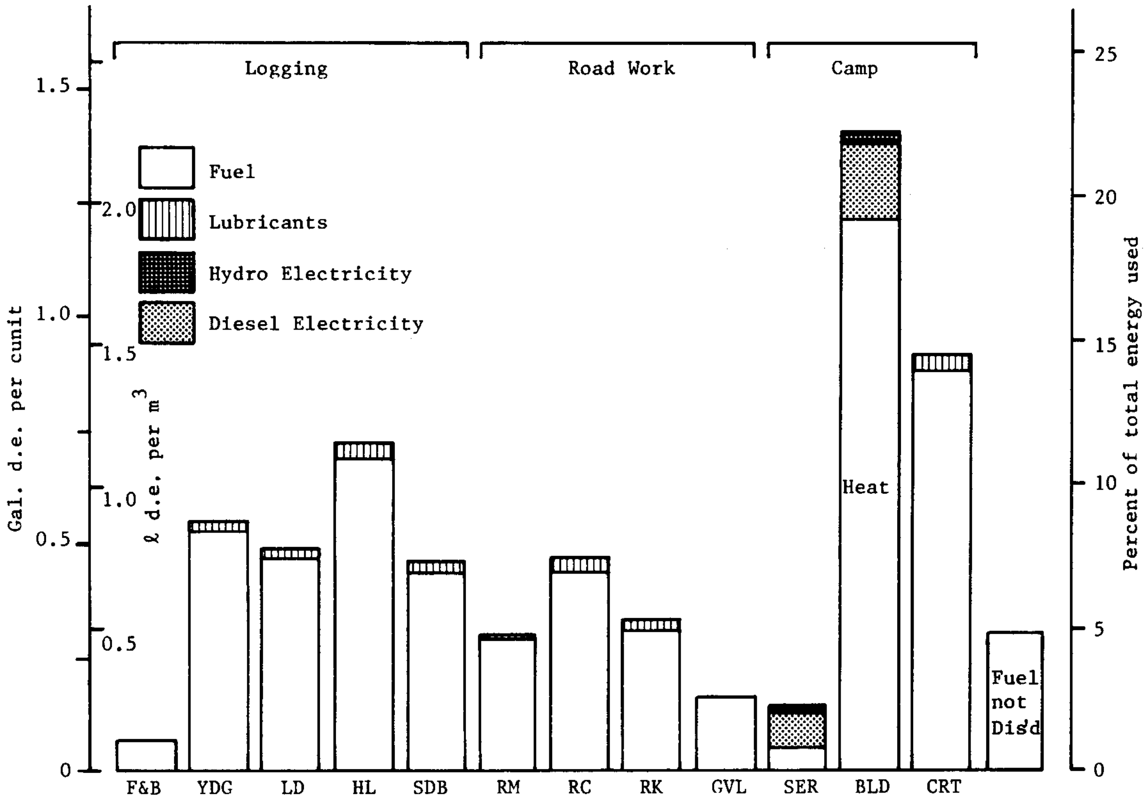

FIGURE 2. Energy consumed by phase - 1977

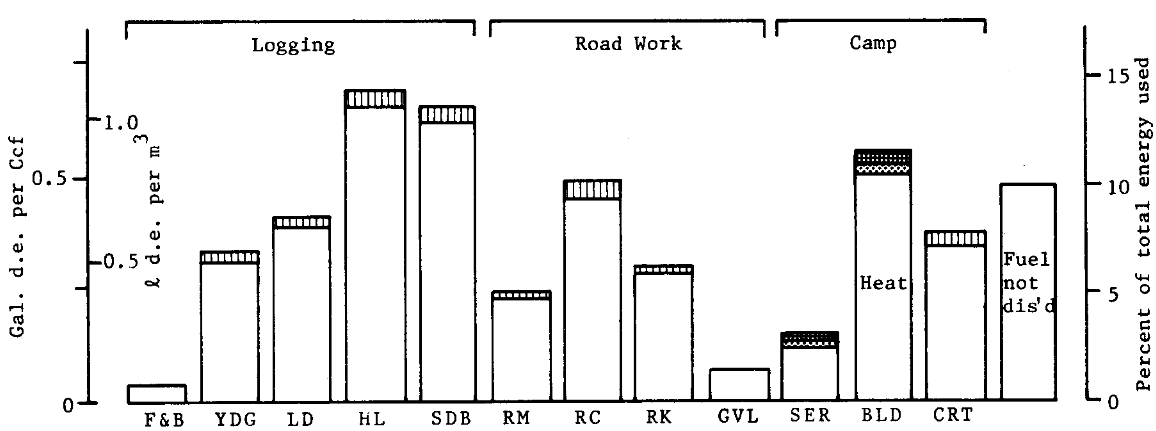

FIGURE 3. Energy consumed by phase - 1979

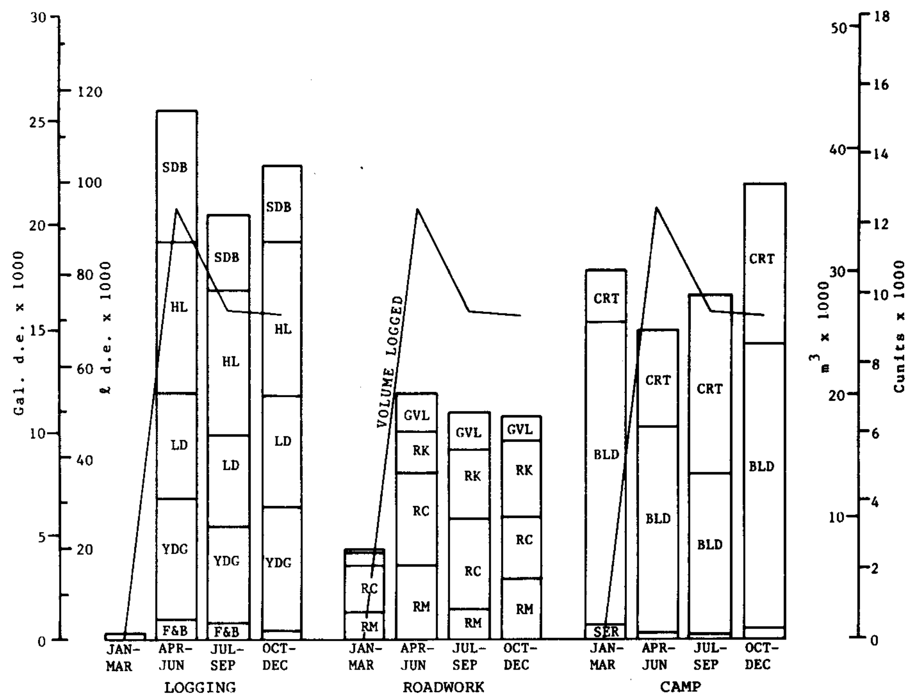

FIGURE 4. Fuel consumed by process, by season - 1977

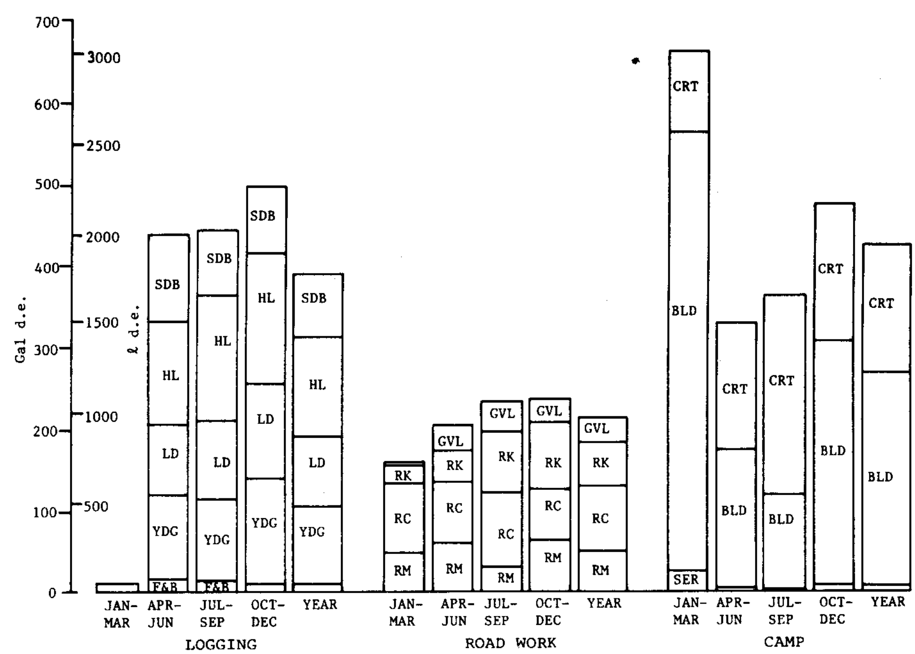

FIGURE 5. Fuel consumed per operating day by process, by season - 1977

three-month period. The figure does not include fuel which could not be assigned to a specific usage category.

Figure 5 shows consumption per operating day by process, by season in 1977. The figure does not include fuel which could not be assigned to a specific usage category.

Figure 4 shows that fuel consumption in LOGGING and ROAD WORK roughly matched the level of log production. In camp, however, fuel consumption continued regardless of log production. Figure 5 shows that the fuel consumed per-operating-day in LOGGING and ROAD WORK does not vary much during active periods. Again this relationship is not apparent in CAMP.

Fuel consumption per unit of volume for active periods is shown in Table 7. The values do not include fuel not categorized by usage.

TABLE 7. Fuel Consumption During Active Periods

PERIOD	LOGGING gal d.e./cunit (ℓ d.e./m^3)	ROAD WORK gal d.e./cunit (ℓ d.e./m^3)	CAMP gal d.e./cunit (ℓ d.e./m^3)	TOTAL gal d.e./cunit (ℓ d.e./m^3)
Apr-Jun 77	2.04 (3.27)	.96 (1.53)	1.52 (2.44)	4.52 (7.24)
Jul-Sep 77	2.14 (3.44)	1.13 (1.83)	1.74 (2.80)	5.01 (8.07)
Oct-Dec 77	2.44 (3.91)	1.15 (1.84)	2.32 (3.73)	5.91 (9.48)
Apr-Dec 77	2.18 (3.51)	1.07 (1.71)	1.83 (2.94)	5.08 (8.16)
All 1977				5.80 (9.32)
Apr-Jun 79	2.03 (3.26)	1.11 (1.79)	1.09 (1.76)	4.23 (6.81)

FUEL CONSUMPTION BY INDIVIDUAL MACHINES

Figure 6 shows fuel consumed per operating hour and per unit of wood volume handled for yarders. Values are calculated with 1979 data.

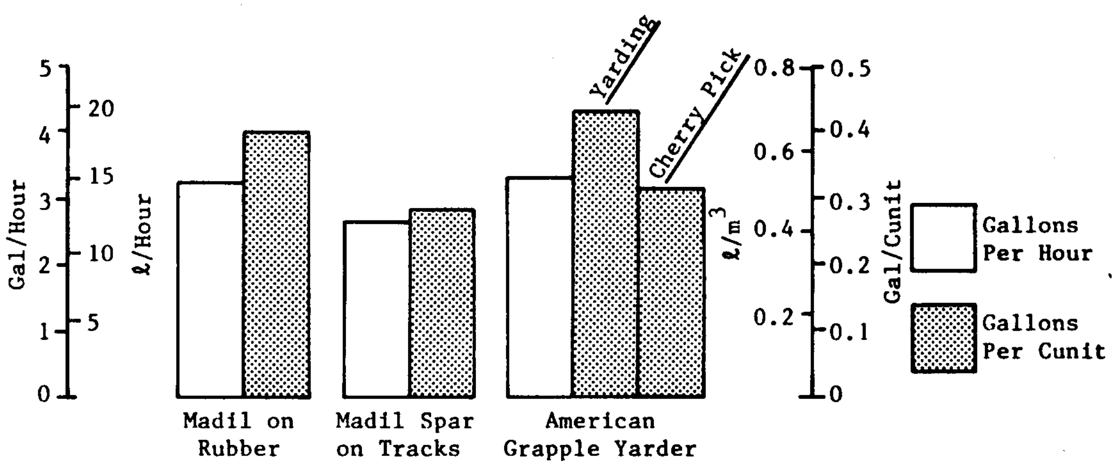

FIGURE 6. Fuel consumption - yarders

If the track-mounted spar had received its regular fueling during the last week of the study, both spars would have had similar hourly consumption rates (as was the case at the end of June). The track-mounted spar was more productive and its consumption per-unit of wood volume would have been lower in any case. The grapple yarder's consumption rates reflect productivity differences of the machine engaged in two tasks. This machine spent 80% of its time rigged to cherrypick right-of-way logs.

Figure 7 shows fuel consumed per-operating-hour and per-unit of wood volume handled for loaders. Values are calculated with 1979 data.

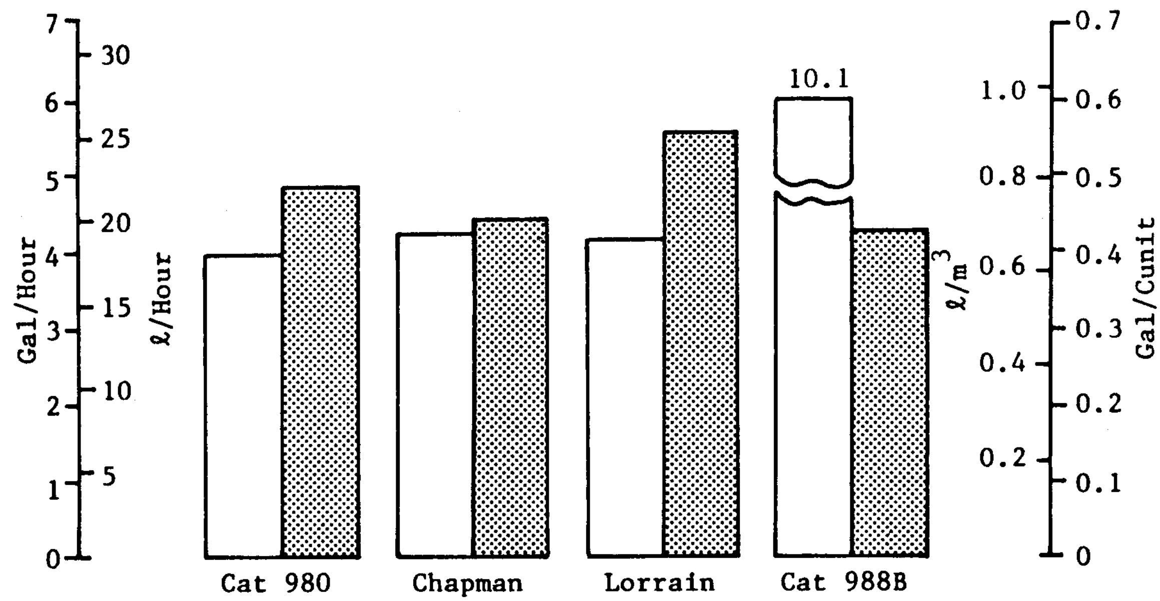

FIGURE 7. Fuel consumption - loaders

The first three loaders required almost the same amount of fuel per hour. Their productivity and therefore their per-cunit requirements were tied to the yarder they worked with. The 980 worked with the rubber-mounted spar, the Chapman with the track-mounted spar and the Lorrain with either the grapple yarder or filling for the 980. The 988B worked in the sort yard, receiving logs in a relatively steady flow from the truck fleet.

Figure 8 shows fuel consumed per-operating-hour and per-unit of wood volume handled for log trucks. Values are calculated with 1979 data.

The trucks with the greatest utilization spent the lowest percentage of total operating time lowbedding. These trucks required the least fuel per hour, according to the data collected. Used for lowbedding 36% of its time, Truck 1 had the lowest total operating hours and the highest fuel requirements per hour, per cunit and per cunit-mile. Truck 3, which was used almost exclusively for log hauling, had the second highest total operating hours, the lowest fuel requirements per cunit and per cunit-mile, and the second lowest fuel requirement per hour. This ranking by use generally held true for the other three trucks.

Figure 9 shows the hourly fuel consumption rates of the other machines involved in the study.*

A list of all equipment involved in the 1979 period and consumption rates is shown in Appendix C.

CONCLUSION

The production of one cunit of logs at Pitt Lake required an energy input of 6.4 gallons diesel equivalent (10.2 litres d.e. per cubic metre) in 1977. A great deal of this energy was used in non-operating periods. During a full-production period in 1979, the energy required was 4.8 gallons diesel equivalent (7.7 litres d.e. per cubic metre). The actual cost of this energy at the time it was consumed was $3.95 per cunit ($1.40 per cubic metre) in 1977 and $3.47 per cunit ($1.23 per cubic metre) in spring 1979. Fuel prices increased 19% between the two periods.

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*The consumption rates shown in Figures 6, 7, 8 and 9 were calculated using reported fuel. The fuel taken from woods diesel tanks was sometimes not reported and the consumption rates of some machines are too low.

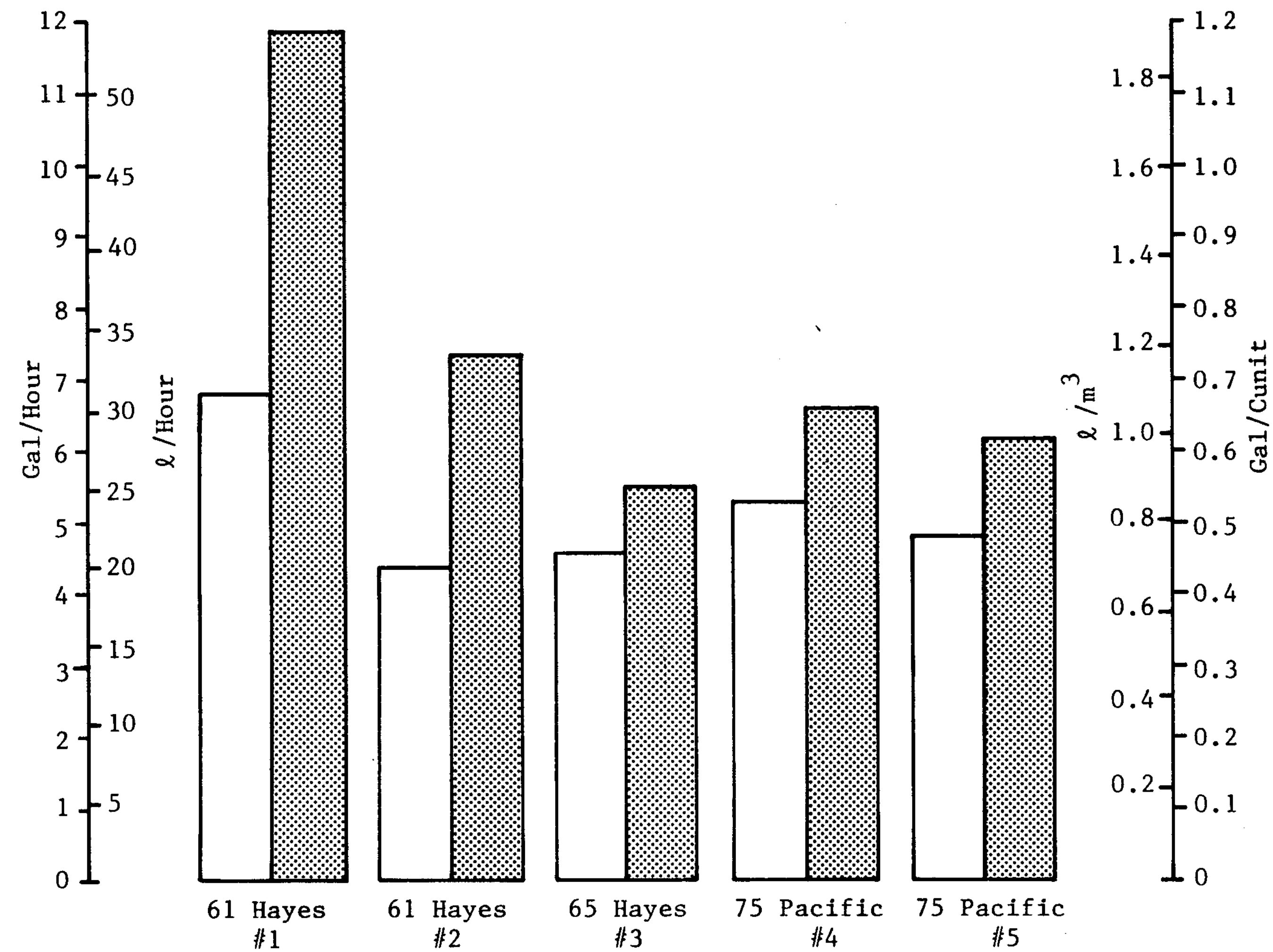

FIGURE 8. Fuel consumption - log trucks

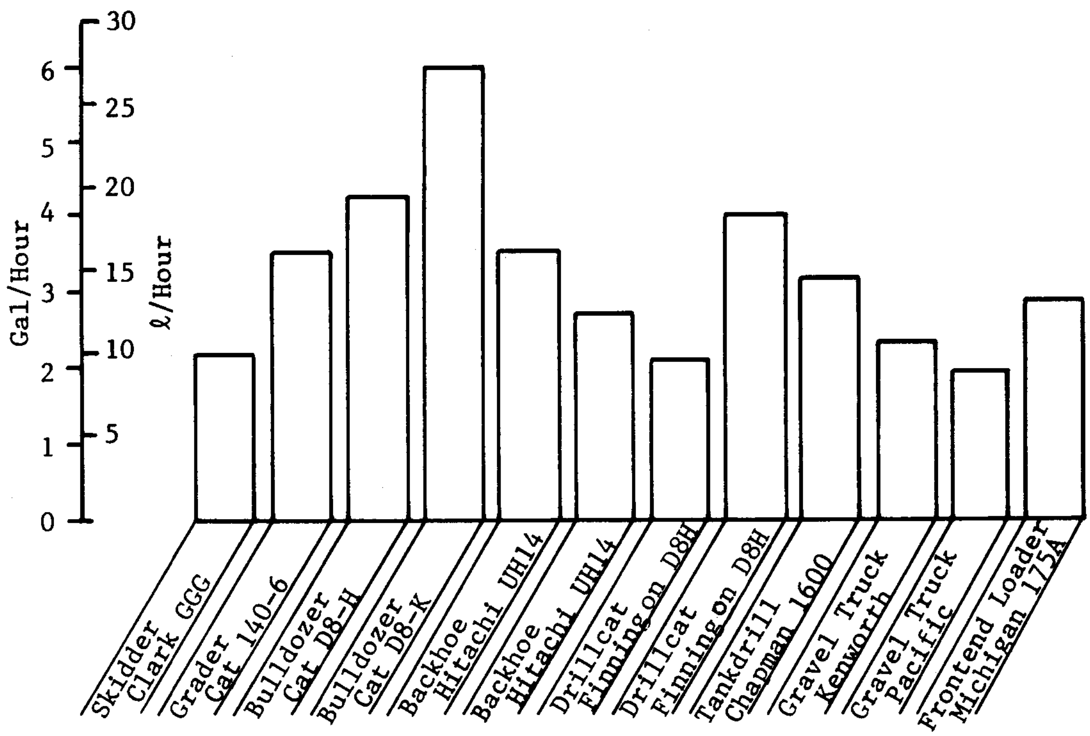

FIGURE 9. Other equipment

The following points were noted.

- Much of the difference between the two periods was due to heating fuel consumption during the inactive period in 1977.

- Diesel fuel accounted for 58-71% of all the energy consumed, followed by substantial amounts of gasoline and heating fuel.

- Lubricants formed 11% to 16% of the total energy cost.

- The company-owned hydroelectric generator significantly reduced electricity costs.

- The phases consuming the most energy annually were CREW TRANSPORTATION and BUILDINGS (heat and light).

- Fuel demand in productive processes (LOGGING and ROAD WORK) was relatively constant during active periods. CAMP demands varied widely.

- Fuel consumption per-unit of wood volume for an individual machine depended more upon its job and productivity than upon its machine characteristics.

This study did not examine the costs and benefits of any conservation measures but consumption could probably be greatly reduced in some phases. The following are suggestions for consideration--their potential has not been evaluated.

Building-heating was the largest single requirement at the camp. The approaches to energy conservation here are well established. Insulation, weatherstripping and double-glazed windows should be considered in regular building maintenance. Many logging camps are operated in a way that presents special opportunities. Is heat wasted in non-operating periods and on weekends? Can bunkhouses and buildings that are not in use be shut down and the heat completely or partially turned off? Savings could be made immediately by controlling heating fuel consumption during non-operating periods. Are buildings overheated? Is the heating system adequately maintained?

The energy required in Crew Transport could also be reduced. Are vehicles over-powered or too big? Are engines left running to keep the battery charged for the radio or to keep the cab warm? Consider using radios with a lower amperage draw or higher-rated batteries; consider using an independent vehicle heater like the type used in older Volkswagons.

In all phases, plan a policy on idling machines. Remember fuel economy when buying new equipment or engines.

The presence of the hydro-generator at Pitt Lake points out another area where energy could be saved. Many logging camps could utilize nearby streams for at least part of their electricity requirements and the economics of small hydro-generation are becoming much more attractive.

This report is concerned with energy consumption at a coastal logging operation. Studies of consumption patterns of other logging systems in other areas are needed, as well as studies of the costs and benefits of various conservation strategies. FERIC is considering further work in fuel and energy conservation.

APPENDIX A

CONVERSION FACTORS

	Net Heating Value			Source
Diesel 2, 35° API[1]	156360 BTU/Imp.gal	=	1 gal d.e.[2]	Imperial Oil
Gasoline, 60° API	144600 BTU/Imp.gal	=	.9248 gal d.e.	Imperial Oil
Stove oil, 42° API	151440 BTU/Imp.gal	=	.9685 gal d.e.	Imperial Oil
Lubricating oils, 25° API	163680 BTU/Imp.gal	=	1.0468 gal d.e.	Imperial Oil
Varsol, 48° API	147360 BTU/Imp.gal	=	.9424 gal d.e.	Imperial Oil
Greases, 90% oil	@ 18010 BTU/lb	=	.1037 gal d.e.	Imperial Oil
Propane	110000 BTU/Imp.gal	=	.7035 gal d.e.	Blue Flame
Electricity	3112 BTU/kWh	=	.0218 gal d.e.	Marks Standard[3]

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[1] °API is specific gravity by American Petroleum Institute scale.

[2] 1 gallon d.e. is the net heating value equivalent to one gallon of #2 Diesel fuel.

[3] Marks Standard Handbook for Mechanical Engineers 7th edition.

APPENDIX B

DESCRIPTION OF OPERATION

	Volume	Area
1977	31444 cunit (89 050 m^3)	348 ac. (141 ha)
1979 Planned	35000 cunit (99 100 m^3)	430 ac. (174 ha)
1979 Completed April-July	18791 cunit (53 216 m^3)	

Species Mix:

Douglas-fir	15%
hemlock	31%
balsam	30%
cedar	14%
cypress and others	10%

Average Piece Size: 55 cu ft (1.6 m^3)

Equipment: 1977 -
- 3 spars
- 3 line loaders
- 1 hydraulic-boom loader
- 1 front-end loader
- 5 off-highway log trucks
- 1 front-end loader-stacker
- 1 dozer boat

1979 -
- 2 spars
- 1 grapple yarder
- 2 hydraulic-boom loaders
- 1 front-end loader
- 5 off-highway log trucks
- 1 front-end loader-stacker
- 1 dozer boat
- 1 lake tug

Average Haul (two way): 1977 - 34 mi (55 km)
1979 (Apr-Jul) - 27 mi (43 km)

Logging Employees: 1977 - 41 hourly
1979 - 40 hourly

ROAD WORK:

Annual Construction

Average: 8 mi (12.9 km)

1977: 4.5 mi (7.2 km) mainline, 3.0 mi (4.8 km) spur
1979 Planned: 4.8 mi (7.6 km) mainline, 3.8 mi (6.0 km) spur
1979 Completed (April to July): 50%

Timber Developed: 6000 cunit/mi (10 600 m^3/km) average
Ballast: 80% developed onsite, 20% hauled from gravel pits and quarries

Equipment:	1977 -	1 grader 1 spread dozer 2 construction dozers 2 drill dozers 1 tankdrill 1 front-end loader 2 gravel trucks
	1979 -	1 grader 2 construction dozers 2 backhoes 2 drill dozers 1 tankdrill 1 front-end loader 2 gravel trucks

Road Employees: 16 hourly

Contractor 1977: 1 backhoe, 1 construction dozer, 2 men

CAMP:

Seven main buildings heated and in regular use, partly insulated.

Bunkhouses:	4 with 10 rooms each, 2 beds per room, 14 single rooms in office building.
Heating:	diesel-fired boilers in each building; also provide hot water for washing, showers etc.
Equipment:	7 service vehicles, 2 buses, 18 crummies and pick-ups.
Employees:	22 (kitchen, shop and administrative).

APPENDIX C

Equipment List - 1979

Machine	Year	Model	Engine	Rated H.P.	Fuel Consumption Imp.gal/hr: From Camp Costing	From Study	Manufacturer's Suggested Fuel Consumption
Highlead Spar	1971	08 Madill 3-500 (rubber)	Cat 9L-5136	510	2.5	3.23	n/a*
Highlead Spar	1968	08 Madill 3-500 (tracked)	Cat 9L-4305	510	2.4	2.61	n/a
Skidder	1972	Clark 666	GM 8V-53	n/a	3.8	2.19	n/a
Grapple Yarder	1978	American 7220	GM 8V-71	318	3.9	3.28	9
Logloader	1974	Caterpillar 980	Cat 3306	250	4.1	3.92	7.5
Logloader	1977	Chapman 1800	GM 8V-92	360	3.9	4.26	n/a
Logloader	1973	Lorrain 48-H	Cummins N855-C	250	3.9	4.17	11.2 @ 2100 RPM
Log Truck	1961	Hayes	GM 12V71N	456	3.6	8.62	(3.9 mpg)
Log Truck	1961	Hayes	GM 12V71N	456	3.6	4.37	(3.9 mpg)
Log Truck	1965	Hayes	GM 12V71N	456	3.7	4.51	(3.9 mpg)
Log Truck	1975	Pacific	GM 12V71N	456	3.3	5.10	(3.9 mpg)
Log Truck	1975	Pacific	GM 12V71N	456	3.7	4.90	(3.9 mpg)
Loader-Stacker	1977	Caterpillar 988B	Cat 3408	325	8.4	10.12	11.0
Dozer Boat	1967	John Manly	GM 6V-71	228	n/a	n/a	n/a
Tug			GM 8V-53	n/a	4.6	4.95	n/a
Grader	1975	Caterpillar 140G	Cat 3P755	150	3.8	3.53	4.3
Bulldozer	1974	Caterpillar D8H		270	6.9	4.26	8.2
Bulldozer	1975	Caterpillar D8K	Cat D 342	300	6.9	5.99	8.7
Backhoe	1978	Hitachi UH14	Isuzu E 120	n/a	4.0	3.56	n/a
Backhoe	1979	Hitachi UH14	Isuzu E 120	n/a	3.5	2.76	n/a
Drill Cat	1968	Finning on D8H	Cat D 342	180	3.5	2.13	6.7
Drill Cat		Finning on D8H		180	3.5	4.05	6.7
Tank Drill	1973	Chapman 1600-Gardner-Denver		n/a	3.5	3.17	n/a
Gravel Truck	1965	Kenworth	Cummins NTC 350	350	4.2	2.37	n/a
Gravel Truck	1965	Pacific	Cummins Turbo 350	350	4.0	1.97	n/a
Front End Loader	1969	Michigan 175A	GM	n/a	2.6	2.92	n/a
Diesel Generator	pre-war	Caterpillar D13000	Cat 1300	150	n/a	n/a	n/a

*not available

The fuel consumption values shown in the "From Study" column were determined using reported consumption. The actual consumption of some machines was probably higher; not all of the fuel taken from woods tanks was reported.