FERIC FOREST ENGINEERING RESEARCH INSTITUTE OF CANADA
INSTITUT CANADIEN DE RECHERCHES EN GÉNIE FORESTIER



# Manual Snow Clearing for Winter Falling

## Two Experimental Snowblowers Compared with the Snow Shovel

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## SUMMARY

In 1975 the Interior British Columbia logging industry and Forest Service asked FERIC to develop a simple, economical method to clear deep snow so that chainsaw fallers could cut low stumps safely.

We found that the original manually-operated snowblower we developed (the FERIC Snowblower MK VI) was not a practical snow clearing tool for winter falling. Its design was based on a brushcutter suspended from a harness worn by the operator. This arrangement limited its reach and it could not clear a deep hole within a reasonable period of time.

The second tool FERIC developed was a snowblowing attachment for a chainsaw power unit. Our tests showed that the saw-powered blower could clear deep holes faster than a hand shovel and indicated that blowing could be more economical than shovelling in deep snow. Blowing was more physically demanding than shovelling in the moderate snow depths at the test areas. We suspect that in deep snow both clearing methods would be equally demanding. The blower could clear large holes with several escape routes faster and more easily than the shovel. Large holes are less likely to trap the faller but only very extensive and time-consuming clearing would make the hole as safe to use as if no hole was present.

Since 1975 interest in snow removal has been low due to a series of light-snowfall years.

Snow clearing costs per $m^3$ of wood can be offset if enough extra wood is recovered from cleared stumps. This was not demonstrated by 1980 field tests, mainly because the snow was shallow. The net extra costs of test clearing by two methods were:

| | NET EXTRA LOGGING COST, $\$/m^3$ | |
|---|---|---|
| | Hand Shovel | Chainsaw Blower |
| All trees in stand (snow 0.4 - 2.0 m) | $ .80 | $ .94 |
| Selected trees (deeper snow, 0.6 - 2.0 m) | .86 | .07 |

The results for deeper snow suggest that as snow deepens, chainsaw blowing would become cheaper than hand shovelling and ultimately could pay for itself.

At present, the most practical ways to avoid high winter stumps are to employ felling machines capable of penetrating the snow or to plan winter manual felling for areas with less snow. FERIC does not presently plan any further work with snowblowers.

# INTRODUCTION

The winter of 1974-75 brought deep snow to parts of the Nelson and Kamloops forest regions in the Interior of B.C. Hand-fallers either cut higher stumps or resorted to hand-shovelling snow from around each tree before felling. The waste wood from high stumps was unacceptable to the Forest Service while the safety hazard to fallers working in shovelled holes was unacceptable to the Workers' Compensation Board. By the following winter, Forest Service limitations on stump heights and Compensation Board limitations on shovelling depth were in conflict wherever snow depth exceeded about one metre. The Forest Service and the Interior industry requested FERIC to investigate snow-removal methods or equipment which would be acceptable to all parties.

Myhrman (1978) and Sinclair (1980) defined the problems in detail and developed and tested a series of hand-held and self-propelled snowblowers. Tests of these machines in 1977-1979 were hindered by lack of deep snow, but indicated that the addition of special snow-removal equipment for occasional use would be costly. In 1979 it was suggested that costs could be reduced if a snowblower unit could be temporarily attached to a standard chainsaw. This report describes the development of the saw-powered snowblower and relates its clearing performance to that of the snow shovel.

## OBJECTIVES OF MOTORIZED SNOW REMOVAL

The ordinary snow shovel is highly portable, but requires heavy labour to clear deep or icy snow for safe falling. A motorized blower, to be a successful replacement must:

1. Dig deep enough to reduce stump height .60 to .90 m, with more speed and less exertion than a shovel.
2. Shape the holes to give the faller working space and safe escape routes.
3. Be effective over a full range of slope, brush, blowdown and snow conditions.
4. Be simple and safe to use.
5. Result in wood costs no greater than those for shovelling.
6. Comply with Workers' Compensation Board and Forest Service regulations.

## REGULATIONS (1980)

The Workers' Compensation Board will not permit snow clearing if the faller cannot comply with Industrial Health and Safety Regulations 60.48 ("...faller shall quickly move away to a predetermined safe position...") and 60.44 ("...obstructions...to a safe escape route are cleared before falling."). A Workers' Compensation Board inspector that saw the test work at Golden said that the cleared holes could meet the intent of the regulation. Interpretation of the regulations is left to local inspectors, however.

The Forest Service has acknowledged that winter logging may be desirable for continuity of employment or protection of sensitive soils from skidding damage. Accordingly, high winter stumps are now tolerated (although monetary penalties may be charged) provided stumps are cut at least 0.30 m below the snow level.

Both sets of regulations governing winter falling have been somewhat relaxed since 1975.

## FERIC MARK VI SNOWBLOWER

The FERIC Mark VI was a portable snowblower mounted on the end of a Husqvarna 165R brushcutter. This machine was described by Myhrman (1978). A rotary impeller driven by the motor blows snow forward and upward (see Figure A). The entire unit, weighing 16 kg, is suspended from a harness worn by the operator.

FIGURE A. The Mk VI Snowblower

Eight Mark VI snowblowers were made and distributed to Interior operators for field-testing in the winter of 1976-1977. Unfortunately, light snow conditions that winter prevented proper testing.

In March and April, 1978, FERIC tested the Mark VI with results as shown in Table 1.

TABLE 1. Mk VI Snowblower Tests, March-April, 1978

| | NAKUSP | | AVOLA | |
|---|---|---|---|---|
| | Mk VI | Shovel | Mk VI | Shovel |
| Snow Depth, m | 1.2-1.8 | Not Tested | 0.9-1.5 | 0.9-1.5 |
| Snow Condition | hard, icy | | loose, granular | loose, granular |
| Av. Tree Butt Diameter, cm | 48 | | 41 | 46 |
| Trees Cleared | 29 | | 62 | 28 |
| Trees Cleared per Hour | 10.1 | | 29.6 | 63.9 |
| Av. Stump Gain, m/tree | 0.34 | | 0.37 | 0.35 |
| Stump Gain, m/hour | 3.4 | | 9.1 | 22.3 |
| Stump Volume Gain, $m^3$/hour | 0.66 | | 1.17 | 4.75 |

The Avola test of the Mk VI blower was discouraging. The shovel achieved similar depths on more trees per hour. However, neither method reduced stump heights much more than they were already reduced by the faller when he packs the snow at the tree with his snowshoes.

In the Nakusp test, where snow was deeper and icy, no shovelling was done for comparison, but the Mk VI blower enabled only minor reduction in stump height (0.34 m per tree) and cleared only 10 trees per hour.

The snowblower harness restricted the operator's movements and low limbs restricted use of the blower. It was decided not to proceed further with this concept.

# CHAINSAW BLOWER ATTACHMENT

The concept of a chainsaw-driven snowblower was suggested several times during work on the Mk VI Snowblower. Since the chainsaw is universally available, the only added investment would be for the snowblowing attachment. A chainsaw unit should be much more compact and lighter than the Mk VI. It would not have the handling difficulties associated with the harness and long shaft of the Mk VI.

The attachment we designed is shown in Figures B and C. It replaces the standard bar and chipper-tooth chain and could be installed on most powersaws using 3/8-inch pitch chain. We used a Husqvarna 480 as the power unit for our tests, primarily because it was a common saw in Interior B.C.

Use of the attachment requires some minor modifications to the power unit but these would not affect its operation later as a saw. Changing from the snowblower back to a saw could be done in the field.

The modifications made to the Husqvarna 480 were:

- A 1.5 cm x 0.6 cm slot was cut in the clutch cover for chain clearance.
- The automatic chain oiler was set at "Minimum" (a manual oiler would have been more suitable).
- Shields were placed in front of and inside the starter recoil assembly to reduce the amount of snow sucked in around the flywheel and engine. The front shield was made out of a plastic jug; the inside shield is a Husqvarna part supplied for operation of the saw in powder snow.

Specifications--Power unit with attachment:

| | |
|---|---|
| Weight | 13.5 kg |
| Length | 75 cm |

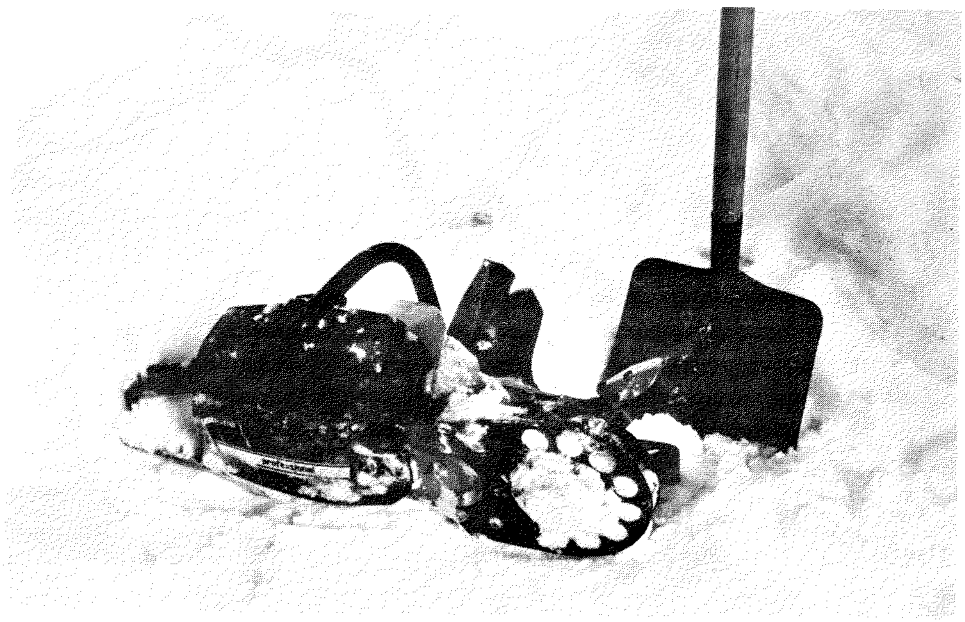

FIGURE B.   Chainsaw with snowblower attachment

FIGURE C.   Blowing crusted snow at roadside (Golden)

# FIELD TESTS

The chainsaw-powered blower was field-tested by FERIC near Princeton in early March, 1980 and at Golden in mid-March. The impeller shroud did not function correctly at Princeton and was modified before the Golden test. As in previous snowblower trials, the snow was too shallow to determine the effectiveness of snow removal over a wide range of snow depths.

The same worker followed the same procedures on both tests, using the chainsaw blower and the shovel alternately. At each tree he first packed the surface snow with snowshoes, as a faller would in any case. He then cleared additional snow by blower or shovel, usually to ground level or in deep snow to the "point of futility" where almost as much snow was falling back into the hole as was being removed. Figure D shows the shape of a typical cleared hole.

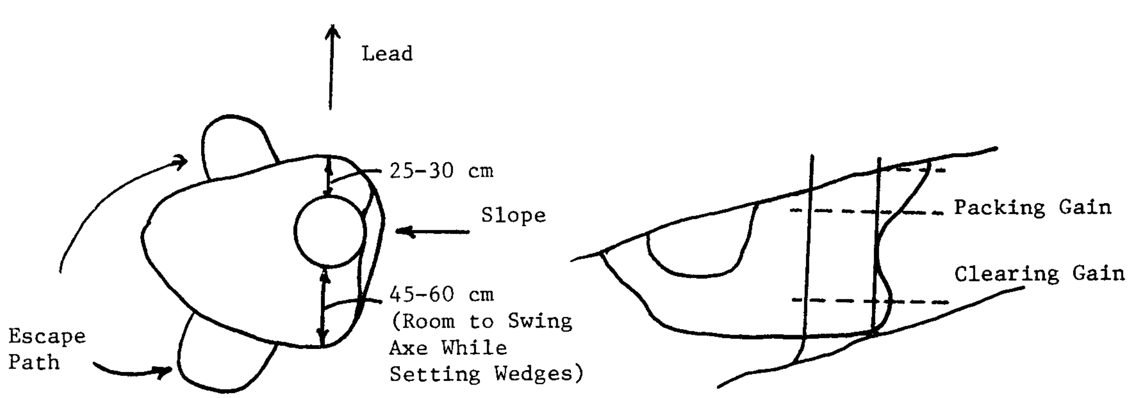


FIGURE D. Shape of typical cleared hole

We assumed that the stump height would be about 30 cm above the final snow level after packing only or packing and clearing. The hole would also have to be wide enough so that the faller could see the tip of the saw-bar and could swing an axe for wedging. Stump height reduction through shovelling or blowing was measured as the difference between the packing level and the final cleared level (see "Clearing Gain" in Figure D).

# TEST RESULTS

## CLEARING RATE

Table 2 compares the stump height and wood volume gain obtained by blowing and shovelling at Princeton and Golden. Gains per hour are for clearing only; they do not include normal snowshoe packing. Results for the chainsaw blower are slightly better than for shovelling, but differences are not great.

It was felt that the blower might out-perform the shovel in deeper snow. To test this idea, the same trees cleared at Golden were grouped into two categories: shallow holes (total packing plus clearing less than 0.60 m deep) and deep holes (total packing plus clearing over 0.60 m). Table 3 shows the results after grouping. For the deep-hole category, the blower cleared more trees per hour (9.1 trees vs 7.1), and gained more wood volume per hour (0.99 $m^3$ vs 0.52 $m^3$ per hour). These results suggest that the blower would out-perform the shovel by a wider margin if the snow were deeper (e.g., about 2 metres).

The blower was also faster in hard, icy snow and when clearing in brushy stands. It was also effective in clearing the frozen snow heaped around trees beside skid trails. These trailside trees usually could not be dug out at all with the shovel. In contrast, we found that the shovel could clear trees on steep slopes faster than the blower. The snow around these trees could usually be pulled or pushed downhill without digging and lifting.

TABLE 2. Clearing Rates, Chainsaw Blower vs Shovel, March 1980

| | Princeton | | Golden | |
|---|---|---|---|---|
| | Blower | Shovel | Blower | Shovel |
| Snow Depth, m | 0.4 - 1.2 m | | 0.4 - 2.0 m | |
| Snow Conditions | Powder Over Old Pack | | Crust Over Old Pack | |
| Av. Tree Butt Diameter, cm | 39 | 42 | 51 | 52 |
| Trees Cleared | 40 | 30 | 59 | 62 |
| Trees Cleared per Hour | 10.6 | 9.8 | 10.6 | 9.6 |
| Av. Stump Gain, m/tree | | | | |
| Snowshoe Packing | .16 | .16 | .20 | .18 |
| Clearing | .24 | .24 | .31 | .30 |
| Stump Gain, m/hour | | | | |
| Clearing Only | 2.5 | 2.3 | 3.3 | 2.9 |
| Volume Gain, $m^3$/hour | | | | |
| Clearing Only | .30 | .32 | .64 | .50 |

TABLE 3. Clearing Rates, Deep vs Shallow Holes, Golden, March 1980

| | Shallow Holes (Total Depth <0.60 m) | | Deep Holes (Total Depth 0.60 m+) | |
|---|---|---|---|---|
| | Blower | Shovel | Blower | Shovel |
| Trees Cleared | 43 | 40 | 16 | 22 |
| Trees Cleared per Hour | 11.3 | 11.7 | 9.1 | 7.1 |
| Av. Stump Gain, m/tree | | | | |
| Snowshoe Packing | .18 | .13 | .25 | .27 |
| Clearing | .23 | .23 | .53 | .43 |
| Stump Gain, m/hour | | | | |
| Clearing Only | 2.6 | 2.7 | 4.8 | 3.1 |
| Volume Gain, $m^3$/hour | | | | |
| Clearing Only | .48 | .48 | .99 | .52 |

## FALLER SAFETY

Although the trees were not felled during the test, three of the fallers working at Golden observed the cleared trees. Two foresaw no hazards in falling the trees cleared by either method. The third disagreed; he would want a much larger hole around the tree and more extensive escape paths. Since the clearing would normally be done for the faller, he should direct the clearing work until it is done to his satisfaction. The clearing worker found that the extra effort to improve on the basic cleared hole was less with the blower than with the shovel.

## CLEARING SAFETY AND EFFORT

Clearing work by either method must obviously be kept clear of falling trees. The blower operator must also be protected with a face shield or goggles to prevent injury from blowback of ice, gravel or branch fragments. Despite the impeller shroud, snow blowback further affected the blower operator by hindering his vision and keeping him cold and wet.

The tests were lengthy enough to demonstrate that both clearing methods are physically demanding. The shoveller can work more continuously at his chosen pace while the blower operator must work at the blower's pace and then rest. In shovelling, the effort increases as the hole deepens since snow must be lifted higher. Blowing effort is constant throughout.

It was concluded that most workers would prefer the shovel to the blower in the absence of a pay incentive for operaing the blower.

## EFFECTS ON WOOD COST

Snow clearing by either method increases both the shift-cost and the wood-volume produced per shift. The projected costs of three alternatives--no clearing; clear with the saw-powered blower; clear with the shovel--are compared in the Appendix (A). The projections are based on conditions, production rates and cost rates observed at Golden in March 1980. Since the test was not on provincial lands, Forest Service penalties for high stumps were not applicable and were not included in cost calculations. If applied, high-stump penalties would be an additional cost where no clearing is done.

The basic production unit in each alternative includes two fallers, one bucker, one swamper and skidding and loading to handle their output. The two clearing alternatives include three extra workers, either blowing or shovelling all merchantable-size trees. The test conditions at Golden did not permit the added volumes to offset the added clearing costs. The net extra cost of snow clearing in this illustration is:

| | |
|---|---|
| shovelling | $0.80/m^3$ |
| chainsaw blowing | $0.94/m^3$ |

The extra cost of shovelling is lower than that for blowing.

The deep-hole data in Table 3 suggested that the chainsaw blower might be more effective than the shovel in deeper snow. The deep-hole results were used to simulate production if snow depth was about 1.2 m[1]. Since the holes are dug deeper, clearing now requires about 3.3 man-days blowing or 4.2 man-days shovelling to keep ahead of the fallers.

The net extra cost of clearing work (cost of clearing partially offset by added wood recovery) was then:

| | |
|---|---|
| shovelling | $0.86/m^3$ |
| chainsaw blowing | $0.07/m^3$ |

The chainsaw blower in deeper snow appears more cost-effective than the shovel.

In snow over 2 m in depth, it might be possible to break even on snowblowing, but 1980 snow depths prevented a test of this supposition.

[1] The cost calculation is shown in Appendix (B).

# CONCLUSIONS

Our work did not satisfy all of our original objectives--to develop a simple, economical method that will clear deep snow so that fallers can cut low stumps safely. Our tests showed that the saw-powered blower can clear deep holes faster and more economically than a hand shovel. Blowing would be at least as physically demanding as shovelling, however. The blower could clear large holes with several escape routes faster and more easily than the shovel. Large holes are less likely to trap the faller but only very extensive and time-consuming clearing would make the hole as safe to use as if no hole was present.

Snow depths have not been excessive since 1974. Most logging operators have been able to avoid high stump problems by moving to areas with less snow. This alternative was not available in the winter of 1974-75 when the whole of Western Canada was blanketed in deep snow. The saw-powered blower could be of some help in an infrequent emergency such as this. It could also assist the few logging operators that cannot move out of deep snow areas. The saw-powered blower would require further development before it could be a practical tool, however. Interest in snow clearing has been low due to the favourable winters and FERIC does not plan any further work with snowblowers.

At present the most practical way to reduce the waste of wood through high stumps is by limiting winter logging to areas with moderate snow depths. The industry and Forest Service should develop alternative and flexible plans so that cutting in deep snow areas can be avoided. As much as possible, logging should be scheduled throughout the year and not concentrated in the winter. Mechanical felling machines which can dig into the snow will also circumvent the high-stump problems.

This report completes FERIC's work in this field. We regret that we were unable to solve the problem decisively with a simple machine but we are hopeful that as a result of our work the industry and Forest Service will exploit other means to avoid waste from high stumps.

# REFERENCES


Myhrman, D.W., 1978. Tree-Falling in Snow. Forest Engineering Research Institute of Canada (FERIC) Technical Report No. TR-20.

Sinclair, A.W.J. 1980. Mechanized Snowblowing in Deep Snow. Forest Engineering Research Institute of Canada (FERIC) Technical Report No. TR-39.

# APPENDIX: PROJECTED SNOW CLEARING COSTS

## (BASED ON OPERATOR'S 1980 COSTS AT GOLDEN)

Phase Costs per Shift--No Snow Clearing

Falling and Bucking

| | |
|---|---|
| 2 Fallers (9.25 hr[1] @ $18.30/hr[2]) | $ 339 |
| 1 Bucker (9.25 hr @ $13.53/hr) | 125 |
| 1 Swamper (9.25 hr @ $12.56/hr) | 116 |
| Driver Time (1.25 hr @ $18.30 x time and a half) | 34 |
| Power Saws 4 @ ($12 rental + $3 gas) | 60 |
| Supplies | 10 |
| Total Falling and Bucking | $ 684 |
| Total Other Phases (to truck) (skidtrails, skidding, loading, supervision, crew transport)[3] | $4471 |
| Cost per Shift (logs on truck) | $5155 |
| Average Production:[4] | |
| Trees per Shift | 210 |
| Volume per Shift | 213 $m^3$ |

[1] 9.2 hr = 8 hr regular shift + 1.25 hr travel time.
[2] Wages = IWA + fringe benefits.
[3] Exludes any penalty for high stumps.
[4] Operator's average February-March 1980.

A. COST COMPARISON OF ALTERNATIVES: SNOW AS IN 1980

| | No Clearing | | Clear With Saw Powered Blower | | Clear With Shovel | |
|---|---|---|---|---|---|---|
| Trees per Shift | 210[4] | | 210 | | 210 | |
| Volume per Shift $m^3$ | 213 | | 226[5] | | 223[5] | |
| | $/Shift | $/$m^3$ | $/Shift | $/$m^3$ | $/Shift | $/$m^3$ |
| Clearing Costs | | | | | | |
| 3 Blower Operators (9.25 hr @ Bucker Rate) | | | $ 375 | | | |
| 3 Shovellers (9.25 hr @ Swamper Rate) | | | | | $ 349 | |
| Snowblowers 3 @ ($24 Rental[6] + $3 Gas) | | | 81 | | | |
| Extra Crew Cab (@ $35.75/shift) | | | 36 | | 36 | |
| Extra Driver Time | | | 34 | | 34 | |
| Total Clearing Cost | | | $ 526 | $ 2.33 | $ 419 | $ 1.88 |
| Falling and Bucking | $ 684 | $ 3.21 | $ 684 | $ 3.03 | $ 684 | $ 3.07 |
| Other Phases | $4471 | $20.99 | $4471 | $19.78 | $4471 | $20.05 |
| Total Cost On Truck | $5155 | $24.20 | $5681 | $25.14 | $5574 | $25.00 |
| Extra Cost of Clearing $/$m^3$ | | | | $ 0.94 | | $ 0.80 |

Clearing Production (Based on entire test at Golden, Table 2)

Trees Cleared: Blower--3 x 7 hr[7] x 10.6 trees/hour = 223 trees
Shovel--3 x 7 hr x 9.6 trees/hour = 202 trees

Volume Added (Clearing Only): Blower--3 x 7 hr x .64 $m^3$/hr = 13 $m^3$
Shovel--3 x 7 hr x .50 $m^3$/hr = 10 $m^3$

[5]Volume per Shift = 213 $m^3$ + Volume Added.
[6]Assume Blower attachment is same cost as saw.
[7]Productive Time = 8 hr regular shift - .5 hr coffee break - .5 hr extra rest = 7 hr.

## B. COST COMPARISON OF ALTERNATIVES: DEEP SNOW

| | No Clearing | | Clear With Saw Powered Blower | | Clear With Shovel | |
|---|---|---|---|---|---|---|
| Trees per Shift | 210 | | 210 | | 210 | |
| Volume per Shift | 213 | | 236 | | 228 | |
| | $/Shift | $/m³ | $/Shift | $/m³ | $/Shift | $/m³ |
| Clearing Costs | | | | | | |
| 3.3 Mandays Blowing (Bucker Rate) | | | $ 413 | | | |
| 4.2 Mandays Shovelling (Swamper Rate) | | | | | $ 488 | |
| Snowblowers (3.3 x $27) | | | 89 | | | |
| Extra Crew Cab | | | 36 | | 36 | |
| Extra Driver Time | | | 34 | | 34 | |
| Total Clearing Cost | 0 | | $ 572 | $ 2.42 | $ 558 | $ 2.45 |
| Falling and Bucking | $ 684 | $ 3.21 | $ 684 | $ 2.90 | $ 684 | $ 3.00 |
| Other Phases | $4471 | $20.99 | $4471 | $18.94 | $4471 | $19.61 |
| Total Cost on Truck | $5155 | $24.20 | $5727 | $24.27 | $5713 | $25.06 |
| Extra Cost of Clearing $/m³ | | | | $ 0.07 | | $ 0.86 |

Clearing Production (Based on deep hole rates at Golden, Table 3)

Trees Cleared: Blower--3.3 x 7 hr x 9.1 trees/hr = 210 trees
Shovel--4.2 x 7 hr x 7.1 trees/hr = 209 trees

Volume Added (Clearing Only): Blower--3.3 x 7 hr x .99 $m^3$/hr = 23 $m^3$
Shovel--4.2 x 7 hr x .52 $m^3$/hr = 15 $m^3$