SESSION 5
PAPER (a)

# LANDING LAYOUT

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## ABSTRACT :

The purpose of this paper is to describe LIRA work to date in the area of landing size and organisation. Landing practises over a range of clearfelling operations have been surveyed. Various factors influencing landing size and layout are discussed.

## INTRODUCTION :

The initiation of the project was in response to industry concerns regarding the increasing amount of processing and log sorting done on the landing, possibly contributing to a substantial increase in landing size and cost.

The objective has been to explore the potential for improving common current practise to result in :

- reduced landing size
- lower landing formation and maintenance costs
- more efficient landing organisation.

In effect, to answer the questions "How small an area can we operate on efficiently" and "can we operate without landings"?

In the longer term, we plan to set up trials to test the ability to achieve these improvements.

To date we have tended to focus on :

- steep country
- difficult soils (e.g. Northland/Auckland and Otago/Southland clays)
- operations using excavator loaders.

This is because these are directions in which the logging industry is moving and also where cost savings can be made.

A survey of log landing practise was conducted throughout New Zealand from February to June 1986, covering as wide a range of clearfelling operations as possible.

Initially, factors influencing the size of landings were identified and have been reported (Raymond, 1987).

From this it was hoped that the major influences on landing layout could be identified.

## FACTORS INFLUENCING LANDING SIZE

Looking first at the size of landings, several factors have an important influence :

- Construction Difficulty :

  This is primarily a function of soil type and terrain. In the 1986 survey, differences in landing size between rock/gravel and clay/loam soil types and between pumice/sand and clay/loam soil types were found to be significant (Table 1).

TABLE 1 : LANDING SIZE BY SOIL TYPE (1986 SURVEY)

| SOIL TYPE | NO. OF OBSERVATIONS | AV. LANDING SIZE (ha) | RANGE |
|---|---|---|---|
| Pumice/sand | 17 | 0.23 | 0.12 - 0.39 |
| Rock/gravel | 12 | 0.19 | 0.02 - 0.31 |
| Clay/loam | 21 | 0.13 | 0.04 - 0.28 |

Clay type soils are more difficult to work and require more maintenance. This generally results in more expensive construction costs and hence pressure to restrict landing size.

Pumice/sand landings are easily constructed, stable and free draining, resulting in a tendancy towards larger landing sizes. The gravel based landings surveyed were slightly smaller than the pumice/sand landings, although this difference was not significant.

Using a skid site classification of topography developed by FRI (Twaddle, 1984), the effect of terrain on landing size was assessed. All landings were classified on a scale of 1-7 according to the difficulty of initial construction (based on the amount of cutting and filling) and of further extending the landing, taking into account immediate terrain features. Grade 1 was for landings on very flat terrain, with little or no earth movement necessary for formation, and Grade 7 was for sites constructed in steep terrain that required at least one major cut for formation.

Due to the wide variation in data there was no significant difference in landing size over the range of terrain surveyed.

- Tree Size

Tree size, especially extracted piece length, was found to relate strongly to landing size (Figure 1).

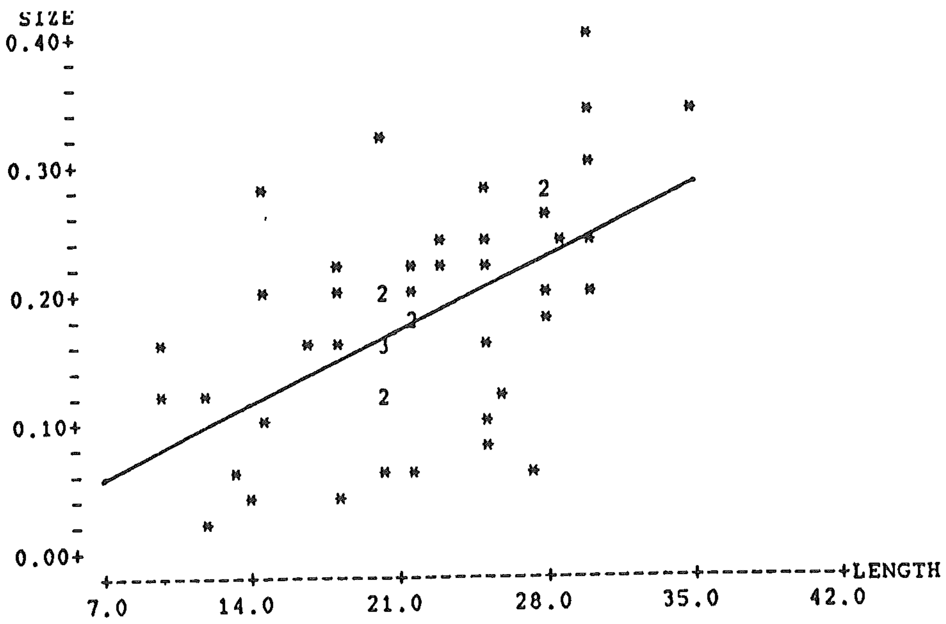



Figure 1 : Landing Size vs Extracted Length

- Gang Production Rate

The production levels at which differences in landing size become significant were determined as :

- less than 80 tonnes per day
- between 80 and 200 tonnes per day
- greater than 200 tonnes per day.

The most important influence on landing size for low production operations is the number of log sorts produced. Medium volume operations are influenced more by the extracted piece length, while the landing size of high volume operations is influenced by the number of log sorts and the number of trucks loaded per day.

- Number of Log Sorts

As expected, the landing size of an operation increases as the number of log sorts produced increases.

The critical number of log sorts where differences in landing size become significant is five. Landing size for operations sorting 1 - 5 and 6 - 12 log sorts is 0.14 ha and 0.24 ha respectively.

Figure 2 shows the effect of producing larger numbers of log sorts on the size of landings.

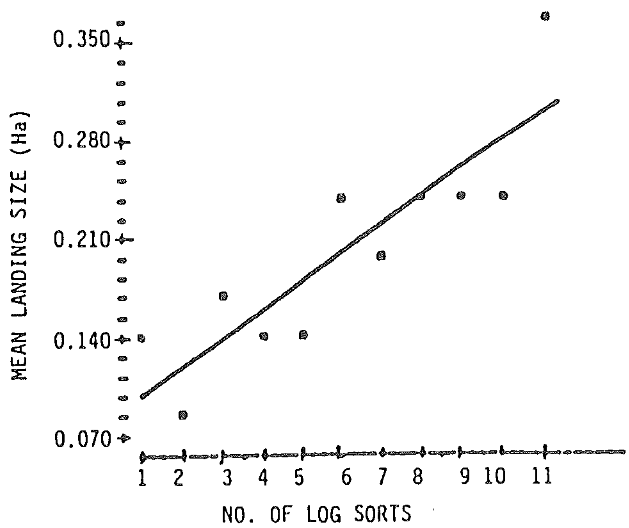



Figure 2 : Landing Size vs No. Log Sorts

- Extraction System

  Landing size for each major extraction system (skidder, tractor, hauler) was highly variable.

  Hauler operations ranged from a mechanised operation producing 45 tonnes per day in two log sorts onto a roadside of only 0.02 ha, to operations producing up to 200 tonnes per day on landings up to 0.35 ha. The most important influence on landing size was found to be the extracted tree length, which ranged from 12 - 30 metres (mean 20.3 m).

  Due to the positive relationship between extracted tree length and landing size, consideration should be given to reducing the radius of large hauler landings to match the length of the extracted wood.

  For example, the effect of reducing landing radius from 30 m to 25 m (-17%) is to reduce the area from 0.28 ha to 0.20 ha (-30%), thus reducing landing construction costs by the same percentage.

The important influences on landing size for skidder operations were the production rate and the number of log sorts.

Landing sizes for skidder operations ranged from a minimum of 0.06 ha (operations producing 70 tonnes per day in 4 - 5 log sorts) to a maximum of 0.40 ha in operations producing 400 tonnes per day in 11 different log sorts.

Interestingly, all the small landing (i.e. less than 0.20 ha) skidder operations surveyed used knuckleboom loaders.

Overall, due to the wide variation in the size of the landings surveyed, there was no difference in the means between tractor, skidder and hauler operations.

Other factors, such as logging planning decisions and individual machine operators and contractors often have a greater influence on the final size and layout of the landing.

For example, landing size is often "prescribed" irrespective of the type of operation (clearfell or thinning), or the extraction system that will be used.

There is evidence that landing size should be tailored more to the individual characteristics of the operation rather than instituting a "blanket" management policy. For example, opportunities exist to reduce the nominal landing size of lower volume operations that produce fewer log sorts (e.g. production thinning or pulpwood only operations) from 60 x 40 (0.24 ha) to 50 x 40 m (0.20 ha). This may have little effect on production efficiency but results in a significant reduction in area for landing formation and stumping (17%).

Thre is obviously potential for major evaluation of the total cost of landings, taking into account factors such as :

- road and landing density;
- effect of future logging systems on optimal haul distance;
- the relative economics of maintaining permanent landings vs restocking after clearfell;
- the loss of productive growing area (opportunity cost), e.g. the importance of siting landings on firebreaks and other non-productive areas, or in adjacent younger stands to reduce the cost of stumping, and the loss of tree value through early clearfelling of the landing area;
- truck configurations and truck scheduling - this includes the interaction between efficient trucking and efficient road and landing construction, e.g. at present, reduction in landing size of Kaingaroa thinning operations is constrained by the size of current rigs and the cold deck loading system;
- potential for roadside processing, avoiding the requirement for landing formation altogether.

In addition to LIRA, research groups working in these fields include Harvest Planning Group of F.R.I. (Rotorua) and the Land Use Impact Section of the Forest Research Centre (Christchurch).

## LANDING LAYOUT

This can mean different things to different people. To a logging planner or roading engineer, layout may refer to the shape and position of the landing with respect to terrain and road access.

A logging supervisor or contractor may interpret layout as the orientation of log stacks in relation to direction of haul and truck loading access.

Both these interpretations are important to overall efficient operation.

(a) LANDING SHAPE

This refers to the basic shape of the landing (circular, square, rectangular), and also the shape with respect to the position of roads for truck access and turnaround.

For wheeled front end loader operations, stockpiles are best positioned around the landing edges. Increased log sorting is thus making the length of "clear" perimeter an important factor in landing organisation.

Problems are often experienced in fitting large numbers of stockpiles around the landing, particularly where the perimeter is used up by extra roadway access (e.g. junction of several roads), and cutover access points. Where this occurs, the tendancy is to stockpile on connecting roadways, to partially block roadways, and to stockpile over landing edges and in previously unused locations.

The effect of landing shape on available perimeter for log stockpiling is important. In general, where front end loaders are used, rectangular shaped landings are more useful than square or circular landings, due to the relationship between shape and landing area.

As shown in Table 2, for the same area, a rectangular landing provides a greater perimeter for log stockpiling.

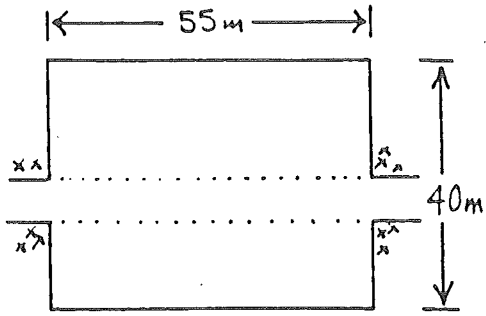
TABLE 2 : EFFECT OF LANDING SHAPE ON PERIMETER

| LANDING DIMENSIONS (m) | AREA (ha) | PERIMETER LENGTH (m) |
|---|---|---|
| 28 m radius circular | 0.24 | 170 |
| 49 x 49 square | 0.24 | 195 |
| 60 x 40 rectangular | 0.24 | 200 |
| 80 x 30 rectangular | 0.24 | 220 |
| 100 x 24 rectangular | 0.24 | 250 |

Survey results showed that in general, operations which handle larger tree sizes and volumes, and more log sorts, do so on rectangular shaped landings.

With regard to the inclusion of roadways onto landing areas, the following landing designs exist, with specific shape varying with site factors.

(i) **Drive through landing**



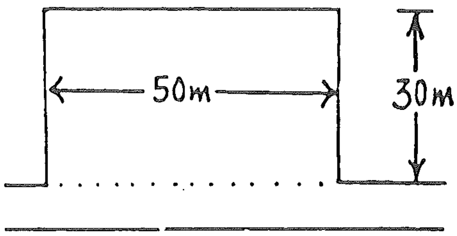

with two or more roadway entries to the landing.

Av. size = 0.21 ha

Trees on the corner of the skid and road exit should be felled to improve egress from the skid.

Where possible, skid and road locations should be planned with loop roads to avoid trucks having to turn on small landings. The skid form shown is ideal from the loading point of view due to flexibility, although at times the road may not be clear of wood. This landing type is more suited to minor 'Class B' roads.

(ii) **Roadside landing**

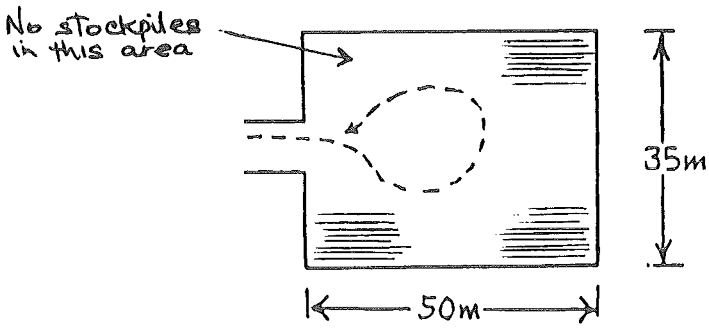



Av. size = 0.14 ha

In this case the road may or may not be used in landing work, although stockpiling often occurs along the roadside. This type of landing is best suited for main routes (since operations are not interrupted by traffic), and where timber is not being pulled aross the road (i.e. from another setting). An alternative standard size for this landing type is 40 x 40 m, giving the same perimeter length (160 m)..

One disadvantage of this type is that the loader cannot load from both sides, if trucks are parked on the road.

(iii) **Road end or spur landing**




Av. size = 0.19 ha

To avoid problems with turning on small landings, an alternative is to extend the landing length by approximately ten metres (unless some off-landing turnaround is available).

Attention must be given to the layout of stockpiles on road end landings. Stockpiling should not be done to the extent that truck turnaround on the landing is restricted. The front or entry side of the landing should be kept clear of stockpiles as shown.

In all cases, roads should be considered part of the effective landing area.

(b) LANDING ORIENTATION

The logging planner is responsible for ensuring that landings are not only of an appropriate size, but are also in the right location for efficient extraction with respect to terrain.

There is a limit to the effectiveness of long narrow landings such as is common along firebreaks. This limit is determined by the shape of the logging setting, the direction onto which timber is pulled, the length of extracted stems and the amount of travel the loader is required to undertake. Problems start to occur in sorting and stacking long lengths on narrow landings, or where the haul direction is such that sharp turns must be made onto the landing.

(c) LAYOUT OF LOG STACKS

In contrast to the size of the landing, the positioning of stacks is primarily determined by the loader operator, and/or the logging contractor.

As such it is largely a matter of personal preference, or experience.

There are however some common patterns :

- As previously discussed, stacks are most commonly placed around the perimeter of the landing. Exceptions to this are where knuckleboom loaders are used. Such loaders commonly stack close to their central location to avoid unnecessary travel.

- Stacks of the "fastest moving" log stocks are normally kept to the front or most accessible part of the landing for ease of loadout.

- Log stacks are often located adjacent to the "drop zone", i.e. where that part of the tree was first landed.

  For example, when butt pulling, butt sawlogs will often be stacked at one end of the landing and pulp (from the head of the tree) at the other. This systematic pattern of stockpiling may be reversed on the opposite side of the landing for head pulled trees.

An example of this layout is of a N.Z.F.P. contract tractor operation (Fig 3). Production is 350 tonnes per day, using a rope crane loader to sort 6 log sorts in 10 stacks.

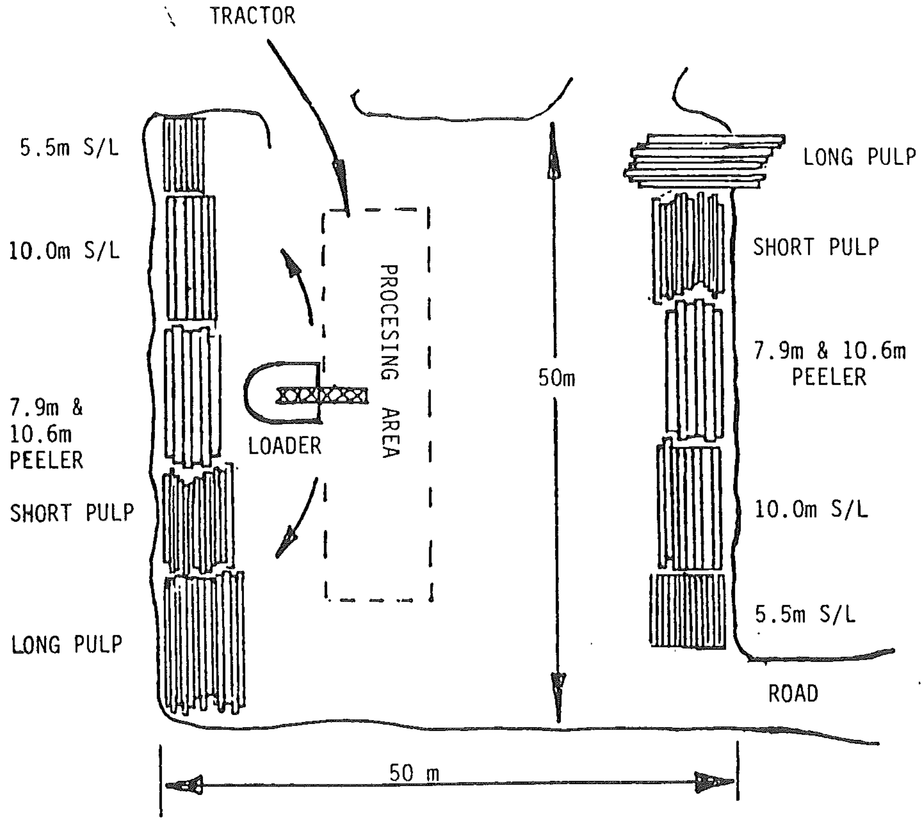



Figure 3 : Reverse Layout of Opposing Log Stacks

- In loading long length radiata thinnings it is common to have the logs on either side of the skid aligned with their butts in the same direction (Fig 4). This allows the loader to work both stacks at once, interspersing heads and butts to maximise loading (Viv Donovan, pers. comm.)

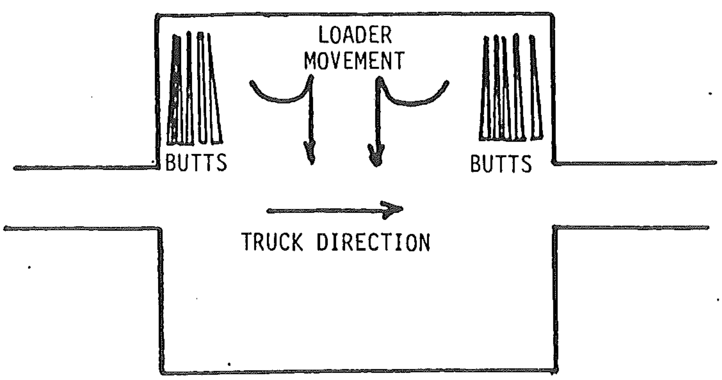



Figure 4 : Layout for Radiata Thinnings

## LANDING LAYOUT FOR KNUCKLEBOOM LOADERS

If the future sees a trend towards smaller landings (e.g. where soil conditions are poor), the use of knuckleboom loaders will no doubt grow in popularity.

At present, knuckleboom loaders (predominantly converted excavators) tend to be used in lower volume operations (<200 tpd), sorting fewer log sorts than wheeled front end loaders (Table 3).

TABLE 3 : CHARACTERISTICS OF LOADER OPERATIONS

| LOADER TYPE | NO. LOG SORTS | | DAILY PRODUCTION | | LANDING SIZE | |
|---|---|---|---|---|---|---|
| | mean | range | mean | range | mean | range |
| Wheeled front end | 6 | 2-12 | 125 | 40-400 | 0.21 | 0.10-0.39 |
| Knuckleboom | 3 | 2-5 | 100 | 40-190 | 0.09 | 0.02-0.20 |

The following diagram shows a typical layout for a knuckleboom loader in a skidder operation which minimises non-productive work elements such as travel, and enables efficient truck loading (Fig 5).

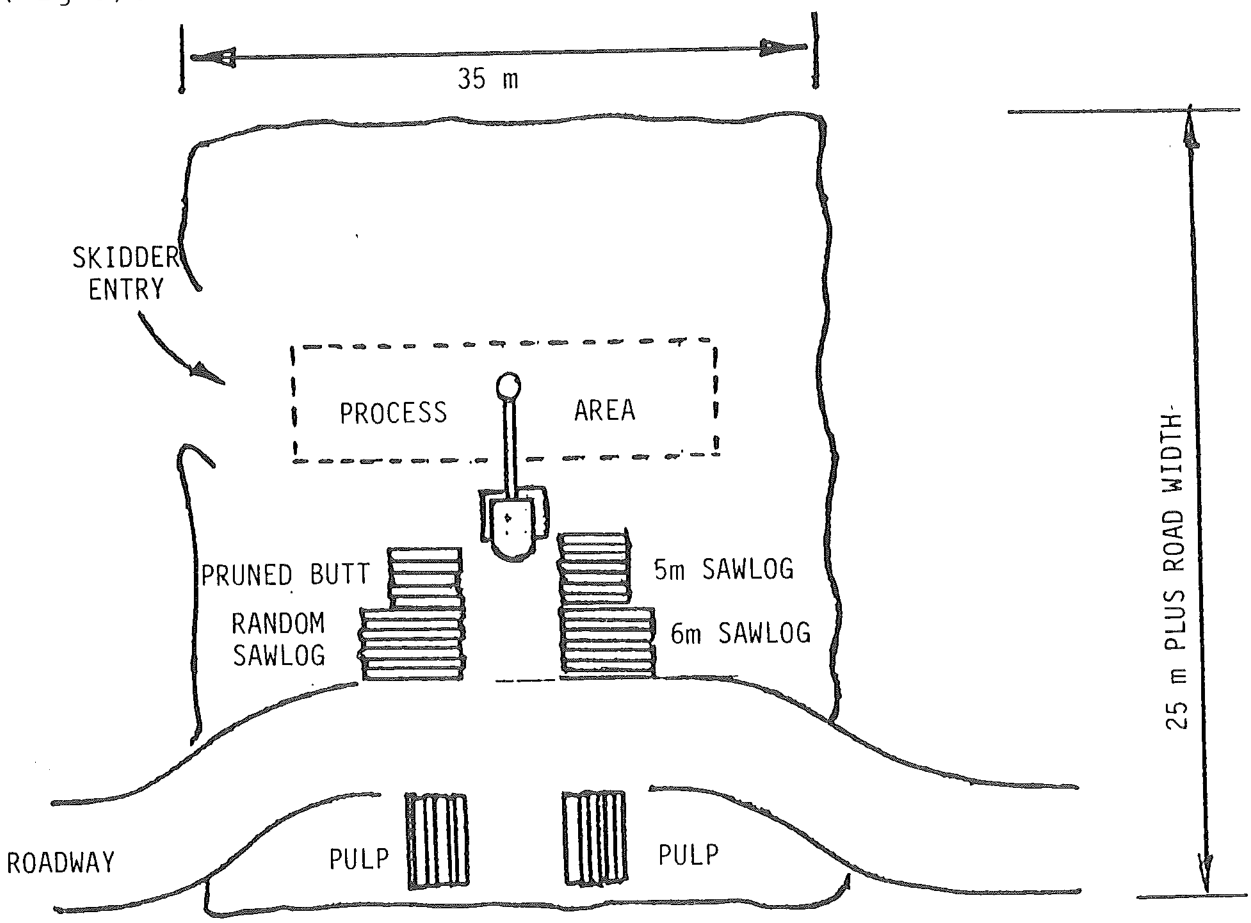



Figure 5

An alternative layout involves the formation of a separate truck turnaround, off the log landing area (Fig 6).

This type of landing often incorporates the use of a loading bank to increase both the visibility and loading ability of the loader.

The advantage of this type of landing is that the truck turnaround area is only a widened road and need be the only part of the landing that is metalled.

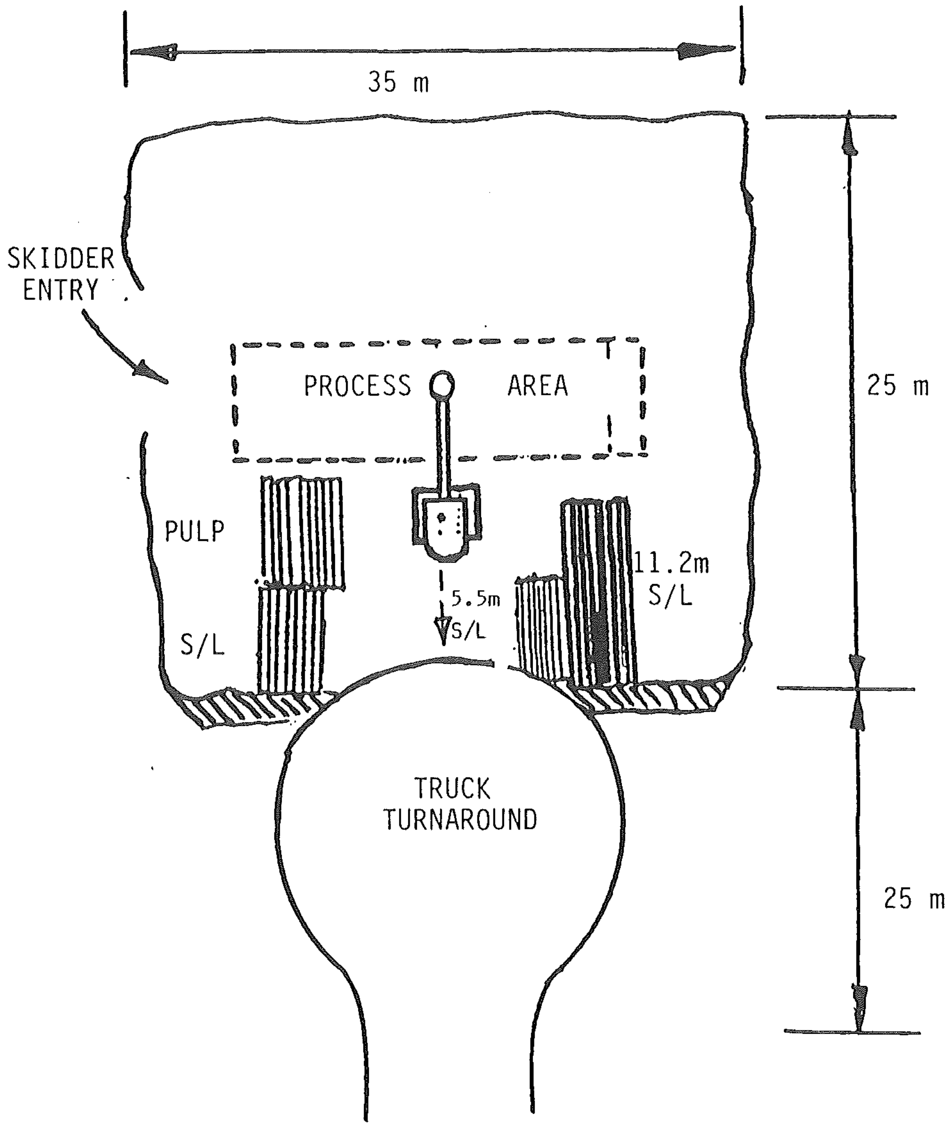



Figure 6 : Landing with Separate Turnaround

There is scope for reduction of the size of hauler landings through the use of knuckleboom loaders.

As with skidder operations, this requires more emphasis on the organisation of log stockpiles. An example showing the radial pattern of layout around the loader is given in Figure 7. Advantages of the knuckleboom include the ability to assist hauling by retrieving partially landed logs, and assisting the skidworkers by shifting wood from under the hauler ropes for further processing.

LIRA has recently undertaken a major study of a medium sized hauler/knuckleboom loader operation which will be published later in the year.

The hauler/knuckleboom loader system (especially the new generation swing-yarders) can also be extended into operation on roadside, without the need for landings. This type of operation is not common in New Zealand, but is highly developed in the Pacific Northwest.

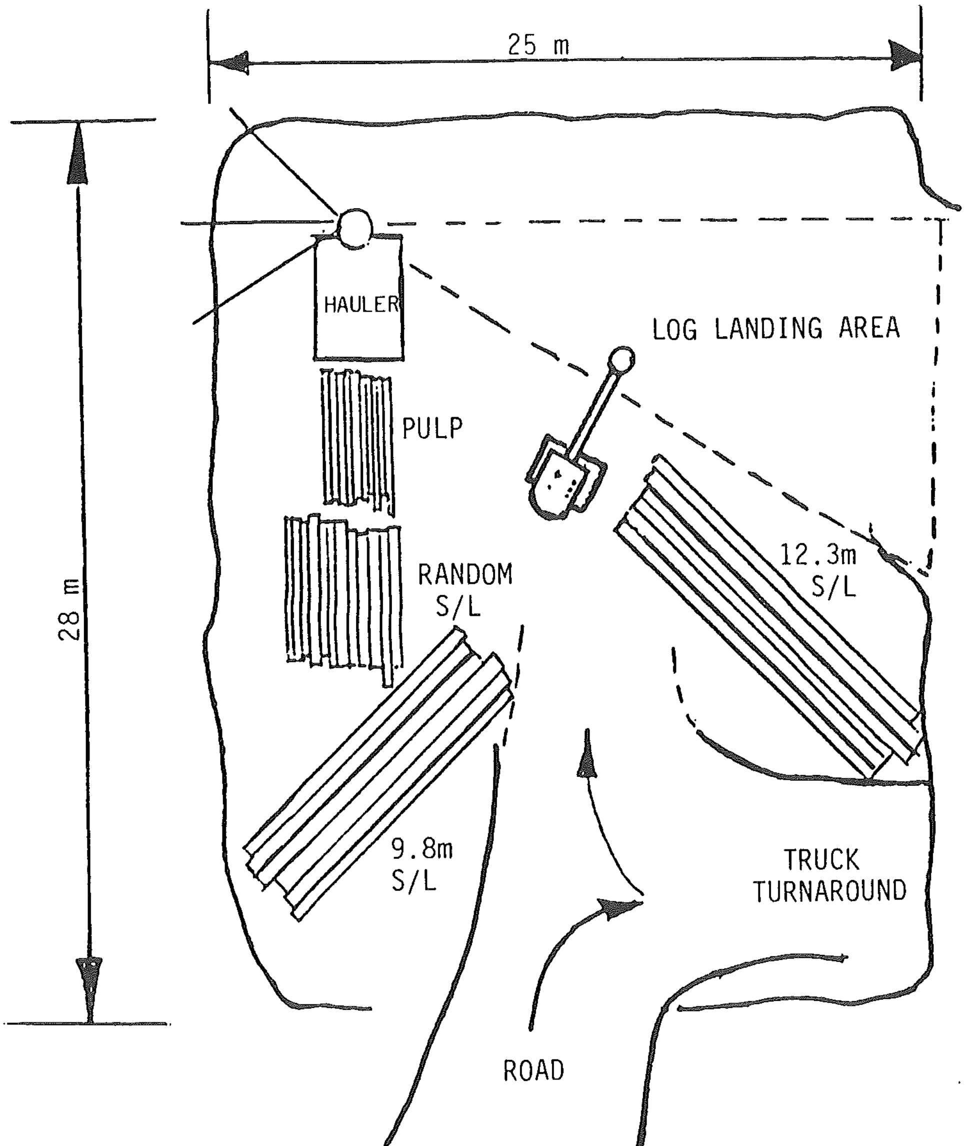



Figure 7 : Layout of Hauler/Knuckleboom System

OPPORTUNITIES FOR ROADSIDE PROCESSING

In this type of operation logs are landed, processed and stockpiled directly on the road edge.

There are three main requirements of this system :

- Use of a knuckleboom loader, due to their reduced working area. For example, a working radius of 8.5 m and 20 m travel, gives a landing area of 0.05 ha.
- Processing to short lengths only.
- A restricted number of log sorts.

Two roadside skidder operations were studied during the 1986 survey. Both operations used knuckleboom loaders to sort and load 2-3 short length log sorts (5-6 metres). Fig 8 shows the typical layout.

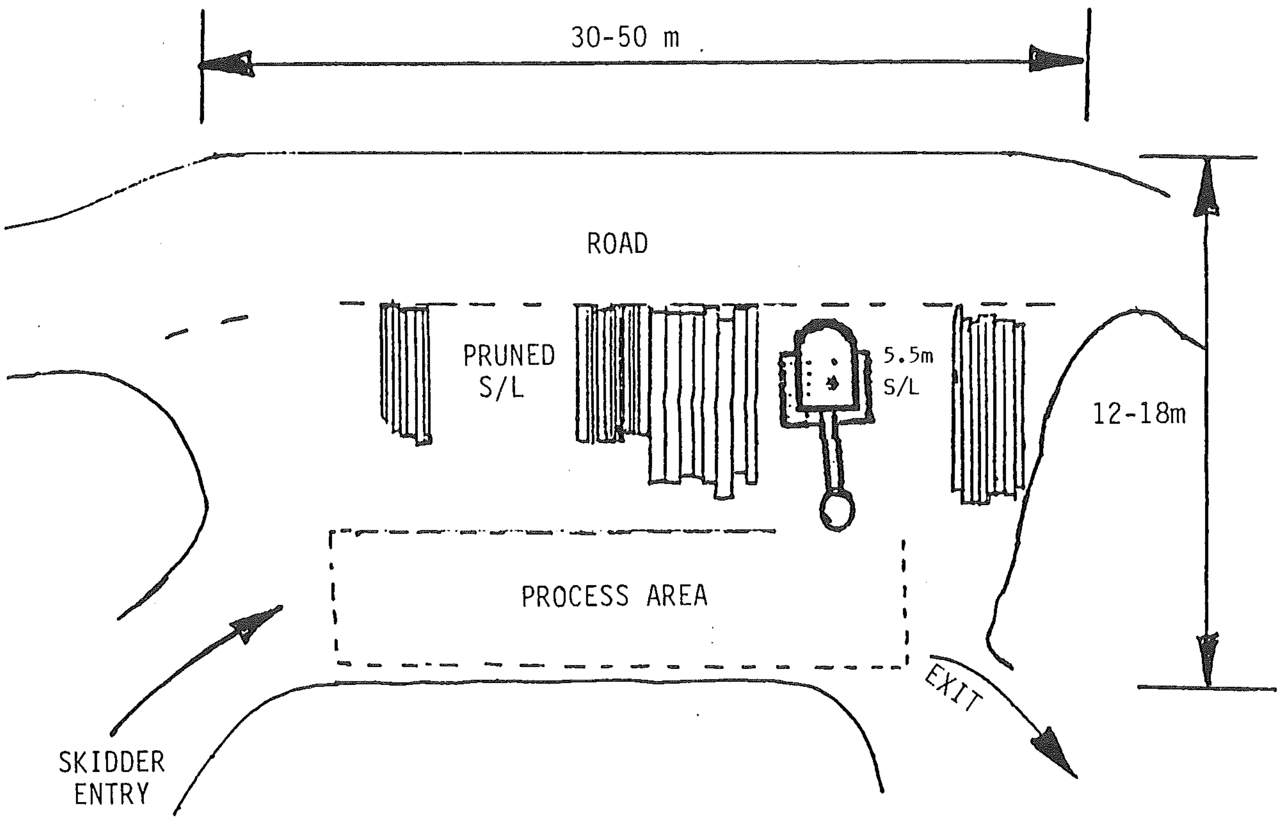



Figure 8 : Layout for Roadside Processing

The log landing/processing area ranged from 30 x 18 m (0.05 ha) to 50 x 12 m (0.06 ha).

Limitations with log sorting and stockpiling are obvious with this system, which is highly dependent on regular truck scheduling.

Advantages are mainly in minimising landing construction and maintenance costs. Opportunities may also exist for the loader to be used for extraction of the area adjacent to the road ("Shovel logging", Hemphill, 1986).

## CONCLUSION

In the final analysis, responsibility for the efficiency of logging operations resides with logging management.

Some management factors that can have significant effects on landing efficiency include :

- Number of log sorts - This is a key factor with the drive towards better marketing and value optimisation. Important questions have also been raised as to the relative merits of processing in bush vs processing on landing vs tree length trucking and processing in a central sort yard.

- Proportion of Output in Long Lengths - Where an operation supplies a range of mills and long lengths are required by mills there will probably be no alternative but to produce larger numbers of log sorts. Sorting of longer lengths by wheeled loaders results in additional manoeuvring and pressure for larger landings.

- Truck Scheduling - Irregularities in truck scheduling or cold deck loading may result in requirements for larger log storage space and result in bottlenecks in the sorting and stacking functions of the loader.

Results of LIRA work to date have shown that operation on restricted landings is possible with lower volume production, shorter log lengths and fewer log sorts. The question is whether this an be extended to large volume operations handling multiple logsorts.

Current work involves comparing the N.Z. situation with common practise in the Pacific Northwest (Hemphill, 1987). This will enable us to further identify and refine any potential improvements to New Zealand methods.

## REFERENCES

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