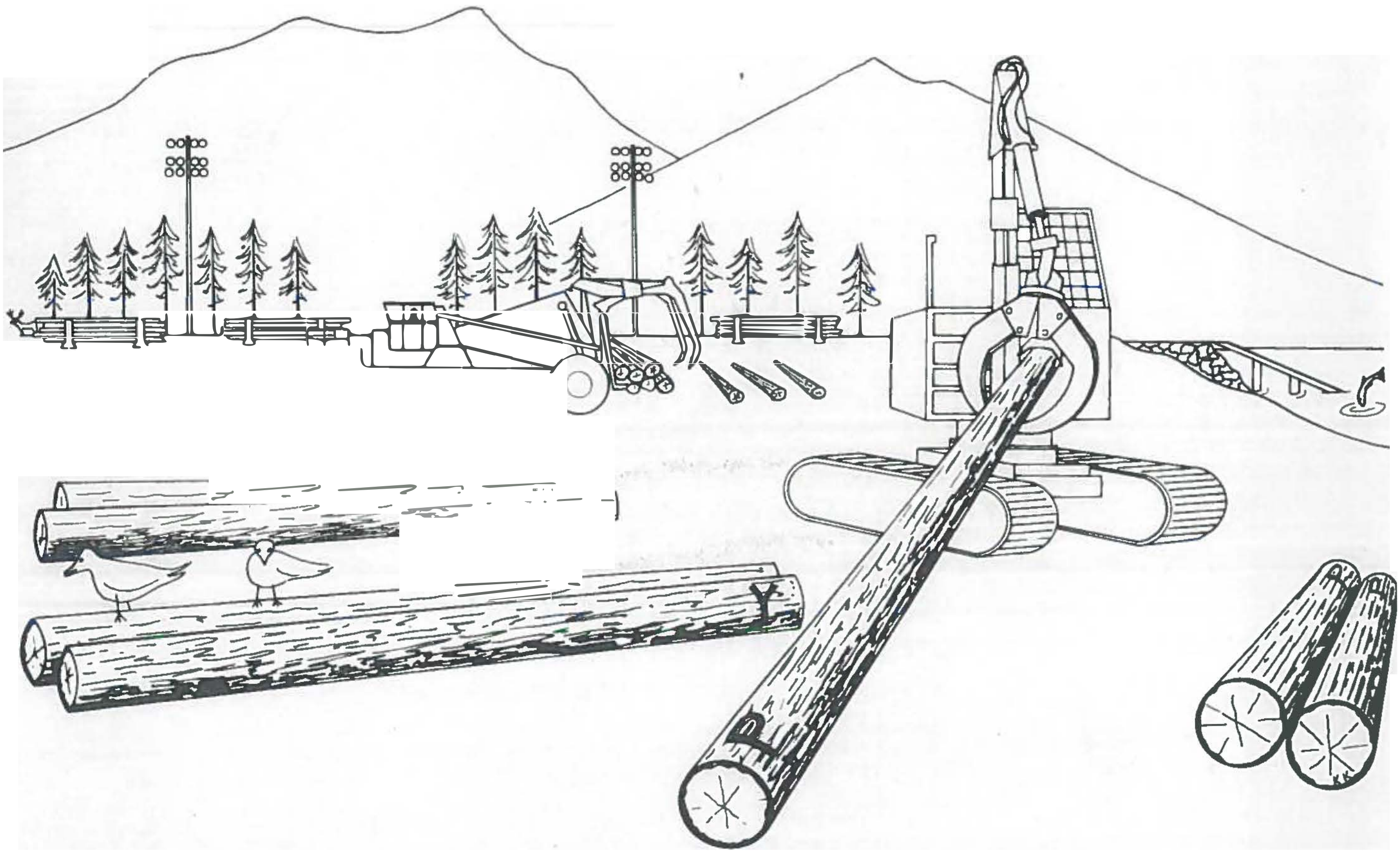
FERIC FOREST ENGINEERING RESEARCH INSTITUTE OF CANADA
INSTITUT CANADIEN DE RECHERCHES EN GÉNIE FORESTIER

A HANDBOOK FOR DESIGNING, BUILDING AND OPERATING A LOG SORTYARD

ALEX W.J. SINCLAIR
G. VERN WELLBURN



FEBRUARY 1984

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AUTHORS

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In 1957, while with B.C. Forest Products Ltd., he conducted the feasibility studies for the Muir Creek and Port Renfrew dryland sorts, which were the first two sortyards constructed on the Coast of B.C. He has had extensive experience in planning and managing log sorting and transportation operations.

LEGAL DISCLAIMER

ACKNOWLEDGEMENTS

Many people assist in the preparation and publication of a handbook and the authors would like to thank them. In addition, they would like to recognize the assistance of those people who reviewed the handbook and offered suggestions for its improvement. They are:

Dick Herring	Canadian Forest Products Ltd.
Monty Mosher	Pacific Forest Products Ltd.
Don Hoffman	Crown Forest Industries Ltd.
George Edgson	MacMillan Bloedel Ltd.
Ted Kimoto	MacMillan Bloedel Ltd.
Greg Turner	B.C. Forest Products Ltd.
Erv Mihalicz	B.C. Forest Products Ltd.
Mike Brownlee	Dept. of Fisheries and Oceans
Les Powell	Dept. of Fisheries and Oceans
Tom Cockburn	Ministry of Lands, Parks & Housing
Geoff Chinn	FERIC - Eastern Division

In addition, Phil Oakley of P. Oakley and Associates was employed to edit the handbook on a grammatical and technical basis. Kristi Knox of FERIC coordinated the reviews, typing, artwork and publication.

CONTENTS

PART I INTRODUCTION

PART I INTRODUCTION

A. OBJECTIVE OF THE HANDBOOK

The objective of this handbook is to provide members of the forest industry with a guide for locating, designing or modifying a dryland sortyard. It provides comprehensive, factual information that can be followed in a step-by-step fashion. It can be used in part or in whole. It stresses sortyard system analysis and design rather than construction details. However, information will be given on common construction methods and their application.

B. READERS GUIDE

An overview of the objectives, sorting methods, equipment, productivity and performance factors of sortyards on the B.C. coast is provided in Part II of this handbook. It poses important questions whose answers will clearly establish the need for and objectives of the proposed yard. It outlines the functions performed within a sortyard and describes the major equipment used to accomplish the work.

An explanation of the financial analysis required for a sortyard project is contained in Part III. It is intended for the use of non-financial people so that they may understand the process and information needed for a sortyard proposal.

The main body of the handbook is contained in Parts IV to IX which detail methods of project organization, site selection, yard layout, sorting systems, design, construction, organization and operation of a sortyard. Included are examples and illustrations of methods currently in use within the industry.

The final section, Part X, provides information on new developments in sortyard design, equipment and operation.

C. INTRODUCTION

The handbook is based on the experience of the authors and Forest Engineering Research Institute of Canada (FERIC) studies of B.C. coastal yards. These sortyards are similar to ones in coastal Oregon and Washington, with the exception that more American yards are located next to mills. B.C. coastal yards differ from the B.C. interior and other Canadian yards in that the coastal yards:

- make more log sorts;
- receive incoming logs at a more uniform rate;
- are not normally adjacent to conversion mills;
- store fewer logs;
- do less delimbing and bucking; and
- scale more logs by volume than by weight.

Although the handbook may appear to be of use only to B.C. coastal operators, the principles of analysis, design and the step-by-step procedures outlined apply equally well to the design and management of sortyards in any geographic location.

D. BACKGROUND AND SOURCES OF INFORMATION

In the past four years FERIC has been asked, on an increasing number of occasions, to assist member companies in the design or re-design of dryland sortyards. During this work it became evident that a handbook would be of value to the logging industry.

In 1980, FERIC became part of a sortyard design project team of a cooperating member company. This study provided case study data for the handbook. Other work and experience that adds to the foundations for the handbook include:

- a survey conducted by FERIC in 1980 for the Estuary, Foreshore and Water Log Handling and Transportation Study, a joint industry/government report in which costs, manpower, machinery and areas were documented and analyzed at twenty-six sorting operations;

- collection of data in 1981 on the productivity of different truck unloading techniques and on the lighting problems associated with double-shift yards;
- a 1982 productivity study of five different sorting systems common to B.C. coastal sortyards;
- direct involvement in the location, design, construction and start-up of a large coastal sortyard;
- field trips to B.C. and Washington log sortyards;
- experience gained through assisting member companies with the design and operational aspects of both conventional and unique sorting systems; and
- research work on methods to solve the disposal problems of log sortyard debris.

A list of books is given in the Bibliography that are helpful in sortyard design.

E. DEFINITION OF TERMS

Five terms commonly used when discussing log sorting are described here.

1. Water Sorting Ground (Sorting Ground)

A water sorting ground receives unsorted logs by land or water and sorts the logs into specific grades with the aid of boomboats or floating log loaders. The sorted logs are then assembled into booms (flat rafts or bundle booms) or loaded onto barges for water transportation to mill or market. The logs are usually scaled after sorting and before bundling.

Figure I-1 is a typical water sorting ground. The figure shows how the different functions in the sorting ground are separated by strings of logs chained together, commonly referred to as a standing boom.

Figure I-1. Typical B.C. Coastal Water Sorting Ground.

Sorting grounds have been in use on the B.C. coast since the early 1900's. Powerful boats and float-mounted log loaders have replaced the men with pike-poles (Figure I-2) who used to move and sort the logs. Sorting in the water has become relatively machine intensive but the trend is to replace sorting grounds with sortyards.

Figure I-2. Sorting with Pike Poles.

2. Dryland Sortyard (Sortyard, Yard)

All the processes present in a water sorting ground are present in a dryland sortyard (Figure I-3). Most land sorted logs on the B.C. coast are still assembled in the water for transportation to the mill or market.

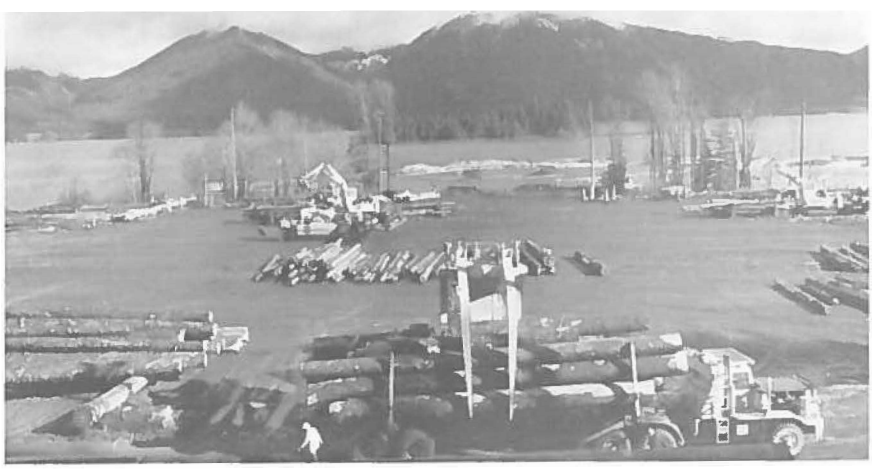


Figure I-3. Typical B.C. Coastal Dryland Sortyard.

Sortyards utilizing log stackers were first introduced into the California redwood forest region in the 1950's. They have been built on the coast of B.C. since the early 1960's. Some of these replaced sorting grounds and others were built when new timber areas were developed. Ideas and techniques have been exchanged between the U.S. Northwest and B.C. and many similarities in sorting systems can be seen.

The sortyard's popularity on the coast of B.C. is primarily owing to the reduced log loss that results when logs are bundled before entering the water. Other benefits are the potential for more accurate grading, scaling and sorting, fewer shutdowns during storms, the opportunity for log upgrading, a reduced requirement for water areas and less impact on the marine environment. Sortyards cost more to build and equip than sorting grounds and, contrary to expectation, there is little reduction in manpower requirements.

3. Booming Ground (Boom)

Booming grounds are used to assemble sorted or unsorted logs for transportation by log boom or barge to mill or market. They are always part of a water sorting ground and are part of most coastal dryland sortyards. The name booming ground is also applied to the area for assembling unsorted logs from a log dump (Figure I-4).

Figure I-4. Typical B.C. Coastal Booming Ground.

In the past, the booming grounds produced primarily flat rafts of individual logs but today most booms or rafts consist of bundles of logs. The log transport method will depend on the water conditions on the route, the distance to the mill, the potential for log sinkage, log storage conditions and log receiving equipment at the mill. Typically, log bundle booms are used in protected waters and log barges or ships are used in the exposed waters found north and west of Vancouver Island.

4. Water Storage Ground (Storage Ground)

Water storage grounds provide space for an inventory of log booms at points throughout the water transportation network. Wherever possible they are located in deep water safe from storms and marine borers. A typical storage ground located at the outfeed of a sorting and booming operation is shown in Figure I-5.

The majority of the coastal mills are located near large population centers. As a result, there is a potential conflict among foreshore users. In most cases, land for log storage near mills is unavailable, prohibitively expensive or deemed a source of unacceptable noise and dust pollution. Therefore, mills must store logs in the water and attempt to minimize the environmental impact.

Figure I-5. Typical Coastal B.C. Water Storage Ground.

5. Land Storage Yard (Storage Yard)

Most coastal sortyards do not store sorted logs on land. However, if the booming ground has a limited usable water area, then sorted logs have to be accumulated on land (Figure I-6) until there are enough to make up a complete boom.

Figure I-6. Land Storage of Logs in a Sortyard.

Some sortyards store unsorted logs to balance daily and seasonal surges in log production. This may reduce investment in equipment and overtime costs and increase the working year of the crew but it may also reduce efficiency, increase investment in land and subject the logs to increased ambrosia beetle damage.

PART II SORTYARDS - AN OVERVIEW

PART II SORTYARDS - AN OVERVIEW

A. SORTYARD OBJECTIVES

In this portion of the handbook, the intention is to stress the importance of establishing the reasons for building a sortyard, to examine all the alternatives and to highlight the potential conflicts between objectives. This type of analysis must precede construction of a sortyard and should be done with the same intensity and enthusiasm as is put into designing and building a new sortyard.

1. Why Build a Sortyard?

When a sortyard is first being considered, the questions to ask are: "Why?" and "What problems will the sortyard solve?" These are important because there may be other better solutions.

Dryland sortyards cost more to build and operate than sorting grounds (Table II-1). In addition, there are problems associated with the construction, start-up and operation of the yard. Consequently, it is vital to establish the reasons why the yard is to be built before construction starts.

Table II-1. Comparison of an Average B.C. Coastal Sorting Ground and a Sortyard.*

	Average Sorting Ground	Average Dryland Sortyard
Annual Volume Sorted (m^3)	595 800	517 200
Number of Men	24.1	24.2
Pieces per Manday	62.1	61.2
Total Cost/Piece	\$3.68	\$5.73
Total Capital Invested/m^3	\$2.69	\$6.89

*Evaluation and Economic Analysis of Twenty-Six Log-Sorting Operations on the Coast of British Columbia - FERIC TN-39, December 1980.

The following is a list of the more common reasons for building a sortyard and other ways to obtain the same results:

a) Reduction in Log Loss

Bundling reduces log loss. A dryland sortyard is not needed to bundle logs. Some companies dump bundled truckloads of logs into the water, open the bundles over a submersible grid, sort, scale and rebundle logs and then raise the submersible grid and recover the sinkers. This system works where the percentage of sinkers is low but does not work where the volume of sinkers is high. Timber stands which have a large percentage of sinkers should be sorted in a yard.

b) Improved Grading, Scaling and Sorting

More of the log is visible when it is on land than when it is in the water and thus the potential is greater for more accurate grading, scaling and sorting. However, if the logs are to be sold, it is questionable whether the company receives more money because of this. Log traders negotiate a value based on the amount of material that can be recovered from the log in the mill. Tighter, more accurate measurements do not change the real value of the boom of logs, but do make it easier to sell. On the other hand, if the logs are to be used within the company it is important that the logs are graded and sorted accurately so that they go to the correct mill.

Another aspect is the timing of scaling. In most sortyards the logs are scaled before sorting, whereas the reverse is true in sorting grounds. Thus, there is greater potential for scaling and sorting errors in log booms from a sortyard than from a sorting ground.

c) Improved Log Values Through Remanufacturing

Remanufacturing or bucking to grade can be done in the water as well as on land. However, in both cases, the log market must be watched closely to ensure that bucking to grade is increasing the value of the log. For example, in some market conditions pulp logs and sawlogs will have the same value and bucking the sawlog content out of the pulp logs will not increase value but only add to costs.

d) Environmental Impacts

Sorting and booming operators working near the mouth of rivers or in shellfish areas often experience difficulty in obtaining permits to dredge bark deposits. They may decide to build a dryland sortyard to solve the problem. However, changing the location of the existing log dump and sorting ground may solve the problem with less capital investment. In any case, the new dryland sortyard will need a log dump and bark may still need to be dredged. In addition, the sortyard may solve a marine problem but create a debris disposal problem on land.

e) Sorting and Booming Ground Bottleneck

As the log size diminished, many sorting operations became bottlenecks and limited total production from a logging operation. Sortyards have solved bottleneck problems, but did the designers examine methods to improve the sorting ground with as much effort as they spent in designing the new sortyard? An improved sorting ground may have solved the bottleneck more economically.

The foregoing should not be interpreted negatively but as a critical examination so that the most economical solution is not overlooked. In 1981, at least two potential dryland sortyard projects on the B.C. coast were cancelled after a critical analysis of existing facilities.

2. What Problems Will the Sortyard Solve?

Once the need for the sortyard has been established, the objectives of the yard must be set. These may be the solution to financial or operational problems, or both.

Evaluation of an intended improvement in performance is only possible when the objectives are clear and financial and operational priorities have been established.

In most companies, a proposed sortyard must be justified on a financial basis and at some point the yard designers will commit the future operators to investment in land, buildings and equipment to reduce annual operating costs. Thus, from the financial point of view, the yard objective is to save money.

The operational objective will be to improve the productivity and quality of sorting. However, it may be unrealistic to achieve high productivity and also a better sort without adding more equipment and men than planned. This may compromise the financial objective because if the yard costs more than planned, it must also save more.

There is an implicit responsibility for the operators to achieve the financial objectives of the yard and, normally, senior management will require the savings to be measured and reported. If the major economic justification for the yard was a reduction of log sinkage, then the yard operators are obligated to ensure that log bundles are well built and that the bundle will survive the dump into the water and the tow to the mill. If the savings are real, the mills should require fewer logs to produce the same amount of product. In another case, the yard may have been financially justified on the basis of savings resulting from better grading, scaling and sorting. While it is very difficult to document these savings, the mills should recognize an improvement in the logs. The supervisors are obligated to ensure the savings are realized by checking that the graders are indicating the correct sorts, the scalers are accurately determining grade and volume and that the machine operators are putting the logs into the sort indicated. Trying to achieve the financial pro forma rates and costs can cause conflicts because it is easy to lose control over scaling and grading quality while concentrating on increasing log production through the yard. On one hand, the operating costs and production rates are being achieved but on the other, the company is losing revenue through inaccurate grading and scaling.

The objectives of the sortyard may also conflict with the objectives of the logging division. The division manager will want the yard to process the logs at budgeted costs and rates without adversely affecting the rest of the system. He will make rules, such as "logging trucks must be unloaded in less than ten minutes", because longer turnaround will result in a buildup of logs in the landing and loss in yarder productivity. In order to achieve the ten-minute turnaround, the yard should not increase log breakage or decrease the quality of other work. It is important to rank all the objectives in order of priority to minimize future conflict.

The ideal objective for a sortyard is to maximize the return of the investment consistent with safe operation and minimal impact on the environment. In practice, this is difficult to achieve and measure. Logging divisions are traditionally measured on quantity of production, not on quality; on the basis of cost rather than revenue; and on the basis of the volume, not the number of logs processed. The engineering and financial plans for the yard must anticipate these problems and choose measurement units which will truly reflect the final performance.

3. Alternatives to a Dryland Sortyard

a) Sorting Grounds

In some cases, water sites along the coast between the logging operation and the mill provide an alternative place suitable for scaling, sorting and bundling logs. Water sites are cheaper to develop (Table II-2) and are easier to relocate than dryland sortyards.

Table II-2. Ownership Cost Comparison - Dryland Sortyard Versus Sorting and Booming Grounds.*

	Size Class (m^3/yr)			
	0 to 169 900	169 900 to 456 000	456 000 to 739 200	739 200 to 1 416 000
Total Capital Invested per m^3 of Logs Sorted Annually				
Sorting Grounds	—	$3.14	$2.25	$2.74
Dryland Sortyard	$5.20	$8.85	$7.70	$6.11

*Report to the Council of Forest Industries' Subcommittee on Foreshore and Estuary Use - May 1980.

Existing sorting grounds may be modified to overcome some of their present shortcomings. Crown Zellerbach Canada has improved and mechanized their sorting grounds. In their latest design, bundles of unsorted logs are broken down over a submersible grid (reduction of sinker loss) and the logs are tiered and pushed into a raceway. There the logs are graded and scaled and then sorted by a floating log loader into submersible log bunks.

Finally, completed bundles are strapped and dumped into the water for shipment to the mills. Floating log loaders are more productive than boomboats and the log bundles are secure and well built. In one installation of this type, sorted log production is weight scaled and only a portion of the logs are stick scaled to maintain statistical accuracy of the volume-weight ratio. The system works well and sinker loss is minimized (Table II-3).

b) Sorting in Landing

Another alternative to the sortyard is sorting in the landing. The Tahsis Company has successfully sorted the majority of their log production in the logging landings for over ten years and in terrain where landing construction is difficult and expensive. They make four different sorts: pulpmill logs, cedar logs, hemlock/balsam sawmill logs and logs for resorting. Table II-4 gives a comparison of the estimated costs of sorting and booming landing-sorted bundles versus dryland sorting and booming of the same wood.

Table II-3. Comparison of a Mechanized Sorting Ground and an Average Large Sortyard.*

	Mechanized Sorting Ground	Average Large Sortyard
Annual Volume Processed (m^3)	909 920	1 136 580
Pieces/Manday	58.5	71.2
Pieces/Sorting Machine Hour	21.3	39.2
Operating Cost/m^3	$2.33	$2.42
Total Cost/m^3	$3.02	$3.31
Capital Invested/m^3 Sorted	$4.10	$6.11

*Evaluation and Economic Analysis of Twenty-Six Log-Sorting Operations on the Coast of British Columbia - FERIC TN-39, December 1980.

Table II-4. Cost Comparison of Landing-Sorted Logs Versus Dryland Sorting.*

	Sorting & Booming (Landing Sort)	Dryland Sortyard
Annual Volume Processed (m^3)	361 100	322 800
Operating Cost/Piece	$2.81	$3.54
Ownership Cost/Piece	$0.39	$0.85
Total Cost/Piece	$3.20	$4.39
Total Capital Invested/Piece	$2.87	$4.93

*Evaluation and Economic Analysis of Twenty-Six Log-Sorting Operations on the Coast of British Columbia - FERIC TN-39, December 1980.

A variation is to sort the logs in the landing for end destination rather than mill requirements. The logs can be final sorted near the mill and transferred between different mills if they are at the same location. There would be additional costs at the mill for equipment and people but there would be similar savings at the logging operations. In addition, mill personnel would be doing the final sorting for their mill and a better sort may result. Also, as the mills on the coast are clustered, trading of logs between companies would be facilitated and trades could be made in smaller packages.

B. SORTING METHODS AND EQUIPMENT

This section will discuss the functions performed that are common to all sortyards and the types of equipment that are available to perform these functions. In addition, yard size and its relationship to equipment selection will be examined. It is the intent of the authors to provide the reader with thumbnail sketches of sorting methods and equipment which will be enlarged and refined in subsequent sections of the handbook.

1. Functions Performed

These functions are performed in all sortyards but not necessarily in the order shown below.

a) Unload or Receive

Most small and medium sized sortyards are located adjacent to a booming ground and the unsorted logs arrive by truck or rail car. Usually the logs are secured by binders which must be removed from the load. At this point the load of logs is either pushed or lifted from the vehicle so that the logs may be processed in the yard. Loads may vary from 20 to 100 tonnes in weight and, depending on the equipment used, may be unloaded in single or multi passes.

Figure II-1. Lift Unloading.

Large sortyards are either located in similar locations to medium and small yards or are located away from logging camps and receive barge loads or bundle booms of unsorted logs from several sources. In the former case, the logs are usually unloaded in a single or two-pass system using large mobile equipment. In the latter case, there is usually specialized equipment, such as a marine railway or an overhead crane, to dewater bundles or loose logs in preparation for processing in the yard.

Figure II-2. Dewatering Bundles with Overhead Crane.

b) Transport

In every sortyard there is a need to move or transport logs between processes. Often the sequence is as shown in Figure II-3.

UNLOAD OR RECEIVE

↓ TRANSPORT

GRADE OR SCALE

↓ TRANSPORT

SORT

↓ TRANSPORT

BUNDLE

↓ TRANSPORT

DUMP OR RELOAD

Figure II-3. Transport Sequence.

Depending on the size and capacity of the sortyard and the equipment available, logs may be transported singly, several at a time or in large bundles. The design of a successful sortyard hinges to a great extent on matching the transport equipment to the size, capacity and other characteristics of the yard.

c) Grade & Scale

Grading or marking a log to designate it for a particular end use is an essential process of any sortyard (Figure II-4). It should immediately precede sorting the log. The process is sometimes performed by the sorting machine operator but it is preferable that this essential task be done by a qualified and competent grader. For the grader to work efficiently, the logs are spread so that all the logs may be examined (Figure II-5).

Figure II-4. Marked Logs.

Figure II-5. Grading a Deck of Spread Logs.

Scaling or estimating the volume and quality of a log may be performed at several stages in the sorting process. For example, it can be before unloading, after grading or after sorting. There are two scaling methods commonly used: stick scaling - where all logs are measured and recorded, and weight scaling - where groups of logs are weighed and the volume calculated by sample scaling a percentage of the total volume. Stick scaling is usually performed when the logs are spread for grading or, in some cases, after sorting. Weight scaling is usually done prior to grading the logs but can be done when the logs are sorted, bundled and ready to leave the yard.

d) Sort

This is the primary function of the yard and can be performed with the greatest accuracy if the logs are graded and marked prior to sorting. The sorting function involves taking individual logs and aggregating them with the logs of the same end-use sort. In general, logs are sorted by species and end-use sort, such as pulp, small sawlogs, medium sawlogs, large sawlogs, and higher grade logs. Small yards make as few as 5 sorts, whereas large yards make up to 20 sorts. The average is 12 for B.C. coast sortyards. The number of sorts, log size and daily throughput all influence the type and number of sorting machines required in the sortyard.

e) Bundle

After the logs are sorted, most yards on the coast of B.C. bundle the logs prior to leaving the yard. This is done to decrease booming and transport costs and to reduce sinker loss. The loose, sorted logs are placed in bunks (Figure II-6) where they are bundled with wire rope or steel banding. The size and number of straps depends on the weight of the bundle, impact on dumping, water transportation method (barge or raft) and the exposure of the bundle raft to adverse weather conditions. Normally, bundles delivered by rafts crossing Georgia Strait or by barge require the strongest bundling material.

f) Dump or Reload

Once the logs are bundled, they are ready to be dumped into the booming ground which is adjacent to most sorting yards. In situations where the yard is not on the waterfront, the logs are reloaded onto trucks or rail cars for the trip to the booming ground or mill. Most sortyards use a dump ramp (Figure II-7) to put the bundles of logs into the water. Some large sortyards use marine railways, stiff-leg derricks or overhead cranes to place logs in the water.

Figure II-6. Bundling Bunks.

Figure II-7. Typical Dump Ramp.

2. Major Equipment Used

a) Front-end Loaders

A typical front-end loader is shown in Figure II-8 and, depending on size, costs from $235 000 to $490 000 (1983 $). It has a lifting capacity of from 11.0 to 19.0 tonnes. The machine can be used for unloading, transporting and sorting but is not as efficient as specialty machines in performing any of these functions. It is best used for unloading limited numbers of trucks, sorting large logs and transporting logs short distances. Because the front-end loader can do several functions and is an ideal back-up machine, it is found in most yards, large or small.

Figure II-8. Front-end Loader.

b) Log Stackers

These machines were developed for use in sortyards and mill log storage yards where large loads need to be unloaded or transported medium to long distances (Figure II-9). The lifting capacity of the log stackers varies from 40.8 to 54.4 tonnes and the capital cost varies from $510 000 to $635 000 (1983 $). They are capable of offloading highway size trucks in a single pass but the largest stacker is not able to remove the load from large off-highway trucks in one pass. They efficiently spread logs in preparation for the scaling and grading function and are able to stow and retrieve logs from large storage piles. These machines are used in large and medium sized sortyards.

Figure II-9. Log Stacker.

c) Hydraulic Log Loaders

Log loaders are used primarily for sorting logs but on occasions or in emergencies may be used to unload trucks, build high storage piles or reload outgoing trucks. The typical log loader, as shown in Figure II-10, is a diesel-powered, hydraulically-operated, crawler-mounted machine with a capital cost of from $470 000 to $680 000 (1983 $). Stationary loaders may also be used to sort logs. In this case, it is fed logs by a stacker or front-end loader and sorts them into bunks. (The logs are later removed by a stacker or front-end loader.) An alternative system is for the log loader to be mobile and work its way along the deck of spread logs, bunching logs of the same sort. The bunches of logs are then recovered and usually transported to bunks for bundling. Log loaders are capable of sorting 700 to 900 logs per shift.

Figure II-10. Log Loader.

d) Overhead Cranes

This type of machine is capable of unloading or receiving log bundles from water, transporting logs within the yard, storing logs in high decks and reloading trucks or placing bundled logs into the water or onto the decks of barges (Figure II-11). They perform equivalent functions to the log stackers but can also receive and return log

Figure II-11. Overhead Portal Crane.

bundles to the water without the need for a marine railway or dump ramp. They have higher capital costs, lower operating costs, and are far less flexible than log stackers. At this time, overhead cranes have not gained wide acceptance on the B.C. coast.

e) Tables and Linear Systems

These systems are presently not used extensively on the coast of B.C. although popular in Scandinavia, parts of the B.C. Interior and Pacific Northwest (Figure II-12). These systems have a high production potential if the logs are relatively small and of uniform size. As more second growth stands are logged, these systems may be adopted on the coast.

Figure II-12. Linear Sorting System.

f) Delimbing and Bucking Machines

These portable machines shown in Figure II-13 are now in use in small and medium sized sortyards where tree-length second-growth logs are trucked into the yard. The machines have a capital cost of $230 000 and will process 500 to 900 trees per shift. The logs produced are clean and bucked to the correct length. After the logs are delimbed and bucked, they are sorted and bundled with conventional equipment.

Figure II-13. Tree Length Delimber and Bucker.

3. Yard Size and Equipment Selection

Sortyard size, in terms of physical size and the number of pieces per day to process, has a significant influence on the type of equipment used in a yard. Based on the equipment characteristics outlined in the preceeding section, Table II-5 summarizes the equipment selection available for small, medium and large sized sortyards. This table is only intended as an introductory guide and the steps outlined in Parts IV to VIII should be followed when designing and equipping a sortyard.

Table II-5. Yard Size and Equipment Selection.

		EQUIPMENT			
Function	Yard* Size	Front-end Loader	Log Stacker	Log Loader	Overhead Crane
Unload	Large		P		S
	Medium	S	S		
	Small	P			
Transport	Large	S	P		S
	Medium	S	S		
	Small	P			
Sort	Large			P	
	Medium			P	
	Small	P		S	

P — Preferred Equipment
S — Suitable Equipment

*small = 0 - 200 000 m³/year
medium = 200 000 - 500 000 m³/year
large = 500 000 - 1 500 000 m³/year

C. SORTYARD PRODUCTIVITY FACTORS

The productivity factors and conclusions shown in this section are based on a study of twenty-six different operations on the coast of B.C. done by FERIC for the Council of Forest Industries in 1979-80. More detailed information relating to this study is contained in later sections of this handbook.

1. Pieces Versus Volume

The most reliable measures of productivity in sortyards are pieces per machine hour and pieces per manday. The number of pieces to be handled determines the machinery and men that will be needed in the sortyard. However, accounting records and statements usually record volume or cubic metres/manday. The only real effect of volume relates to weight and whether the equipment has the capacity to lift the heavy pieces or bundles. The comparison of costs by volume versus piece is shown in Table II-6. As can be seen, when yard A is compared to yard B on a cubic metre basis, yard A appears more efficient. However, on a per piece or log basis, yard B is more efficient. It takes the same time to grade, scale and sort a little log as a big log so pieces control productivity.

Table II-6. Comparison of Cost - Volume Versus Piece.

	Yard A	Yard B
Cost/m^3	$4.00	$5.00
m^3/Manday	110	100
m^3/Shift	1100	900
m^3/Piece	1.6	1.1
Cost/Piece	$6.40	$5.50
Pieces/Manday	68	91
Pieces/Shift	687	818

2. Cost Versus Value of Product

Measurement of productivity and costs should emphasize the principle that the effort expended on a product should be in proportion to the value of the product. When a pulp log that sells for $6.00 is costing $6.50 to sort, then something is wrong and the sorting system must be re-examined. This is particularly true of the lower grades of logs. It is questionable why so much time is spent scaling and sorting pulp logs rather than rough grading, sorting in bulk and weighing. Measuring costs and productivity by the piece, rather than by volume, will highlight the principle of marginal returns.

3. Weight Scaling and Stick Scaling

Replacing stick scaling with weight scaling will increase the productivity and reduce the costs of a sortyard. Also, it reduces the involvement of government employed scalers in the production process. However, few sortyards on the coast of B.C. are using only weight scaling. Stick scaling is preferred by log traders for determining the value of the logs in a boom. Some companies weight scale logs that are consumed within the company and stick scale logs that are traded or sold. This system increases productivity and reduces costs in proportion to the amount of weight scaling. Yards that use weight scaling have higher manday productivities than yards that use stick scaling.

4. Presorting Versus Camp-run

A truckload of logs of predominantly one species or grade is much easier to sort than a mixed truckload, and presorting increases yard productivity. However, many companies will not consider sorting logs in logging landings because larger landings are needed and landing costs increase. One operation tried sorting in the landing and reported a 30 percent decrease in woods productivity. Sorting logs in the landing should only be considered when there is a significant proportion (60 percent plus) of the logs in one or two species. Thus, if a company's log production has 60 percent of the logs in cedar and hemlock, then they should seriously consider making a hemlock/cedar and "other" sort in the landing. Presorting in the landing does not preclude further sorting in the sortyard.

Presorting gives the yard a batch of logs where fewer sorts are needed. Thus, machine travel, less area and fewer grading, scaling and sorting decisions are needed and the productivity is increased.

5. Effect of Number of Log Sorts

Increasing the number of log sorts made in the sortyard decreases the productivity, increases the cost and increases the volume of logs in inventory. The added costs must be offset by the added benefits received from the additional sorts and be reflected in improved profitability of the sortyard or the company. The number of sorts also has an effect on the best sorting system to use. Obviously, a stationary log loader which can effectively make 4 major and 4 minor sorts cannot be used where 10 major and 10 minor sorts are needed.

6. Effect of Number of Handling Operations

Every time an operation requiring extra handling is added to the sortyard, the productivity decreases and the cost increases. This will be stressed throughout the handbook. A primary reason for added handling steps is safety. Reasonable space must be allowed between people and machines. If men and machines are working too close together, then one must wait or the logs must be moved to an area where there is less interference. Another common justification for an additional material handling step is that the benefits gained outweigh the cost. Moving logs to a bucking area for upgrading into higher value logs will increase handling costs but may be justified by the added revenue.

7. Effect of Storage

Putting logs into storage reduces productivity, increases costs and increases the chance of log damage. However, in some cases, there is no alternative to log storage and without it, productivity would be lower and costs higher. Yards with extreme swings in log input, inadequate space in the booming ground or teredo infested storage grounds require log storage. Yards with large log storage areas have lower productivity than yards with less storage area.

8. Productivity and Sortyard Size

Smaller yards which have fewer sorts and minimal log storage have high machine productivity, the lowest capital investment per cubic metre and lower than average total costs per cubic metre and piece. Large yards which have the most sorts and little log storage have the highest machine productivity, higher than average manday productivity, the lowest total cost per cubic metre and piece, and lower than average investment costs per cubic metre. The largest yards achieve some economies of scale. Medium sized yards are less productive than small or large yards.

9. Productivity and Area Utilization

Area utilization is usually not considered when measuring a yard's productivity. However, the capital invested in developing and building the sortyard site can easily exceed the investment in equipment. The ownership cost of the site forms a significant part of the total cost of sorting. Area utilization, measured by pieces sorted per shift per hectare, indicates how effectively the site and the investment in it is being used. However, not enough area results in congestion and machine idle time.

PART III FINANCIAL ANALYSIS

PART III FINANCIAL ANALYSIS*

This section of the handbook is for people who do not have a financial or accounting background but need to understand the process and information required to do a financial analysis. It will show how to evaluate various projects taking into account: capital cost allowance and tax effects, the time value of money, constant dollars versus inflated dollars, methods of discounting cash flows, and examples of these methods. In addition, non-financial factors which take precedence over financial factors will be discussed.

A. PROJECT EVALUATION

The main economic justification for using a dryland sortyard is that the required investment provides the best cash flows relative to the other alternatives for sorting logs. If the sortyard replaces an existing water sorting ground, senior management will need to know the financial return on the investment. Also, several different projects may be competing for capital funds and the sortyard project will be compared with these. It may happen that, although replacing the sorting ground with a sortyard is financially attractive, it is not as attractive as other capital projects in the company. The financial analysis of a project must accurately represent the costs and benefits and permit fair comparison between proposals.

A new project is usually compared against the status quo. A new project requires an investment of capital whereas the status quo alternative usually requires no new investment. If the status quo alternative does require some maintenance investment, now or in the future, it should be included in the analysis. The financial evaluation must determine the net investment necessary to complete the new project. The economic analysis must determine the differences in operating costs between the new project and the status quo. The new project must have cost savings or produce higher sales revenue (both improve cash flow) or the investment is not economical. The project team must isolate and document these benefits which might include: improved sorting and scaling, remanufacture of logs, reduced sinker loss, improved transportation cost, reduced log inventories and changes in operating costs.

Projects will normally be evaluated and compared on an after-tax, discounted cash flow basis. Other measures, such as payback, average rate of return and financial exposure are not now commonly used.

B. CAPITAL COST ALLOWANCE AND TAX EFFECTS

Economic evaluation is usually done on an after-tax basis to reflect the impact on the company's income statement and real cash flow. Capital cost allowance (CCA) as well as operating expenses are deducted from income to arrive at taxable income. The principle behind capital cost allowances is that the earnings protected from taxes will be reinvested in the company to replace worn out or obsolete equipment. There is no capital cost allowance on land.

The capital cost allowances currently permitted for the logging industry are 30 percent of the declining balance regardless of tax class. This includes mobile equipment, boats, buildings, facilities, improvements to land, roads, etc. Also, new equipment, with the exception of light vehicles, is allowed 7.5 percent of the original cost as a direct tax reduction. However, the capital cost allowances are then started at 92.5 percent of the original cost. Table III-1 shows the effect of capital cost allowance on the company's cash flow.

As can be seen, the effect of capital cost allowance is to increase the cash flow to the company by reducing taxes. In periods when the company is losing money, the capital cost allowance has no effect on after-tax cash flow; however, the company can carry the allowances forward until the company becomes profitable (within certain time limits).

For the purposes of calculating capital cost allowances, assets of the same class are normally pooled together. Thus, on a project that replaces older assets with new ones, the allowances are based on the net investment. For example, the new asset purchased for $100 000 goes into the pool at $100 000 and the old asset sold for $10 000 (its current market value) comes out of the pool, so the net amount is $90 000.

*See Bibliography for reference material.

Table III-1. Effect of Capital Cost Allowance on Cash Flow.

Cash Flow	No CCA ($)	CCA ($)
Income After Operating Expenses	1.00	1.00
Less: Capital Cost Allowance	—	0.40
Taxable Income	1.00	0.60
Less: Income Taxes @ 50%	0.50	0.30
Income After Tax	0.50	0.30
Add: Capital Cost Allowance	—	0.40
After-tax Cash Flow	0.50	0.70

C. DISCOUNTED CASH FLOW

1. Time Value of Money

The time value of money refers to the fact that a dollar received now is worth more than a dollar received at some time in the future. Cash received today can be reinvested to earn a return and is, therefore, more valuable than the same amount received sometime in the future. The various discounted cash-flow methods of financial analysis all recognize the time value of money and place heavy emphasis on early results. The impact of future costs or benefits which accrue has a lesser effect for each year into the future and is negligible at over 20 years.

In order to determine the "present value" of a dollar received or spent in the future it must be discounted.

2. Constant Dollars Versus Inflated Dollars

Given the changes that occur with inflation rates, it is important to establish whether projected cash flows for new investments should reflect fully the anticipated price-level changes or whether such forecasts should be made in constant dollars. The cost of raising funds in the capital markets tends to parallel the inflation rate, since investors strive for a real return of 3 to 6 percent over and above the rate of general price level changes. Therefore, to be consistent, projected cash flows should reflect anticipated price level changes if current rates of return are used. However, if projected cash flows are made in constant dollars, then the discount rate to be applied must be a non-inflationary one.

3. Discounting Methods

Each discounting system has implicit assumptions or characteristics. The company chooses the system which best matches its corporate financial goals. The various discount methods include:

a) Net Present Value

Net present value is the discounted value of the after-tax cash flows less the present value of the investment. Usually, the company's cost of capital (as a percentage rate) or opportunity cost is used to discount the future cash inflows and outflows. If the present value of the inflows is greater than the outflows or the net present value is greater than zero, then the project is financially attractive. However, a rate is needed in order to discount and some companies find it difficult to estimate a realistic rate. Another problem with net present value is that to compare different projects they must have the same project lives. This is rarely the case, so usually several replacement cycles of the project must be analyzed in order to achieve comparability and it may not be valid to assume the company will go through these replacement cycles.

b) Internal Rate of Return

This method overcomes the problems of obtaining a discount rate and the unequal project lives. The method involves applying various discount rates until one is found that makes the present value of the cash inflows equal the present value of the outflows. This is the rate that the inflows will return on the investment as well as pay off the investment. Differences in project life do not affect the comparison between projects. The method makes the implicit assumption that the company can reinvest the cash coming off of the project at the same interest rate that the project is returning and this may not be valid. This method assumes the company's objective is to maximize the rate of return which also may not be valid. However, it is a method that allows you to say that if X dollars are invested in this project, then the project savings will generate a rate of return of Y percent as well as pay off the initial investment.

c) Equivalent Annual Cost or Worth

This is calculated by converting the net present value to a series of equal annual payments. Whether costs or savings are used will depend on whether it is decided to look at the status quo and new project separately or on a net basis. If the two are examined separately, then the one with the lowest equivalent annual cost is chosen. If the projects are examined on a net basis, then the equivalent annual worth is calculated and can be compared to other competing projects to decide which one is more attractive. This method overcomes the problem of unequal project lives that is inherent in the net present value method.

d) Other Methods

There are other methods available to determine the economic attractiveness based on discounted after-tax cash flow. Sometimes, these systems come as a package and involve tables, graphs and rules. As a result, they have an advantage in larger companies where the method will be followed uniformly. However, some people may follow the method without understanding it. Some of the systems take into account the amount of investment in a project. This is significant when capital is rationed. It is possible for one large project with a high rate of return to use up all the company's capital and prevent several smaller projects with slightly lower rates of return from being built. If the large project costs more to build or to operate than planned, the company may have been better advised to invest in the smaller projects and spread the risk. Also, these methods stress return on investment rather than interest rate. One system ranks competing projects on the basis of the highest to lowest equivalent annual worth ratio which is obtained by dividing the equivalent annual worth into the investment.

4. Sensitivity Analysis

When a financial analysis of a sortyard project is being prepared, factors should be considered that test the sensitivity of the project to changes in the assumptions about future conditions. Sensitivity analysis is, in essence, contingency planning concerned with "what if" questions. For example:

- How do the economics change if the construction costs are greater than estimated?
- How are the annual savings affected if the manday productivity in the yard is lower than planned?
- Can the new sorting system be implemented by the existing personnel from the sorting ground?

  Why are other existing sortyards not as productive as estimates for the proposed yard?
- Will the sorting and scaling improve as forecasted?
- Is the estimate of change in sinker loss accurate?
- What improvements could be made in the existing sorting ground to reduce the potential cost savings of the proposed sortyard?

Many more similar questions should be asked and the revised forecasts should be substituted into the financial analysis to determine what deviation from the original estimated value can be tolerated without jeopardizing the project.

D. PROJECT EXAMPLE

A company is planning to replace an existing sorting ground with a sortyard. The annual production volume is 150 000 cubic metres. The net investment, net operating savings, capital cost allowance, and after-tax cash flows will be calculated for an eight-year period. Using this information, the present net value and internal rate of return will be calculated and compared.

1. Net Investment

The company estimates the investment in the sortyard will be $2 000 000 before the yard starts operating, and an additional $900 000 for replacement equipment in the fifth year of operation. If the sortyard is built, $500 000 of equipment in the sorting ground will be sold because it is no longer required. If the sorting ground continues to operate, replacement equipment costing $400 000 will be needed in year five. The net investment is shown in Table III-2.

Table III-2. Net Investment.

Time (Years)	1 Investment in Sortyard ($)	2 Investment in Sorting Ground ($)	Net Investment (1 minus 2) ($)
0	2 000 000	500 000	1 500 000
1	—	—	—
2	—	—	—
3	—	—	—
4	—	—	—
5	900 000	400 000	500 000
6	—	—	—
7	—	—	—
8	—	—	—

2. Net Operating Savings

To obtain net operating savings it is necessary to calculate the costs and benefits for both the sorting ground and the proposed sortyard for each year of the project life or discount period. The difference is the net operating savings per year.

Inflation makes it difficult to use historic costs as a base for estimating future costs of the status quo alternative. The annual labour costs for the company are estimated by multiplying the number of men in each job class by the current rates (plus on-charges) and by budgeting operating hours. Budgeted or historical overtime percentages are included. The cost of maintaining and operating the facilities is estimated by using the latest costs plus an inflationary factor. The cost of operating and repairing equipment is calculated by using the expected average operating and repair cost over the life of the boomboats or other type of equipment. To arrive at the sortyard costs, the company uses the same estimating process. Estimates are built up from the basics, such as number of machines and men, the number of operating hours planned, the number of bundle wires to be used, the anticipated fuel consumption, etc. These estimates are checked where possible with the costs at operating sortyards.

Based on an annual production volume of 150 000 cubic metres, the operating costs of the sorting ground and sortyard are estimated at $395 700 and $448 527 per year, respectively. If a sortyard is built, then annual operating costs will increase by $52 827. The annual operating savings that result from improved sorting and scaling, reduction in sinker loss and reduced towing costs are estimated to be $642 750 in this example. The towing savings result from a bigger bundle and the sinker loss savings result from more bundling and no loss in the sorting process. The net operating savings per year are $642 750 minus $52 827 or $589 923.

Combining the net investment with the net operating savings over the eight-year period results in a positive cash flow of:

($589 923 x 8) - ($1 500 000 + $500 000) = $2 719 384

This is shown in the cash flow profile in Figure III-1.

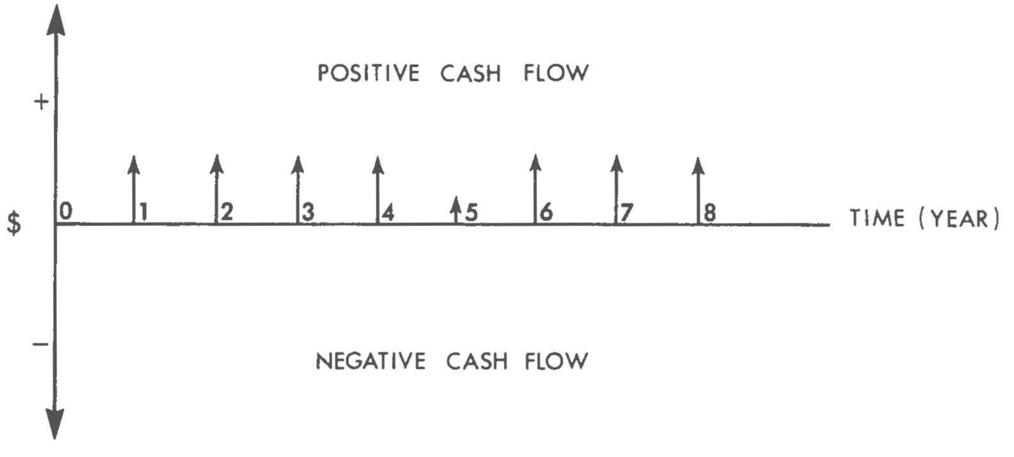


Figure III-1. Cash Flow Profile.

3. Capital Cost Allowance

To determine the real effect on the company's income statement and balance sheet, the cash flows should be done on an after-tax basis. To do this, the capital cost allowances resulting from the project have to be applied to the net operating savings and then the income tax deducted. Table III-3 illustrates the process of calculating the capital cost allowance.

Table III-3. Calculation of Capital Cost.

Year	Net Investment ($)	Balance ($)	CCA ($)
0	1 500 000	1 500 000	—
1	—	1 050 000	450 000
2	—	735 000	315 000
3	—	514 500	220 500
4	—	360 150	154 350
5	500 000	752 105	108 045
6	—	526 474	225 632
7	—	368 532	157 942
8	—	257 972	110 560

CCA 30% declining balance

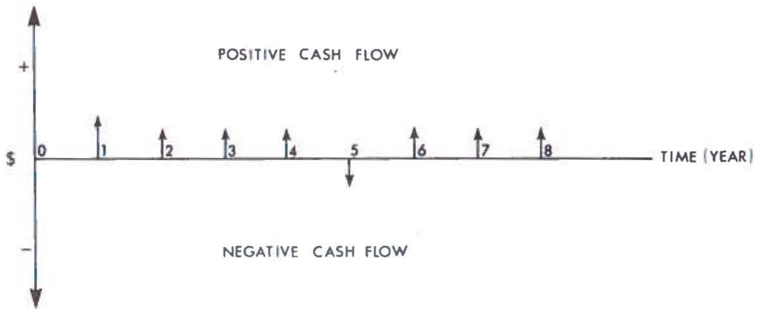
4. After-tax Cash Flow

Table III-4 shows the method for calculating the after-tax cash flow which is positive in all years except year 0 and year 5.

Table III-4. After-tax Cash Flow.

	PERIOD (YEAR)								
	0	1	2	3	4	5	6	7	8
(1) Net Operating Savings ($)	—	589 923	589 923	589 923	589 923	589 923	589 923	589 923	589 923
(2) Capital Cost Allowance ($)	—	450 000	315 000	220 500	154 350	108 045	225 632	157 942	110 560
(3) Savings - CCA ($) (1-2)	—	139 923	274 923	369 423	435 573	481 878	364 291	431 981	479 363
(4) Taxes @ 50% ($) (0.5 x 3)	—	69 962	137 462	184 712	217 787	240 939	182 146	215 991	239 682
(5) After-tax Savings ($) (3-4)	—	69 961	137 461	184 711	217 786	240 939	182 145	215 990	239 681
(6) Add Back CCA ($) (2+5)	—	519 961	452 461	405 211	372 136	348 984	407 777	373 932	350 241
(7) Investment Flow ($)	(1 500 000)	—	—	—	—	(500 000)	—	—	—
(8) After-tax Cash Flow ($) (6+7)	(1 500 000)	519 961	452 461	405 211	372 136	(151 016)	407 777	373 932	350 241

After-tax Cash Flow = 1/2 (Savings + CCA) - Investment



5. Net Present Value

The net present value of the cash flows shown in Table III-3 may be calculated using tables which give the present value factors for various interest rates by year. In this example, it is assumed that the company wishes to receive an after-tax rate of return of 15 percent (30 percent before-tax rate of return). The net present value calculation is shown in Table III-5. The net present value is $129 729 and, therefore, the project should be built. If the project is built and all estimates are correct, then the overall rate of return for the company of 15 percent will be increased by this project. The project can withstand some cost overruns in construction or slight increases in operating costs before it becomes uneconomic.

Table III-5. Net Present Value of Project.

Year	After-tax Cash Flows ($)	Present Value Factor @ 15%	Present Value of Cash Flows ($)
0	(1 500 000)	1.0000	(1 500 000)
1	519 961	.8696	452 158
2	452 461	.7561	342 106
3	405 211	.6575	266 426
4	372 136	.5718	212 787
5	(151 016)	.4972	(75 085)
6	407 777	.4323	176 282
7	373 932	.3759	140 561
8	350 241	.3269	114 494
		Net Present Value	129 729

6. Internal Rate of Return

Calculating the internal rate of return is similar to the net present value method except you are searching for the discount rate that makes the present value of the inflows just equal to the present value of the outflows. This calculation is shown in Table III-6 using the after-tax cash flow from Table III-4. It is evident that the after-tax internal rate of return is slightly less than 18 percent because that interest rate will make the present value of the cash inflows equal to the cash outflows. If the company has a hurdle rate of 15 percent, then the sortyard is an attractive investment.

Table III-6. Internal Rate of Return of Project.

Year	After-tax Cash Flow ($)	PV Factor @ 17%	NPV @ 17% ($)	PV Factor @ 18%	NPV @ 18% ($)
0	(1 500 000)	1.0000	(1 500 000)	1.0000	(1 500 000)
1	519 961	.8547	444 411	.8475	440 667
2	452 461	.7305	330 523	.7182	324 957
3	405 211	.6244	253 014	.6086	246 611
4	372 136	.5337	198 609	.5158	191 948
5	(151 016)	.4561	(68 878)	.4371	(66 009)
6	407 777	.3898	158 951	.3704	151 041
7	373 932	.3332	124 594	.3139	117 377
8	350 241	.2848	99 749	.2660	93 164
			40 973		(244)

E. NON-FINANCIAL FACTORS

Discounted cash-flow criteria provide measures of economic worth, but if the company has objectives of a non-monetary nature, these will not be measured in the financial analysis. An example of this would be a debris settling pond in a sortyard, which adds to capital and operating costs, but is essential for the project to receive government agency approval. In general, where environmental, safety, or public relations concerns have priority, financial measures will be overruled. However, if two or more sorting systems meet the needs of the non-financial factors, the one having the best financial return should be chosen.

PART V SORTYARD SITE SELECTION

This section on the selection of a sortyard site will examine the present and future log flow system, constraints in the system, possible sites and how they match the total log flow, financial analysis, qualitative site factors and recommendation. In short, this part of the handbook will detail the analysis that should be done by the total system project team.

A. DOCUMENTATION OF THE PRESENT AND FUTURE LOG FLOW SYSTEM

The new dryland sortyard must fit the present and future log flow system of the company. The log flow system is a dynamic, interrelated series of functions which is probably operating reasonably well at present. Interjecting one or several sortyards may result in a less efficient system. To minimize this, it is necessary to understand and document the existing system in detail.

At the minimum, the team should strive for a documentation that includes the supply and demand for logs, location of camps and mills, species distribution, major sort identification, log size distribution, costs and flexibility of the system. While the documentation must measure and record the present log flow in detail, it must not ignore future company plans which may have an effect. Many companies have 20-year forest management plans and five-year logging plans. These must be examined for any major shift in log supply. Forest management plans may show significant changes in log sizes or species distribution. In addition, most companies have long range development plans which may indicate changes in demand for logs.

A hypothetical forest products company is used to illustrate the documentation procedure. The company has logging and mill operations on the B.C. mainland coast and Vancouver Island.

1. Supply of Logs

Where do they enter the system? What volumes of logs are processed at each location annually? This information describes the resource on which the system operates and also defines the size or production level of the system. A documentation of the sources and volume of all logs may allow concentration of effort and analysis in a few specific areas because they generate the majority of the log volumes.

The log supply base for the hypothetical forest products company is shown in Table V-1.

Table V-1. Log Supply by Source - Present and Future (Hypothetical Company).

	Present				Future (5 Years)			
Supply	**Pieces**	**%**	**m³**	**%**	**Pieces**	**%**	**m³**	**%**
Company Production	1 468 000	91	1 700 000	89	2 132 000	89	1 900 000	86
Outside Purchases	141 000	9	200 000	11	254 000	11	300 000	14
Total	1 609 000	100	1 900 000	100	2 386 000	100	2 200 000	100
Source of Supply								
Company Production								
Mid Island	1 025 000	64	1 128 000	59	1 266 000	53	1 128 000	51
South Mainland	290 000	18	345 000	18	252 000	11	250 000	11
North Mainland #1	153 000	10	227 000	12	434 000	18	322 000	15
North Mainland #2	—	—	—	—	180 000	8	200 000	9
Outside Purchases								
Howe Sound	110 000	7	150 000	8	214 000	9	250 000	11
Fraser River-Lower	31 000	2	50 000	3	40 000	2	50 000	2
Total	1 609 000	100	1 900 000	100	2 386 000	100	2 200 000	100

In this hypothetical company, only 9 percent of the logs currently handled are outside purchases and they are bought relatively close to the mills. In most cases, purchased logs are already sorted and have a small influence on the company's log flow system and the selection of a sortyard site. The lower half of the Island and Mainland contribute 90 percent of the logs to the sortyard.

PART IV PROJECT ORGANIZATION

PART IV PROJECT ORGANIZATION

At some point in time a company may realize there is a need to add to, change in part, or change totally the log sorting system. At this time it is advisable for the management to consider the organization of the project.

A. PROJECT SCOPE

At an early stage it is important to decide whether the project is large or small, and what effect it has on the log supply system. If the project is far reaching, the organization and people involved in the planning process will vary considerably from those involved in a project which has local effects that do not impact on other functions within the log flow system.

1. Total Log Flow System

If the project is such that the whole log flow system is under review or the change contemplated will affect other groups or functions, the project team must have contact with and fit within this large organizational structure. The concerns of logging management, marine transportation, log supply and mill management must be listened to and reconciled if the project is to be a financial and operational success. The conceptual plan should be accepted by these groups and the project team should be positioned in the organization so that acceptance is likely.

2. Specific Sortyard

If the project is confined to a single sortyard which does not alter any of the parameters for marine transportation, log supply, or mill management, the project team will be effective if it fits within the local management group.

In many cases, a large project encompassing the total log flow may be broken down into several single sortyard projects after the initial conceptual plan is approved. In this way, the general location and design of the sortyard gets the overall approval of the company and site specific problems are dealt with by a local management group. It is advisable to have one or more of the conceptual design group on the specific sortyard team to provide continuity.

B. PROJECT TEAM

To plan, design and construct a single, or several sortyards, takes many skills which are not likely to be found in one person. For a plan to be perfected and delineated requires constant attention and focus. For these reasons, successful sortyard projects are generally designed and constructed by project teams.

1. Team Members

Usually a three to five person group is best, inviting others with a particular expertise onto the team on an as-required basis. The core team should include people with a good background in forest engineering, sortyard design, sortyard operations and accounting. One member of the team should be designated the team leader or manager.

If the purpose of the project team is to examine the overall log flow, the team should include generalists with a sound background of the overall coastal industry. In particular, knowledge of, or skills in, long range log supply, logging, log scaling and sorting, water transportation, mill requirements and financial accounting are important. The team members should have a capability to conceptualize and think in broad terms.

If the project team is to be responsible for the design and construction of a particular sortyard, their background should be similar but with a better knowledge of detail. For example, a knowledge of construction, equipment performance, space requirements, productivity, crewing, yard operation and cost accounting are necessary. This team must have the capability to work with specifics and detail. At this stage, personnel who will eventually operate the yard should be team members or involved in the detailed planning and estimating process. As mentioned before, it works well to have one or more members of this sortyard project team from the total system group.

2. Responsibilities

a) Total System Project Team

The team's responsibilities include:

- determining the present and future log flow system;
- analyzing constraints in the system;
- geographic site selection;
- financial analysis of the options;
- considering non-financial factors; and
- recommending a system.

These duties are detailed in Part V of this handbook.

b) Specific Sortyard Project Team

The project team and its specific responsibilities may include:

Logging Engineer

- Subsurface drilling program if dredging or filling required
- Soil analysis of potential sources of fill and aggregate material
- Survey of site to determine cut and fill volumes
- Sources of rip rap material
- Location of spoil sites
- Location of water supply
- Analysis and selection of construction method for site preparation
- Analysis, design and recommendation of final designs for booming grounds, floats, buildings, settling ponds, fire suppression system, sewage system, potable water system, spill containment, night lighting, security fencing, dump ramp, marine railway
- Design of running surface, asphalt mix design, compaction standards, concrete mix design
- Preparation of documents for solicitation of bids
- Solicitation, analysis and recommendations on quotations for all construction projects
- Application for necessary permits for sewage, water supply, electrical, building, etc., discussions with regulatory agencies
- Accumulation and presentation of cost estimates for individual construction projects

Designer

- Design, analysis and recommendation of sorting system, area requirements, layout of reloading, spreading, sorting, bundling, dumping and storage areas
- Assistance in design and location of booming ground facility, marine railway, dump ramp, yard surface profile
- Determination of manpower and equipment requirements
- Establishment of sorting and booming cost

- Analysis and recommendation of grading, scaling and bucking systems
- Analysis and design of sorting bunks, bundling systems, log accounting system, boomstick boring method
- Solicitation of quotations on machinery, equipment and supplies
- Preparation and presentation of costs of sorting equipment, personnel and supplies
- Job description and job priorities for machine operators

Accountant

- Assemble cost information from engineer and designer and prepare rate of return calculation for project
- Set up project cost accounting and reporting system
- Set up variance analysis reporting
- Set up purchase order preparation and approval system
- Set up asset receipt, payment and control system
- Perform normal accounting functions for project

Operations Man

- Act as operations advisor to designer and engineer
- Advise on feasibility and practicality of designer's estimates of manpower and machine productivities, etc.
- Set up crew retraining and/or training program
- Become completely knowledgeable about reasons for design and construction features and objectives of sorting system

3. Reporting Structure

The project team and, in particular, the project leader should report to and work for a single group or individual. The total system project team should be controlled by the general manager or vice-president in charge of forestry, logging and the supply of logs to the converting plants. The specific sortyard project team should include or report to the appropriate logging manager or individual responsible for the function or geographic area where the yard is located.

Also at this stage, funds should be supplied to the group and a project proposal deadline established. Further, a formal scheduling system should be drawn up to show individual responsibilities, due dates and how all the various sub-projects tie together.

PART V SORTYARD SITE SELECTION

PART V SORTYARD SITE SELECTION

This section on the selection of a sortyard site will examine the present and future log flow system, constraints in the system, possible sites and how they match the total log flow, financial analysis, qualitative site factors and recommendation. In short, this part of the handbook will detail the analysis that should be done by the total system project team.

A. DOCUMENTATION OF THE PRESENT AND FUTURE LOG FLOW SYSTEM

The new dryland sortyard must fit the present and future log flow system of the company. The log flow system is a dynamic, interrelated series of functions which is probably operating reasonably well at present. Interjecting one or several sortyards may result in a less efficient system. To minimize this, it is necessary to understand and document the existing system in detail.

At the minimum, the team should strive for a documentation that includes the supply and demand for logs, location of camps and mills, species distribution, major sort identification, log size distribution, costs and flexibility of the system. While the documentation must measure and record the present log flow in detail, it must not ignore future company plans which may have an effect. Many companies have 20-year forest management plans and five-year logging plans. These must be examined for any major shift in log supply. Forest management plans may show significant changes in log sizes or species distribution. In addition, most companies have long range development plans which may indicate changes in demand for logs.

A hypothetical forest products company is used to illustrate the documentation procedure. The company has logging and mill operations on the B.C. mainland coast and Vancouver Island.

1. Supply of Logs

Where do they enter the system? What volumes of logs are processed at each location annually? This information describes the resource on which the system operates and also defines the size or production level of the system. A documentation of the sources and volume of all logs may allow concentration of effort and analysis in a few specific areas because they generate the majority of the log volumes.

The log supply base for the hypothetical forest products company is shown in Table V-1.

Table V-1. Log Supply by Source - Present and Future (Hypothetical Company).

	Present				Future (5 Years)			
Supply	**Pieces**	**%**	**m^3**	**%**	**Pieces**	**%**	**m^3**	**%**
Company Production	1 468 000	91	1 700 000	89	2 132 000	89	1 900 000	86
Outside Purchases	141 000	9	200 000	11	254 000	11	300 000	14
Total	1 609 000	100	1 900 000	100	2 386 000	100	2 200 000	100
Source of Supply								
Company Production								
Mid Island	1 025 000	64	1 128 000	59	1 266 000	53	1 128 000	51
South Mainland	290 000	18	345 000	18	252 000	11	250 000	11
North Mainland #1	153 000	10	227 000	12	434 000	18	322 000	15
North Mainland #2	—	—	—	—	180 000	8	200 000	9
Outside Purchases								
Howe Sound	110 000	7	150 000	8	214 000	9	250 000	11
Fraser River-Lower	31 000	2	50 000	3	40 000	2	50 000	2
Total	1 609 000	100	1 900 000	100	2 386 000	100	2 200 000	100

In this hypothetical company, only 9 percent of the logs currently handled are outside purchases and they are bought relatively close to the mills. In most cases, purchased logs are already sorted and have a small influence on the company's log flow system and the selection of a sortyard site. The lower half of the Island and Mainland contribute 90 percent of the logs to the sortyard.

Within 5 years, the company plans to increase its log volume from 1 900 000 cubic metres to 2 200 000 cubic metres or 10 percent. The north Mainland production will increase 130 percent and log purchases will increase 50 percent. While the log volume from the camps will increase 12 percent, the piece count will increase 45 percent. The sortyard design must make allowance for this significant increase in the number of pieces.

2. Demand for Logs

Where do the logs go? Where are the log consumers located? These questions are answered in Table V-2.

Table V-2. Log Demand by Location - Present and Future (Hypothetical Company).

	Present				Future (5 Years)			
Demand	**Pieces**	**%**	**m^3**	**%**	**Pieces**	**%**	**m^3**	**%**
Company Mills	1 169 000	73	1 135 000	60	1 789 000	75	1 870 000	85
Outside Sales	440 000	27	765 000	40	597 000	25	330 000	15
Total	1 609 000	100	1 900 000	100	2 386 000	100	2 200 000	100
Location of Demand								
Lower Fraser River	625 000	39	603 000	32	953 000	40	880 000	40
New Westminster	385 000	24	259 000	14	430 000	18	550 000	25
Victoria Mill	199 000	12	273 000	14	—	—	—	—
Howe Sound Mill	—	—	—	—	406 000	17	440 000	20
Howe Sound Sales	440 000	27	765 000	40	597 000	25	330 000	15
Total	1 609 000	100	1 900 000	100	2 386 000	100	2 200 000	100

Table V-2 indicates that 63 percent of the logs are consumed on the Fraser River, with an additional 27 percent sold in the Howe Sound area, so consumption is concentrated in the Vancouver area. The table also indicates that the company utilizes primarily its smaller-sized logs and sells its larger-sized logs.

It can be seen that the company is not only planning to increase overall usage from 1 900 000 cubic metres to 2 200 000 cubic metres but also to increase internal consumption from 1 135 000 cubic metres to 1 870 000 cubic metres or 65 percent. In addition, the Victoria mill will be closed so that all logs will flow into the Vancouver/Howe Sound area. The company will increase the range of log sizes it uses within the company mills.

3. Volume-Distance Relationship

From the locations and volumes of log source and demand, it is possible to establish the volume-distance relationship. This relationship is presented pictorially in Figure V-1 and gives an insight into the operation of

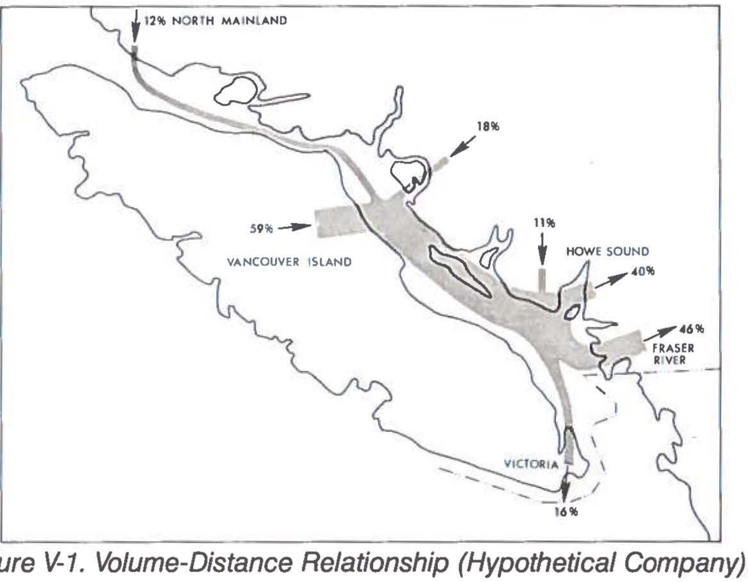


Figure V-1. Volume-Distance Relationship (Hypothetical Company).

the company. It indicates potential areas where (or where not) to locate a dryland sortyard. For example, it would be worthwhile investigating the potential of building a large central sortyard at the major intersection of the three log flows midway down Vancouver Island. On the other hand, the company may want all wood sorted and bundled before it enters the water and so may want sortyards in each operation.

Figure V-2 is a schematic of the volume-distance relationship shown in Figure V-1 with the addition of the future flows.

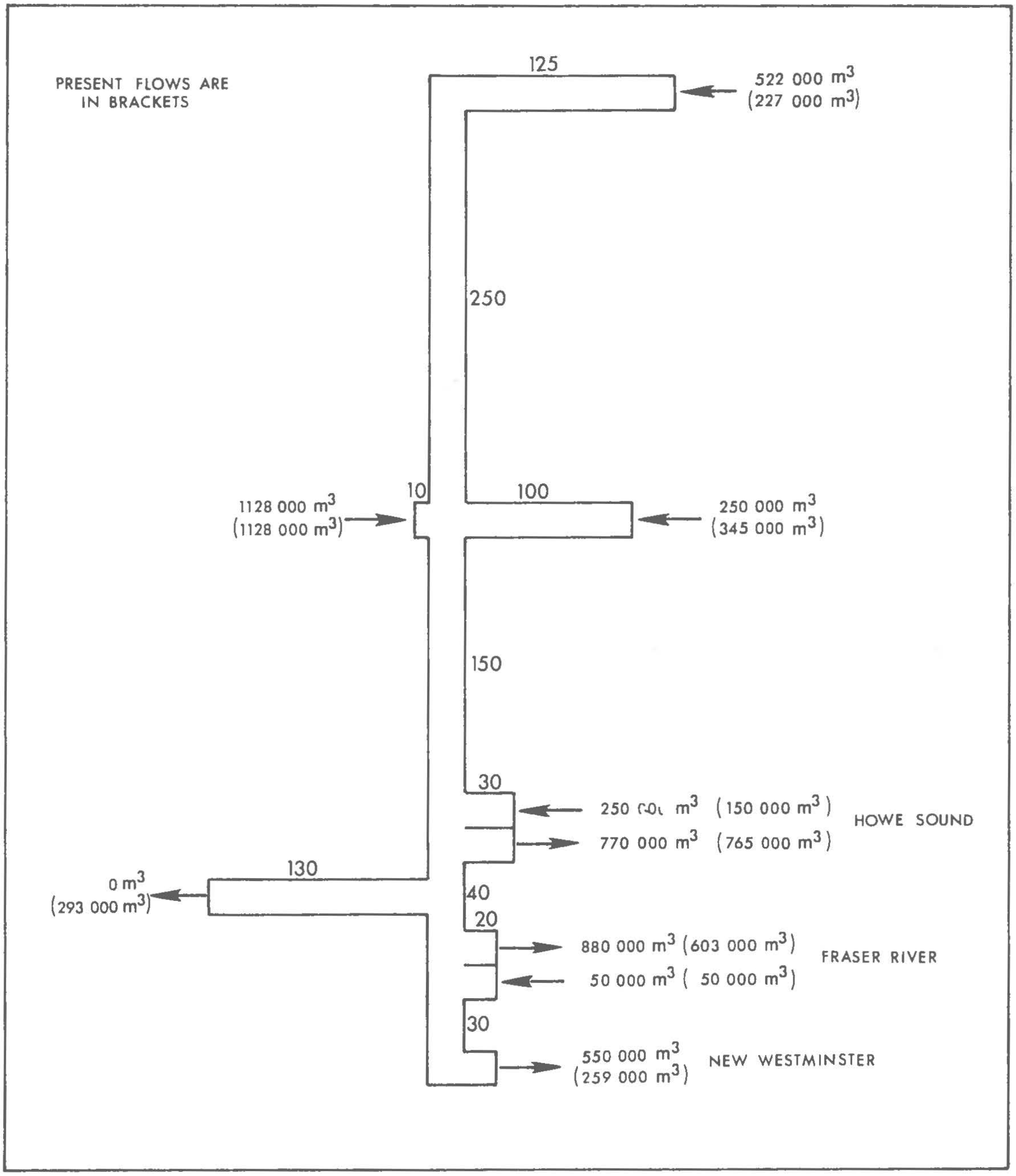


Figure V-2. Schematic of Volume-Distance Relationship - Present and Future.

The volume-distance diagram shows that over the next five years more logs will be entering the northernmost end of the pipeline and more will be exiting the southernmost end. There will be no log flow to Vancouver Island and the flow into and out of Howe Sound will stay the same.

4. Species Distribution

The documentation must include the distribution of the log species to give the raw material mix to be sorted. It may also identify concentrations of species that can be presorted before the logs arrive at the sortyard. The species distribution can be reasonably estimated by using either the previous year's scale records or the current year's logging plan.

The future species and size distribution is taken from the five-year plan. The foresters and engineers should review this to ensure that their forecast of future log sizes is realistic. Table V-3 shows a comparison of present and future species and log sorts.

Table V-3. Comparison of Present and Future Species and Log Sorts (Hypothetical Company).

	Present				Future			
Log Sorts	**Pieces**	**%**	**m³**	**%**	**Pieces**	**%**	**m³**	**%**
Fir								
Peeler	68 660	5	184 470	11	66 400	3	162 000	7
Sawlog	71 060	5	66 760	4	97 700	4	83 400	4
Pulp	36 680	2	37 770	2	55 900	2	48 200	2
Subtotal	176 200	12	289 000	17	220 000	9	293 600	13
Hembal								
Sawlogs								
15.2-35.6 cm	322 130	22	185 180	11	691 900	29	330 200	15
35.6-58.4 cm	197 130	13	326 550	19	266 400	11	400 200	18
> 58.4 cm	31 810	2	118 040	7	40 100	2	135 300	6
Pulp	396 090	27	262 220	15	638 400	27	353 200	17
Subtotal	947 160	64	891 990	52	1 636 800	69	1 218 900	56
Cedar								
Lumber/Shingle	95 210	6	232 880	14	139 600	6	310 400	14
Merch	106 180	7	96 260	5	209 100	9	172 300	8
Pulp	18 810	2	10 860	1	52 600	2	25 300	1
Subtotal	220 200	15	340 000	20	401 300	17	508 000	23
Cypress								
Sawlogs	65 710	4	76 900	5	74 500	3	87 100	4
Pulp	7 690	1	8 100	—	9 900	—	10 400	—
Subtotal	73 400	5	85 000	5	84 400	3	97 500	4
Balsam								
Peeler	51 040	4	94 010	6	44 500	2	82 000	4
Subtotal	51 040	4	94 010	6	44 500	2	82 000	4

As shown, 78 percent of the present log volume is hemlock/balsam/cedar and 52 percent of the pieces are in hembal sorts. Consideration should be given to sorting logs in the landing into three sorts — hembal, cedar and other — as a method to increase the productivity of the sortyard. Also, it can be seen that the fir and cedar logs are large and the hembal logs are basically small. The species and log size mix are significant in selecting the type and size of material handling equipment and systems.

In five years, the company will have shifted to more cedar and hemlock/balsam. The predominant shift in grade will be into more of the hembal peewee (15.2-35.6 cm) sort. Five years hence, 76 percent of the pieces will be in four sorts (hembal peewee, gang, pulp and cedar merch). From a dryland sorting viewpoint, this is an advantage because these sorts could be processed continuously through the sortyard and boomed into rafts.

5. Log Size Distribution

Size distribution, as well as average piece size, is important to determine the type of sorting system and the required equipment size and speed. This information can be obtained from the previous year's scale records or operational logging plan information (see Table V-4).

Table V-4. Size Distribution (Hypothetical Company).

Size Distribution (Butt Diameter) (cm)	Pieces	%	m^3	%
12.7 - 17.8	202 600	13.8	39 100	2.3
17.9 - 30.5	512 300	34.9	238 000	14.0
30.6 - 43.2	367 000	25.0	282 500	16.6
43.3 - 55.9	231 900	15.8	425 000	25.0
56.0 - 68.6	98 400	6.7	374 000	22.0
> 68.7	55 800	3.8	341 400	20.1
Total	1 468 000	100.0	1 700 000	100.0

In Table V-4, almost 74 percent of the logs are less than 43.2 cm (17") at the butt. However, they account for only 33 percent of the volume. The sortyard will have to process a relatively large number of small logs in order to achieve production volume goals. The piece average is 1.16 cubic metres.

6. Variations in Average Piece Production Rate

In most logging operations, the daily production varies significantly from month to month as the logging areas are changed through the year. Traditionally, piece production rates are greater in the summer when smaller, high elevation timber is being logged and lower in the winter when larger, old growth, low elevation stands are logged. However, this may change if some of the low elevation stands are second growth.

Table V-5 lists the months when the variation from the average daily piece rate is greatest.

Table V-5. Variation in Daily Piece Production (Hypothetical Company).

Month	Present % of Average Daily Piece Production Rate	Future % of Average Daily Piece Production Rate
June	97%	94%
July	91%	90%
August	106%	107%
September	121%	133%
October	103%	110%
Average Daily Piece Production Rate	5 125	6 320

As can be seen, the September piece rate is 21 percent higher than the average and will be 33 percent higher than the average in the future. The material handling system and yard layout should have the flexibility to handle these surges.

7. Logging Costs

In order to put the production system in perspective, it is valuable to document the costs of the system by function. In this way, the more costly functions can be indicated. The range and average of logging costs for the three logging divisions of the hypothetical company are given in Table V-6.

Table V-6. Range of Logging Costs (Estimated 1982).

Function	Range Total Cost/m3 ($)	Average Total Cost/m3 ($)
Falling & Bucking	3.00 - 4.50	3.75
Yarding	7.00 - 11.00	9.00
Loading	2.00 - 3.00	2.50
Truck Haul	2.00 - 7.50	4.75
Sorting & Booming	6.00 - 9.00	7.50
Road Maintenance	0.50 - 2.00	1.25
Road Amortization	0.50 - 5.00	2.75
Camp Indirect	8.00 - 15.00	11.50
Stumpage & Royalty	3.50 - 10.00	6.75
Towing & Marketing	4.00 - 6.00	5.00
Total Cost		54.75

Total Cost = Operating Cost & Ownership Cost

Sorting, booming, towing and log selling expenses account for a cost of $12.50 per cubic metre or 23 percent of the total logging costs. In addition, a portion of camp indirect costs should also be allocated to these costs. The final result is that sorting, booming, towing and log selling expenses probably account for over 25 percent of total cost of getting the logs from the stump to the mill. If several million dollars are to be invested in dryland sortyards and sorting, then these functions need more attention than they have been given traditionally.

8. Location of Bottleneck

Every system has a bottleneck which limits production. If it is relieved, the overall cost is reduced.

Using a combination of production statistics and observations of the logging system, it is possible to locate the bottleneck. In most cases, the loggers will know its location and collecting the data will document their conclusions. In the case of the larger logging division in the hypothetical forest products company, the data that was collected to identify the bottleneck is given in Table V-7.

Table V-7. Bottleneck Analysis (Hypothetical Company).

Function	Planned Operating Hrs/ Machine/Year	Actual Operating Hrs/ Machine/Year	Actual Op Hrs/ Planned Op Hrs
Yarding	1 695	1 440	0.85
Loading	1 690	1 724	1.02
Truck Haul	1 695	1 744	1.03
Dumping	2 120	2 631	1.24
Sorting & Booming	1 690	2 031	1.20

The bottleneck occurs at the operation that has to work the most additional hours relative to planned hours. In the case of this logging division, the bottleneck to production is the log dump and sorting and booming ground. After it is relieved, the bottleneck will probably shift to either the loading or truck haul phases. The construction of a dryland sort at the existing sorting ground could relieve the bottleneck. If the dryland sortyard is centralized and not located at this logging division, then the capacity of the log dump should be increased. By first locating the bottleneck in the logging system, it is possible to forecast the likely effect of introducing a dryland sortyard to the system.

9. System Flexibility

The demand for wood products varies and this is eventually transferred back to the logging division. How quickly can the logging divisions respond? Can the dryland sortyard be located and designed to improve flexibility? Table V-8 gives the system flexibility from a strategic or planning viewpoint and Table V-9 gives the flexibility from an operational viewpoint.

Table V-8. System Flexibility - Strategic.

Function	Time Function Performed
Planning	Now
Operational Cruising	1 year from now
Engineering	2 years from now
Road Building	2-3 years from now
Logging	4 years from now
Slashburning	5-6 years from now
Reforestation	5-6 years from now

Table V-9. System Flexibility - Operational.

Function	Delay Time
Falling to Dump	18 weeks
Booming & Storage at Camp	3 weeks
Towing & Storage to Howe Sound	3 weeks
Towing & Storage to Mills	8 weeks
Millpond Handling	1 week
TOTAL	33 weeks

From Table V-8, it is evident that under normal circumstances the planning required to log a particular area starts four years before logging. If the logging plan was completely inflexible, then any change would require four years to get through the system. Of course, the planners design flexibility into the logging plan so that options are available for changes. Thus, it becomes the operational restrictions which limit flexibility (Table V-9).

The average log in this company takes 33 weeks to get from the stump to the mill. This is too much time to take advantage of log market fluctuations. If the planners have allowed enough flexibility in the plan, then it may be possible to switch the fallers into a developed setting in order to get a desired species to the mill quicker. Also, if a desired species is already in the system, it may be possible to get it to the mill faster by shortening the storage times or by shipping directly to the mill. It may be possible to buy or trade for a desired species but most likely other companies will also be wanting that species and a premium will be paid. The log sortyard can supply more or less of a grade within a species by emptying storage or by temporarily changing the sorting standards and bucking rules. However, if there is not enough of the desired species in the system, then nothing can be done at the sortyard to improve the situation.

B. CONSTRAINTS IN THE SYSTEM

In addition to documenting the present and estimating future trends, it is also important to determine the constraints placed on the sortyard. These constraints likely will be:

1. Number of Log Sorts

The logging manager, log trader and mill manager will all have different points of view regarding the number and type of log sorts required. The logger may want to ship everything unsorted. The log traders may want logs sorted by species, grade and diameter classes. Finally, the mill manager may want the logs sorted into rough grades that can be blended together at the mill. Whatever their viewpoints, it is important to get the three parties to agree upon the present and future sorts before the yard is designed. The sortyard designer and yard operators should try to accommodate the needs of the log traders and mill personnel but must remember that it is the yard which will bear the cost of additional log sorts. In small camps, it may not be practical to make all the required sorts because of the low volume. It may be more economic to accumulate these sorts from several operations and re-sort them nearer the mills. Whatever the case, the overall benefit to the company should exceed the cost.

2. Maximum Log Handling Capabilities

The yard must not only handle the average production but must accomodate the peaks. From the sources and volumes of logs, it is possible to estimate the maximum short term requirements at each of the potential sortyards. The capabilities should include present and future variations as well as the averages. This is given in Table V-10.

Table V-10. Present & Future Log Handling Capabilities (Pieces/Day) (Hypothetical Company).

	Present		Future	
	Average	Maximum	Average	Maximum
North Mainland #1	850	1 065	2 410	3 015
North Mainland #2	—	—	1 000	1 250
South Mainland	1 815	2 360	1 575	2 050
Mid Island	4 880	5 905	6 030	8 020
Mid Island Central	5 870	7 340	8 530	11 090

The averages and variations should reflect the historical operating days for each camp and the historical monthly variation in piece production as well as estimates of the future variations. The large central yard has an advantage in that it can operate 250 days or more per year. The smaller yards associated with logging divisions are constrained to work about the same number of days as that division. Historically, this has been in the 180-200 days/year range.

3. Mill Requirements or Restrictions

Some of the company mills or log customers may have special sorting or bundling requirements. The two main restrictions on the B.C. coast are the maximum weight of a log bundle and the maximum width of the log bundle when unrestrained. Other less frequent restrictions are straightness of log, type of bundling material and preference for long logs. The requirements must be accommodated in the design of the yard.

4. Environmental Constraints

There is a procedure to follow during the design and construction phases in obtaining the necessary environmental approvals and permits (see Appendix I). Each location will have restrictions, depending upon the site. However, there are basic environmental constraints that apply to all yards. If these constraints are not met, then there is very little chance of gaining approval and other sites should be investigated. These constraints include:

- protecting fish habitat near streams;
- minimizing earth fill in inter-tidal areas;
- avoiding shallow water in estuaries;
- minimizing bark removal during dumping;
- minimizing the discharge of debris, oil and chemicals into the water;
- minimizing smoke, dirt and noise; and
- being prepared for specialized or time-limited construction techniques at sites with potential environmental problems.

More information is given in Appendix II, which includes sections from "A Handbook for Fish Habitat Protection on Forest Lands in British Columbia", D.A.A. TOEWS, M.J. BROWNLEE, Department of Fisheries and Oceans and "Estuary, Foreshore and Water Log Handling and Transportation Study", Summary Report of the Steering Committee - July, 1981.

The initial design of the location, layout and size of a dryland sortyard can avoid potential conflicts and will increase the chance for approval. However, there will be times when the cost of the constraint versus the benefit to the environment will be questioned and the team must be able to substantiate its cost estimates.

The proposed sortyard must fit into the system with a minimum of disturbance and have enough flexibility to accommodate variations and restrictions. The team must fully understand and document the system and the constraints before it proceeds to the next section on site location.

C. SITE SELECTION

In this section, we will outline the method to evaluate potential sortyard sites, to choose the best site and to begin to prepare the project proposal. The example of the hypothetical forest products company will be used to emphasize the importance of considering the total log flow system.

1. List of Available Sites

All potential sites which meet the basic requirements of deep water, protection from wind, minimal tide influence and reasonable construction costs should be listed. This will include sites near the present log dumps and booming grounds and those near a confluence of log flows.

It is essential for team members to visit and examine each site and to solicit comments from the local management, operating people, long term residents and regulatory agencies.

2. Advantages and Disadvantages of Available Sites

Items to consider when establishing the suitability of a site include:

- operating costs;
- the ownership of the land and foreshore leases;
- the cost of purchasing the land and obtaining the foreshore leases;
- potential environmental conflicts;
- ease of construction;
- suitability for booming and water storage (i.e. exposure to wind, ice, high water, low water, etc.);
- compatability or disruption to existing operations;
- access for crew and services; and
- likelihood of obtaining regulatory agency approval.

When comparing sites, it is useful to use a one-to-ten (bad to favourable) ranking system. Although it does not weight the importance of the various characteristics, it serves at this stage as a rough guide and can reduce the list for closer examination of the better sites. For the hypothetical company, the potential sites are listed below and ranked in Table V-11. Sites located near the Fraser River and Victoria mills are excluded because of high land costs and the need for a backflow of logs to Howe Sound. The potential sites are:

(a) three tidewater sites at the Northern Mainland camp (i,ii,iii);

(b) existing sorting ground site at Northern Mainland camp;

(c) Northern Mainland new site at confluence of flow;

(d) three tidewater sites at mid Vancouver Island camp (i,ii,iii);

(e) existing sorting ground site at South Mainland camp;

(f) confluence of all logging camp flows; and

(g) Howe Sound area.

Table V-11. Ranking of Potential Sites.

Items	Sites a i	a ii	a iii	b	c	d i	d ii	d iii	e	f	g
Operating Cost	7	7	7	8	8	10	10	10	6	9	9
Ownership	10	9	6	10	6	10	9	7	10	9	9
Cost of Ownership	10	9	6	10	6	10	9	7	10	9	9
Foreshore & Leases	10	9	8	10	6	10	9	7	10	9	9
Cost of Foreshore & Leases	10	9	8	10	6	10	9	7	10	9	9
Environmental Conflict	2	9	10	10	10	3	8	7	7	8	9
Ease of Construction	1	9	8	6	6	5	8	4	5	8	6
Potential Disruption	5	10	10	5	10	5	10	6	5	10	10
Isolated Camp	2	2	2	2	2	8	8	8	8	8	8
Regulatory Agencies	2	9	7	10	10	3	7	8	7	7	6
TOTAL	59	82	72	81	70	74	87	71	78	86	84

From the ranking, it would appear that the sites with a total greater than 80 are worthy of a closer look and others eliminated.

3. Matching the Site to the Total Log Flow

The ranking in Table V-11 poses the question whether to have a series of sortyards at the camps or a centralized sortyard at one of two locations. However, the alternative of a combination of satellite yards and a centralized yard should not be overlooked.

Locating a sortyard at each of the camps or in the two centralized areas would not result in backflows (see Figure V-1). The two centralized sites would require the logs to be lifted out of and put back into the water which will add to costs. However, if one of the centralized sortyards was next to the new Howe Sound mill, then only part of the logs would be handled twice.

Location of a sortyard at the mid Vancouver Island operation or at either of the centralized sites would remove the bottleneck presently occuring at the mid Vancouver Island sorting and booming ground. The other camps do not have bottlenecks at their sorting grounds. The logs from the Northern Mainland camp are presently transported by barge to Howe Sound where they are dumped and sorted at a custom sorting and booming ground. If a dryland sortyard was built at either of the Northern camps, then the sorted logs would still be brought from there by barge. This could cause some inefficiency because 10 to 20 percent of the bundles which break during barge dumping would have to be resorted. It could also cause serious scaling and accounting problems.

Centralized log sortyards have the potential to increase the speed of delivery from logging operation to mill and reduce the log inventory because everything flows through one location and is easier to control. Also, lower volume sorts can be accumulated quicker and booms produced sooner. Furthermore, it is easier to introduce changes in bucking and sorting standards at one location rather than several.

D. FINANCIAL ANALYSIS OF THE OPTIONS

1. Capital and Operating Costs of Competitive Sites

It is necessary to establish the costs of operating and building each of the dryland sort alternatives in order to complete the ranking of the sites. To make this a fair comparison, the same sorting system should be considered for each site. However, once a site is selected, every effort should be made to design a sorting system that is the most efficient and cost effective.

The sorting system proposed for each of the dryland sortyards at these logging operations is:

- truck unloaded with stacker or front-end loader;
- logs spread on asphalt surface;
- logs graded, marked and scaled;
- logs sorted and bunched with a mobile log loader;

  bunches forwarded by front-end loader to bunks for bundling;
- bundles dumped into water; and
- bundles made up into booms.

The sorting system at the centralized sortyards would differ slightly in that bundles of unsorted logs would arrive by water. They would be dewatered by a marine railway where the bundle wires would be removed.

At this stage, the estimates of construction and operating costs do not have to be as accurate as needed for the final request for funds. Construction companies can offer advice but should not be expected to provide quotations. Equipment distributors are usually willing to give budget-purpose quotations on their equipment and an estimate of repair, maintenance and operating costs. It is advisable to visit several existing dryland sortyards to become familiar with staffing levels, sorting systems and operational problems. On these visits, it is important to allow ample time to observe how the yard operates and to preplan what questions to ask and what to look for. It is wise to assign each member of the group a list of questions and to discuss the answers after the field visit. Personnel who will operate the yard should be involved in the planning and estimation process at this stage.

Unit costs can be used for the construction cost evaluation. They can be obtained from local experience and other dryland sortyard operators. The following is a checklist that can be used in the development of the capital and operating cost estimate.

a) Construction at Site

i) Engineering - twenty percent of total construction costs - includes soil testing, surveying, drafting, volume estimation, quality control, layout.

ii) Site Preparation - primarily unit costing

- drilling and blasting - X dollars/m^3 (yard)
- dredging - mobilization and demobilization costs plus X dollars/m^3 (yard) for dredging
- stripping site - X dollars/m^3 (yard) or Y dollars/hour/machine
- preparation of waste disposal sites - Y dollars/hour/machine
- hauling waste material - Y dollars/hour/machine

iii) Site Construction - primarily unit costing but with some job costing

- pit run fill - X dollars/m^3 (yard)
- clearing and preparation of material supply sites - Y dollars/hour/machine
- compaction of fill - Y dollars/hour/machine
- crushed base - X dollars/m^3 (yard)
- asphalt base - X dollars/m^3 (yard)
- rip rap - X dollars/m^3 (yard)
- settling ponds - Y dollars/hour/machine

- services - drainage, sewer, electricity, yard lighting, fire suppression, dust suppression system, telephone lines, ambrosia beetle control
- buildings, shops, parking areas, fencing, oil spill containment
- log dump
- floats, boathouse
- sorting and booming ground, storage grounds

b) Equipment and Supplies - primarily from supplier's estimates

- sorting machines
- boomboats, tugs
- bundling equipment
- boomstick boring equipment
- sorting bunks
- lights, poles
- trailer reload, truck watering and fueling station
- unloading ramps
- crew transportation vehicles, service vehicles
- supervisors' vehicles
- shop equipment and supplies
- office equipment
- fire fighting equipment

c) Operating Costs - primarily standard costing

- labour - operators and crew
- supervision
- repair and maintenance parts and labour - percent of initial purchase price
- tires, fuels, lubricant, wear parts
- sorting and booming ground maintenance
- debris disposal costs
- wire rope or steel banding for bundling
- boomgear - chains, swifter wires
- dump machine maintenance
- electricity, water
- supplies
- chainsaws
- safety supplies
- scaling and log marking supplies

Using the foregoing checklists and suggestions, the following estimates of costs for the dryland sort sites for the hypothetical forest products company were made (Table V-12).

Table V-12. Estimated Sortyard Cost.

Site	Average Annual Volume (m^3)	Operating Cost/m^3 ($)	Capital Investment ($ million)
North Mainland #1	322 000	4.05	3.7
North Mainland #2	200 000	3.85	3.4
Mid Vancouver Island	1 128 000	2.80	9.1
South Mainland	250 000	4.70	4.0
Subtotal	1 900 000	3.37	20.2
Confluence Site	1 900 000	3.65	13.9
Howe Sound Site	1 900 000	3.65	14.9

As can be seen, if the company develops dryland sortyards at each logging operation, the total capital investment will be $20.2 million. The total annual cost of sorting and booming the logs at each operation would be $6.4 million. However, if unsorted logs were towed to centralized sortyards, the capital investment would be $13.9 to $14.9 million and the total annual cost of sorting and booming would be $6.9 million. In this case, booming operations would still have to be operated at the camps so the total cost of operating the centralized sortyards would be increased by $700 000 to $7.6 million. There would be no difference in towing costs with either system. From a purely economic point of view, the question is whether to decentralize and spend an additional $6.3 million to save $1.2 million dollars annually. If the company's desired internal rate of return is 15 percent or higher, it should build a centralized sortyard rather than a series of four satellite yards.

The company may also want to consider building the mid Island yard and a smaller centralized yard for the smaller three camps but that alternative will not be discussed in this example.

2. Savings and Return on Investment

In addition to the capital and operating costs of the sortyard, the savings resulting from the sortyard must also be estimated. The savings usually associated with the sortyards include:

a) Reduction in Sinker Loss

Depending upon the proportion of hemlock/balsam being logged, the length of time that loose logs are in the water and whether or not a sinker recovery system is in use, the sinker loss varies from 0 to 8 percent.

b) Better Grading and Sorting

Usually this saving is calculated by assuming that a certain percentage of pulp grade will become peewee sawlog grade, or peewee sawlog grade will become sawlog grade, or sawlog grade will become peeler grade, etc. An examination of scale bills will give an idea of the potential improvement.

c) Labour and Operating Cost Savings

The sortyard design may result in labour and operating cost savings but historically this has not been the case.

d) No Mark Visible, No Paint Visible

The sortyard should result in this charge being eliminated completely. If weight scaling is used, then it is not necessary to timber mark the logs and there may be a labour saving in the logging landings.

e) Log Remanufacturing

If the sortyard includes bucking, then there will be a savings potential from remanufactured logs. Examination of historical scaling records will show where bucking out higher grade portions of the log would have increased revenue to the company.

In our example, the most expensive centralized dryland sortyard alternative is at Howe Sound and will cost an estimated $14.9 million to build and $7.6 million to operate. To determine the savings, find what the cost would be if the company continued with the present sorting grounds, the estimated costs if it builds the new dryland sortyard and then net the two costs to give the savings. The result is a differential cash flow (see Table V-13). Some companies require that this cash flow have capital cost allowances applied, taxes applied to the savings and then the after-tax cash flow discounted to determine a present value or a rate of return. However, from the designer's point of view, the validity or accuracy of the costs and savings estimates of the new sortyard are more important than the financial ranking system.

Table V-13. Differential Cash Flow (Hypothetical Company).

	Annual Costs & Benefits		
	Status Quo ($ million)	Sortyard ($ million)	Difference ($ million)
Sorting & Booming Cost	6.0	6.9	(0.9)
Log Loss @ 5%	5.2		5.2
Log Remanufacture Benefit		0.6	0.6
Improved Grade, Scale & Sort Benefit		1.4	1.4
Net Savings			6.3

The annual before-tax saving on an investment of $14.9 million is estimated at $6.3 million. For this project, the present value of the after-tax flow discounted at 15 percent exceeds the investment. If the company's hurdle rate for projects of this type is 15 percent, then the project should be recommended and presented to management for their approval.

E. QUALITATIVE SITE FACTORS

The selection process has eliminated sites which are physically or environmentally unattractive and has recommended attractive sites which meet the financial requirements of the company. The final choice depends on corporate policy and qualitative factors such as:

- Does the company want the individual logging operation to grade and scale their own log production or should it be done by others at a large central location?
- How important is it to the company to rapidly change the sorting specifications?
- How will the company's public image be affected by locating a dryland sortyard in an area with recreational values instead of in a more remote, logging-oriented area?
- How serious are the problems of dumping barges of sorted logs?
- What are the strategic implications of sorting all log production at one location versus sorting parts at several locations?
- What is the quality and quantity of the labour pool at the various sites?
- Which dryland sort locations will best attract and keep workers?

The qualitative factors can determine whether the estimated economic gains or operational costs are achieved. For example, a dryland sort located in a remote site with high labour turnover may never be as productive as estimated. The importance of the qualitative factors in determining site location must not be underestimated. They should be given as much consideration as the quantitative factors.

F. RECOMMENDATION

The financial analysis of the options indicate that the two central sortyard options were more attractive than the decentralized yards because the investment was less for the central yard and the internal rate of return was also better. The costs and benefits shown in the differential cash flow between the status quo and the central yards showed an after-tax discounted cash flow of well over 15 percent. The difference between the two central sites is marginal in financial terms.

The two qualitative factors — ability to rapidly change sorting specifications and potential problems of dumping barges of sorted logs — reinforce the financial decision to construct a central sorting yard. The choice between central sortyard locations is dependent of qualitative factors. The company decides on the site at Howe Sound rather than a site at the confluence of flows because of the quality and quantity of labour, attractiveness of the site to new workers and proximity to head office, mill and market area.

To gain approval in principle, the material in this part of the handbook should be submitted in the form of a proposal. If accepted, a detailed proposal should be submitted based on an in-depth study as formulated in succeeding parts of this handbook.

PART VI SELECTION OF YARD LAYOUT AND SORTING SYSTEM

PART VI SELECTION OF YARD LAYOUT AND SORTING SYSTEM

After the decision has been made to build a sortyard and the site chosen, the project team must plan the layout and sorting system. These processes are interdependent and must proceed together from the general to the specific by a series of trial proposals. We have chosen to discuss layout first and then sorting systems.

The basic concepts or rules of management science* can be used to advantage in discussing the system and layout of the sortyard. If these concepts are used initially, then the flow will be smooth, bottlenecks will be eliminated and later changes minimized.

Management science stresses a systematic approach to solving a problem. It starts with the questions What? How? Where? When? and Why? Once these questions are answered, the management scientist applies theory to the problem, analyses the alternatives and then recommends the optimal solution.

A. SORTYARD LAYOUT

1. Application of Plant Layout Theory to the Sortyard

Time spent analyzing different layouts of functions, machines and areas for the sortyard is well worth the effort if it avoids costly re-arrangements later. Moving scaled-down shapes around a plan is much easier than moving permanent installations after the yard is built.

The plant layout process moves from general to specific. Initially, an overall layout is agreed upon, then detailed layouts are made of each subarea. The overall layout starts with assembling the log volume information in groups that are meaningful to the process. As number of sorts and pieces are two major determinants of yard productivity, the log volume information is grouped into these catagories and can be shown as a graph (Figure VI-1).

In almost all aspects of production, there is a disproportionate relationship between the quantity of product and the type of product. This relationship is commonly referred to as the 80-20 or 70-30 rule. That is, 70 percent of the products processed involve only 30 percent of the types of products or 30 percent of the items in an inventory account for 70 percent of the turnover.

Figure VI-1 shows that 30 percent of the sorts account for 69 percent of the pieces to be sorted. This distribution favours mass production methods for four sorts and batch methods for nine sorts. However, because of area restrictions, this may be impossible and a layout based upon both mass production and batch production is used. As a general rule, if the quantity-type curve is steep (Figure VI-2), then two separate layouts (mass-production and batch-production) should be used. Therefore, most of the volume, which is at the two extremes, is handled efficiently. Where the quantity-type curve is gradual (Figure VI-3), it is better to design a general layout that uses multi-purpose machines. As most of the production is in the middle of the curve, the layout is made to handle these types of products most efficiently.

The quantity-type curve based on pieces and sorts is important for selecting layouts for sorting machines. However, a log value and sorts grouping is important for scalers and graders (Figure VI-4). It will emphasize that the effort expended on a log should be related to the log value. This influences the layout and material handling process for grading and scaling.

In Figure VI-4, with the exception of the three low value, low volume sorts of cedar, fir and cypress pulp, the normal 70-30 relationship is true and a significant portion of the pieces will fall into low value sorts. A split layout, where low value logs are graded and weight scaled, and high value logs graded, then transported to a separate area where they are regraded, bucked, stick scaled and sorted, may get the maximum value from the logs at the least cost.

*See Bibliography for reference material.

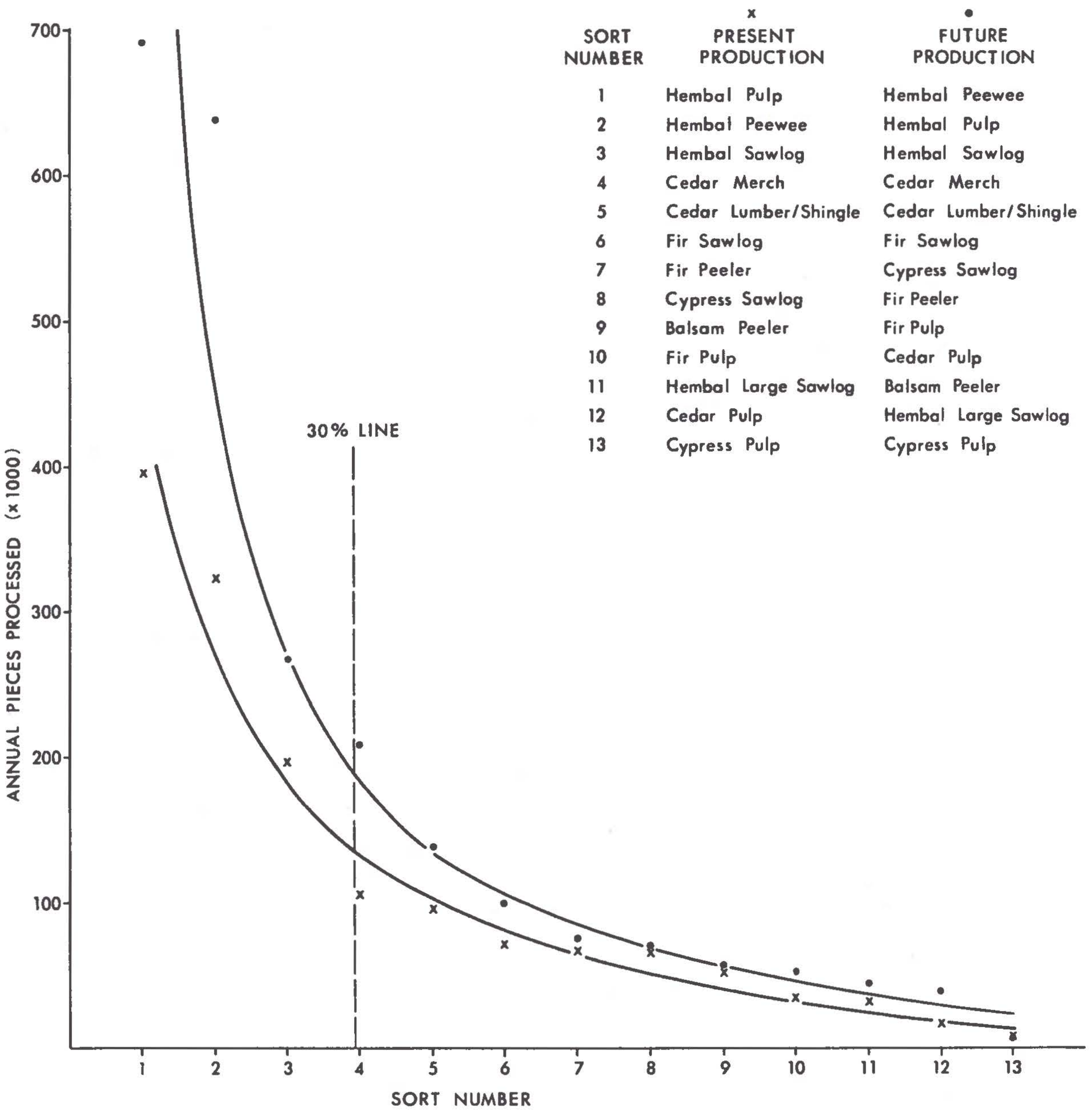


Figure VI-1. Quantity Versus Type Graph for Hypothetical Forest Products Company.

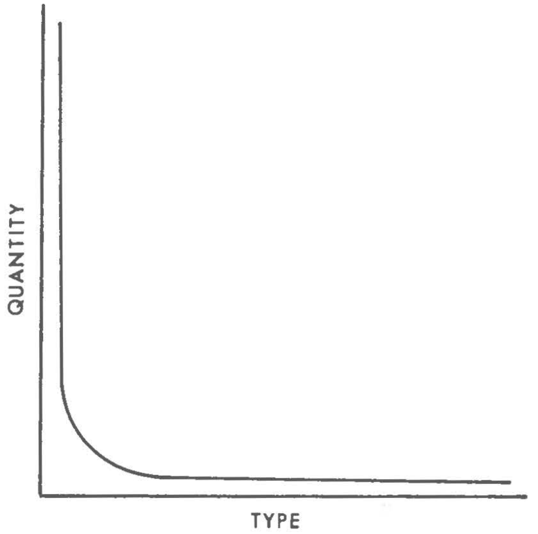


Figure VI-2. Steep Quantity-Type Curve.

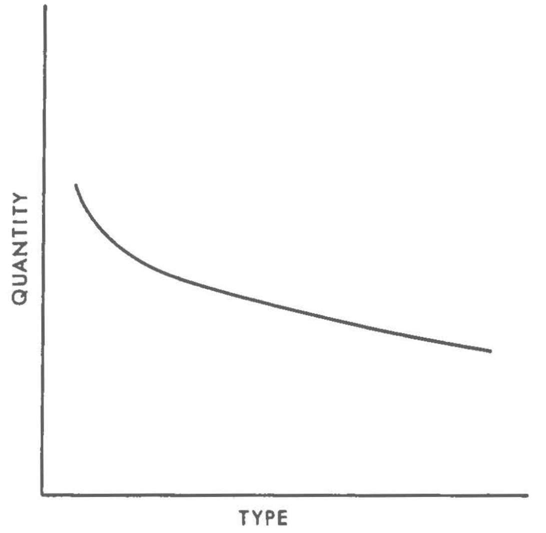


Figure VI-3. Gradual Quantity-Type Curve.

Product, position and process are the three basic plant layouts for production processes. In *product layout*, the typical production line, the raw material is moved directly from one operation to the next. The processing machines are set adjacent to each other and in sequence of the operations to be performed on the raw material. In a *position layout*, the location of the raw material is fixed and the processing machines move to it. In *process layout*, the raw material is moved and processed in a series of separate areas or departments.

Production lines are usually synonymous with layouts by product. Batch or job lot processes are usually laid out by position or process. Sortyards in B.C. are normally operated on a batch basis with a process layout. However, when there is a characteristic that allows a 70-30 or 80-20 split, then a combination of layouts should be considered to increase efficiency.

Production line processes or layout by product will not be efficient unless there are one or two features that significantly dominate the raw material. The Swedes have been able to achieve production line processes in log sorting and manufacturing because of a small range in log diameter. One attempt in B.C. to operate a production line sorting system was unsuccessful because the diameter range and number of species were too great.

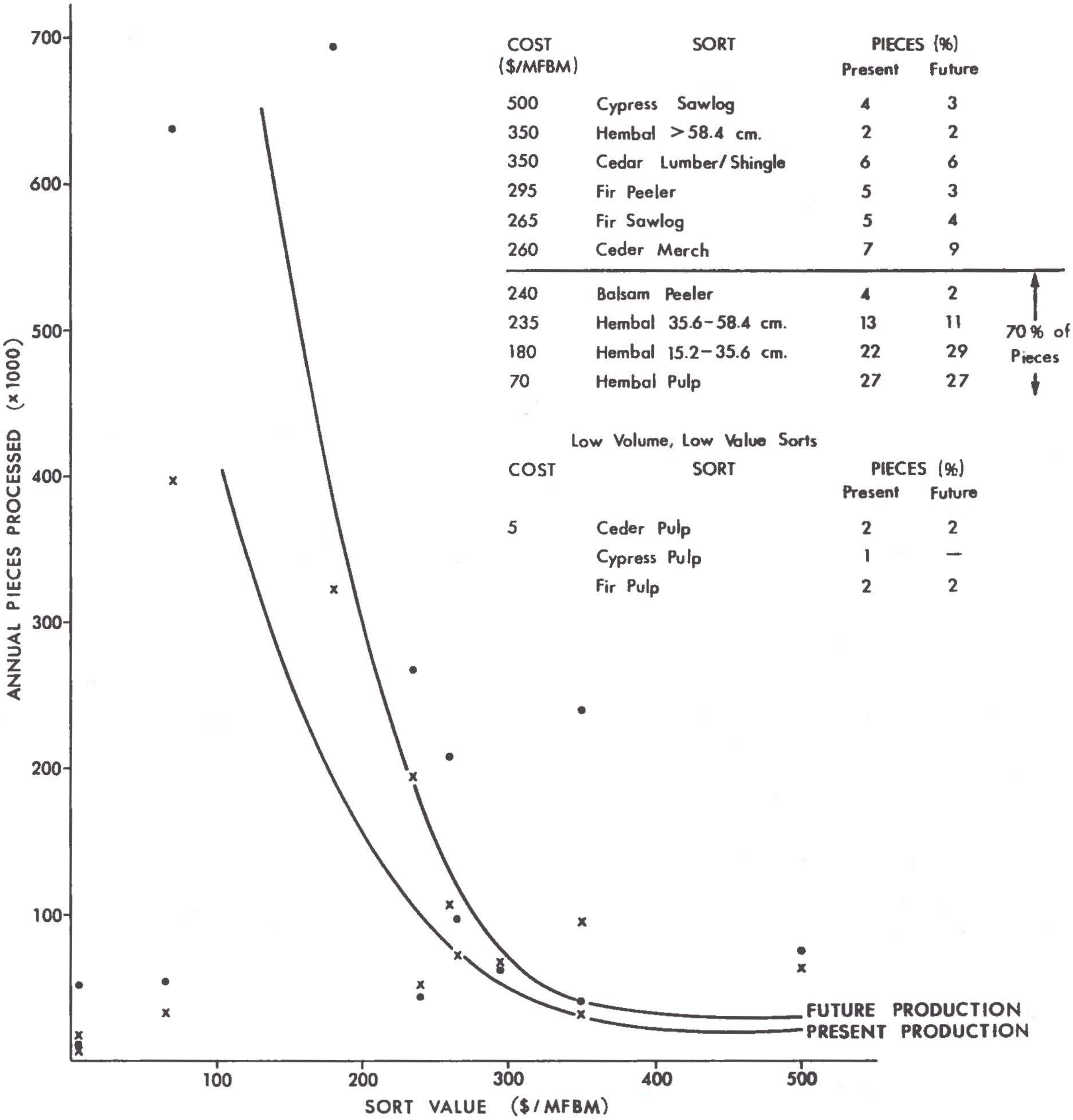
2. Common Sortyard Layouts

A frequent question in sortyard design is, "What is the best yard layout?" The answer, of course, is contingent on physical restrictions at the site, the volume of logs to be processed and the capital available for the material handling system.

a) Lower Volume Yards

The lower volume yards tend to be located at the head of remote inlets and usually next to a tidal plain with a stream in the middle. Environmental impact, high construction costs and low log volume dictate that these yards be as simple and small as possible and fit the local geography. Typically, in the yards that process less than 1 100 m^3/day, the area for the sorting will be less than 2 ha and in some of the smaller yards (300 m^3/day) the sorting area will be 0.2 ha. Log storage on land is limited to accumulating enough logs to make bundles (not booms) and truck trailers are reloaded at the unloading site to minimize the area needed to turn around. Two typical layouts are given in Figure VI-5 and VI-6.

As can be seen from the two figures, land is used economically. Also, there are few people on the ground so the sorting equipment and logging trucks can move safely within the yard. Consequently, travel corridors do not have to be defined and subareas can serve multi-purposes.



COST ($/MFBM)	SORT	PIECES (%) Present	Future
500	Cypress Sawlog	4	3
350	Hembal >58.4 cm.	2	2
350	Cedar Lumber/Shingle	6	6
295	Fir Peeler	5	3
265	Fir Sawlog	5	4
260	Ceder Merch	7	9
240	Balsam Peeler	4	2
235	Hembal 35.6–58.4 cm.	13	11
180	Hembal 15.2–35.6 cm.	22	29
70	Hembal Pulp	27	27

Low Volume, Low Value Sorts

COST	SORT	PIECES (%) Present	Future
5	Ceder Pulp	2	2
	Cypress Pulp	1	—
	Fir Pulp	2	2

Figure VI-4. Quantity Versus Value Graph.

McCURDIE CREEK LAYOUT

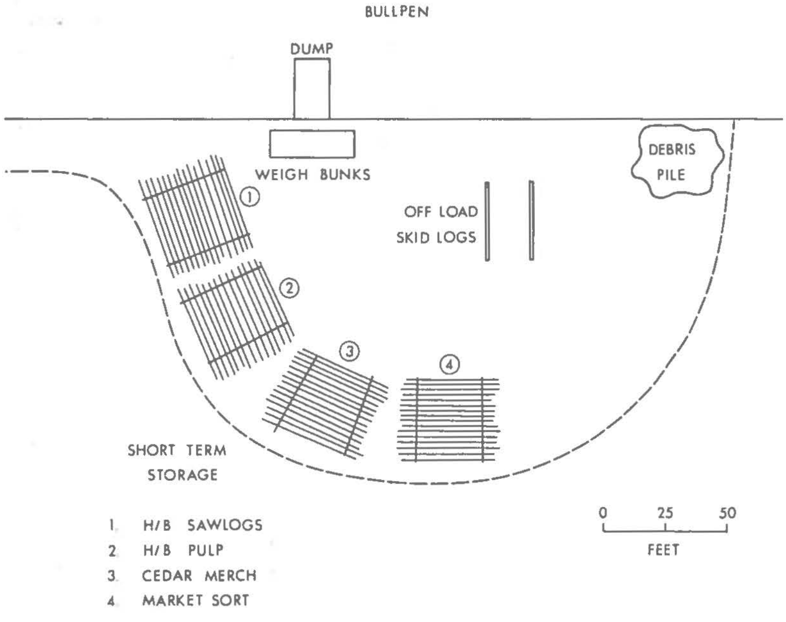


Figure VI-5. Typical Layout for 300 m^3/day Sortyard.

KOKSILAH LAYOUT

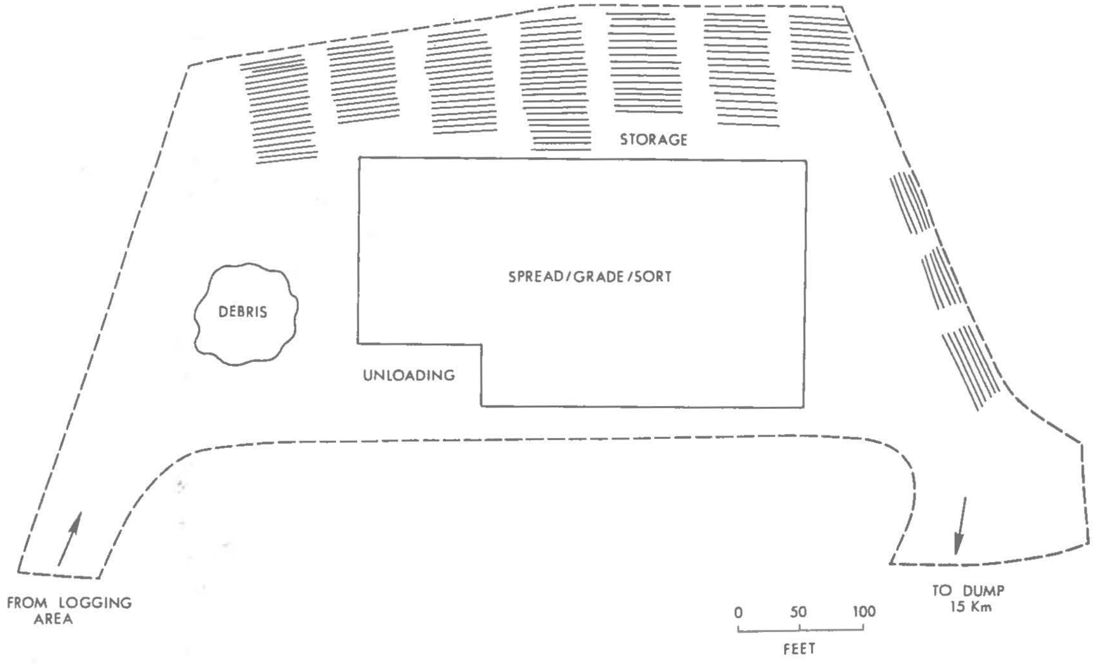


Figure VI-6. Typical Layout for 700 m^3/day Sortyard.

b) High Volume Yards

In the higher volume yards, the designer has more options for layout. Other than physical site restrictions and environmental impact, the main consideration will be the truck unloading method and the amount of log storage required. Differences in sorting and scaling methods have less impact on layout. The controlling factor is the need to spread the logs on the ground for grading, bucking, scaling and, possibly, sorting. Conceptually, logs are handled first as loads, then as individual logs and then again as loads or bundles. Without log storage, when push or pull unloading is used with several unloading ramps, a triangular shape (Figure VI-7) will evolve. The unloading ramps are at the base, sorting section in the centre and dump ramp at the apex. Where lift unloading is confined to one small area, the pear shape develops (Figure VI-8). The bulge is caused by the grading, scaling and sorting functions.

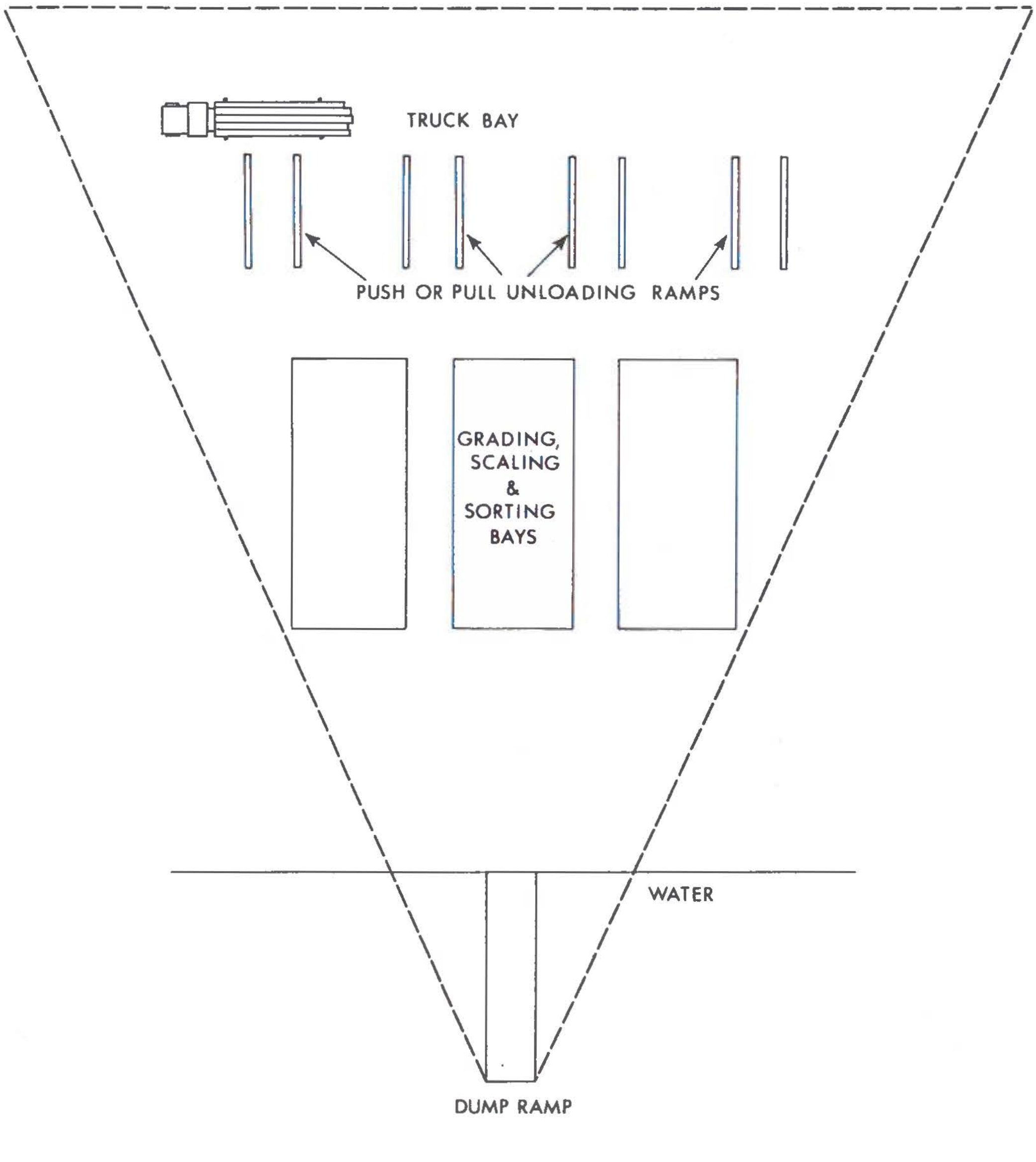


Figure VI-7. Triangular Shape.

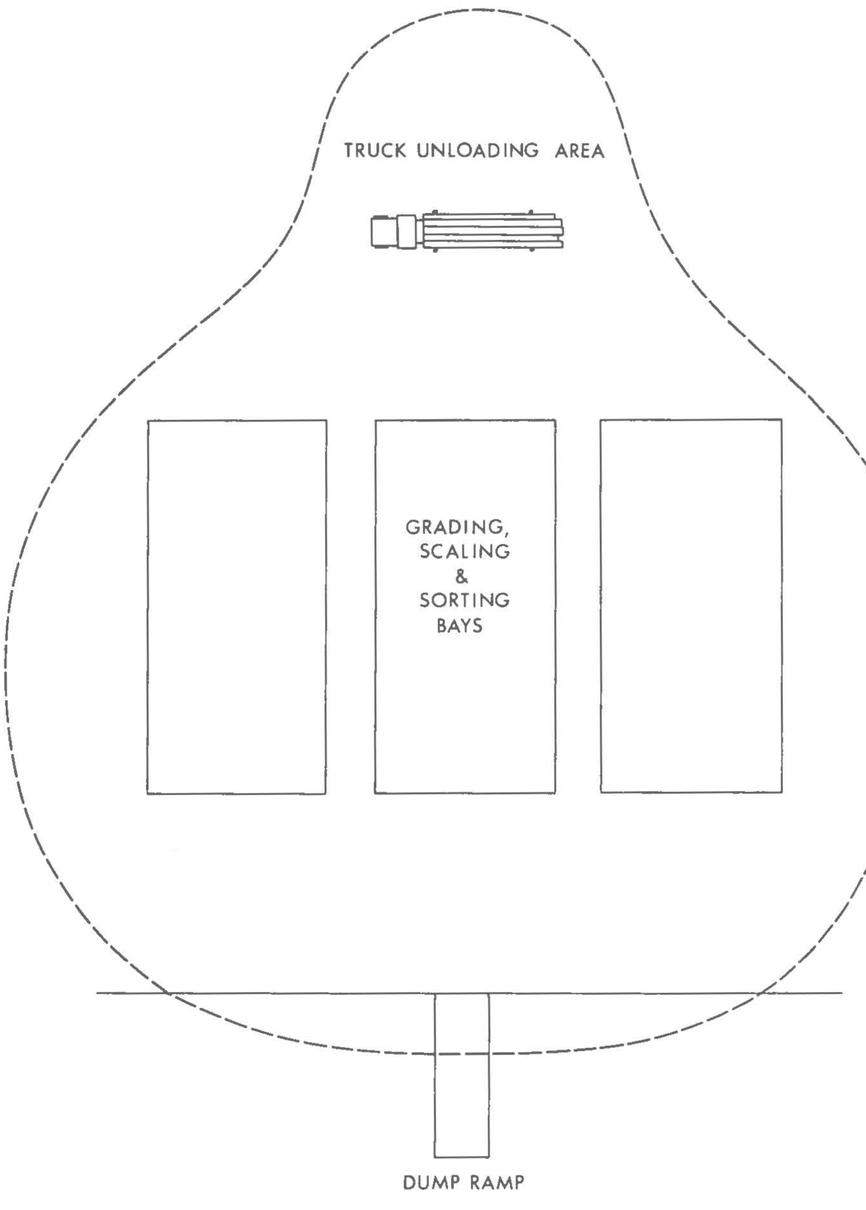


Figure VI-8. Pear Shape.

For ease of construction, lighting and paving, these forms may be revised to form rectangles or squares but basically a triangular or pear shape is all that is needed.

Sorting systems come into play in determining layout shape, but primarily because of the type of unloading machines. If stackers are not used and conventional size bundles are made then several dump ramps will be needed. The result will be a rectangular-shaped layout, particularly if push unloading is used.

The type of scaling system affects yard layout only because of the requirement for a sample scaling area when weight scaling. The logs have to be laid out for grading and bucking regardless of the scaling method.

If sorted and/or unsorted log storage is needed, area can be provided by squaring up the triangular or pear shapes or attaching additional area. Because logs are relatively straight, the most efficient storage areas are perpendicular to other features in the yard. Figure VI-9 shows inefficient and efficient use of storage area.

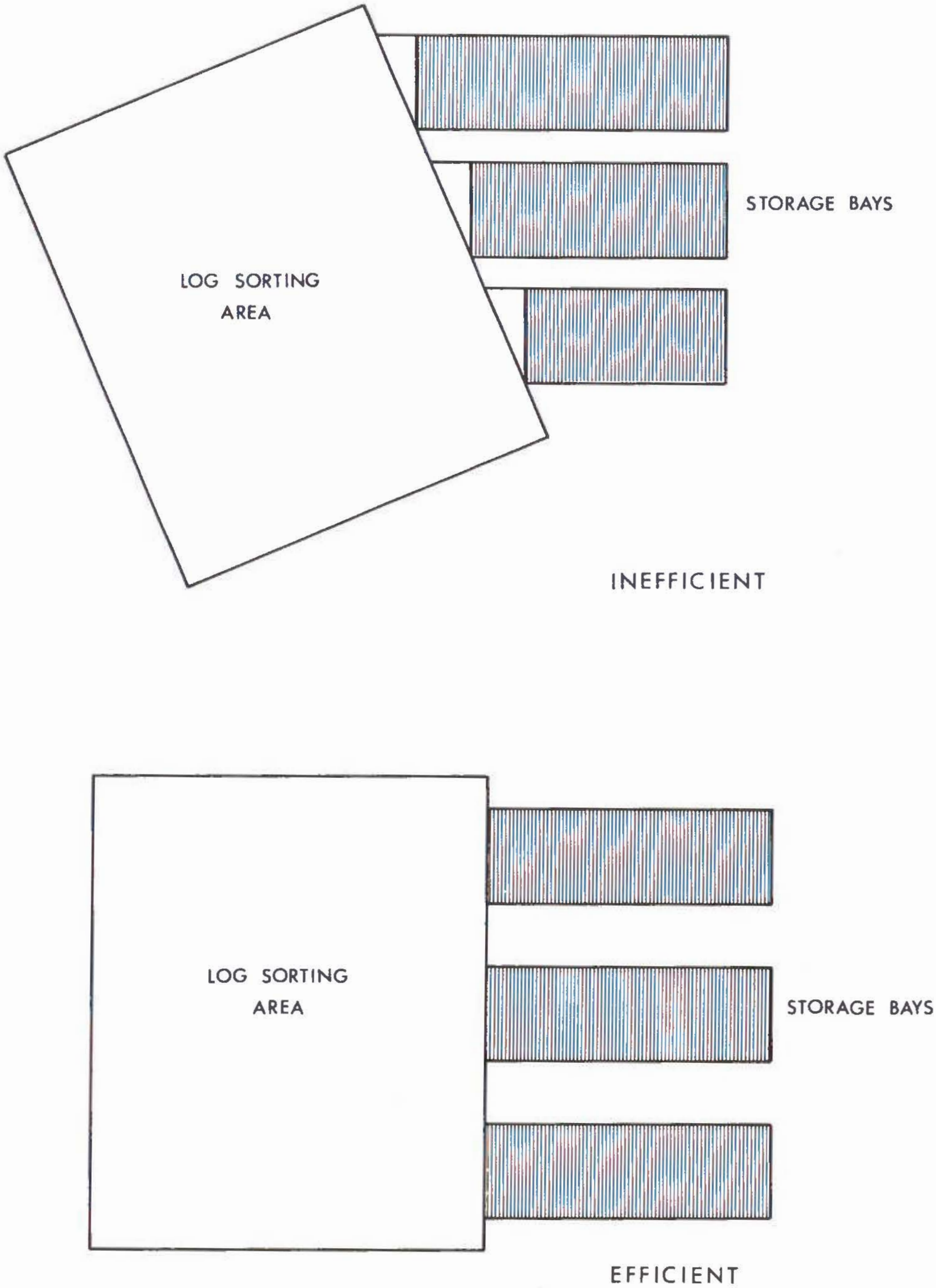


Figure VI-9. Inefficient and Efficient Use of Space.

Some of the yards on the coast receive their incoming logs by water. This has two impacts on yard layout. First, the arrival rate of log loads is predictable and can be controlled so the need for surge inventory areas is minimized and space can be used more efficiently. Second, once the input and output locations are selected and built, they are fixed and as they control the layout and flow, careful planning is required.

After deciding on a preliminary layout for the yard, the next step is to determine the material handling process. At this stage, the step-by-step processing sequence of the logs will have to be established so that yard areas can be allocated.

3. Material Handling Concepts

A sortyard involves material handling with inspection, operation and inventory functions. Every material handling move involves a pick up, a transport and a put down.

Materials, moves and methods are always involved in material handling analysis. In terms of materials, the *key input data* are:

- What is the product?
- How much of the product is there?
- Where does the product have to be routed or what has to be done to it?
- When will the product be there and for how long (timing)?

Obviously, in dryland sortyards the product is logs but more must be known about the characteristics of the logs. This would include maximum, minimum and average diameter; maximum, minimum and average length; maximum weight, size and weight of loads and bundles; risk and cost of damage to logs; and shape and condition of logs. This information is needed to determine the size of material handling equipment, width of travel corridors, width and length of grading and scaling bays, size of sorting bunks, size and type of grapples, etc.

How much product? It is not enough to know just the daily log volume. The daily number of pieces, the types, sizes, weights and volumes of the various packages of logs, and the daily variation in volume of pieces should also be established.

Product routing in the case of sortyards on the coast is usually through the process and into the water as directly as possible. However, if booming ground capacity is limited, log storage may be necessary. In some yards, routing could also include mill infeed, sorted log storage, and outbound logging trucks or railway cars. Product routing, travel distance, and conditions at the end of the route are important in selecting the size and type of material handling equipment and in designing the size and running surface of the route. For example, one would not select a small front-end loader to move a large volume of logs over a long route but instead, would choose a large stacker or overhead crane.

Establishing the timing of arrival of the product and the time available to unload are critical elements. Average arrival rates or average number of loads per day are only useful to the extent of determining if there is enough equipment to handle the average. We must also establish the likely frequency and timing of the loads throughout the day. This, combined with information on the physical characteristics of the logs or loads, can be used to determine the number, type and size of unloading equipment, the amount of surge inventory storage needed, the amount of space for scaling and grading bays, the likely turnaround time on the logging trucks, the number of sorting machines, etc.

Once the designer has established the *four types of key input data*, he can apply the basic concepts in material handling. If data is not available, then educated estimates based on the specific yard design should be used rather than "gut feel" or rule of thumb.

The next step is to assume a *basic layout*. The basic layout chosen will depend, to some extent, on the type of material to be handled. For logs which are diversified in quality and size and are relatively small, the yard is laid out by process. That is, specific functions are performed in separate areas of the yard and the logs are transported to and from the processing areas. In some cases, if the size or species of the logs are uniform, it is more efficient to lay out by fixed position. In this layout, the logs are taken to a stationary processor and transportation is reduced. Layout by product is usually not feasible in B.C. coastal yards unless there is presorting.

After the most efficient layout is chosen, the *flow pattern* is determined. The basic flow patterns are straight through, U-shaped or L-shaped. Most yards are designed on a straight through pattern because they are the simplest. U-shaped and L-shaped patterns are found or are necessary where external site features control entry and exit points. A sortyard with water on one side and steep banks on two sides may dictate an L-shaped pattern.

From the basic layout, the designer can determine:

- the location of the start and finish of each pick up and put down operation;
- routes normally used for each move;
- space available at the start, middle and finish of each move; and
- functions performed in each area.

A simple layout plan will depict this information and will give the distance required for each move and the conditions of the move. The conditions would include running surface, slope, congestion, obstructions and straightness. The previous input data gives rate of flow of logs over each of the routes. As well as the flow rate, the following must also be established: the size of log packages to be moved, whether or not particular types of logs have to be moved together, and the urgency of the moves.

The most common method used for analysis of the material handling moves is flow processing, although route analysis and area analysis may also be used. An example of flow processing of a simple sortyard design is given in Figure VI-10.

PRODUCT	ACTIVITY SYMBOL	DESCRIPTION	WEIGHT (kg)	TRIPS/ DAY	DIS- TANCE (m)	NOTES
Log Loads	○	Unload				
Log Loads	⇨	Transport to Grade, Scale & Sort Area	45 500	30	80	60 Ton Stacker
Logs	□	Grade & Mark				
Logs	□	Scale				
Logs	○	Sort & Bunch	1 360	1 000	5	Small Front-End Loader
Bunches	⇨	Forward to Bunks	4 080	333	30	Medium Front-End Loader
Bundles	○	Put on Steel Bands				
Bundles	○	Unload				
Bundles	⇨	Transport to Dump	45 400	30	60	60 Ton Stacker
Bundles	○	Dump in Water				
					175	

○ = Operation

⇨ = Transportation

▽ = Storage

○ = Handling

D = Delay

□ = Inspection

Figure VI-10. Flow Processing.

With the flow process chart and other information, the routes can be analyzed to see if, for example, the route's slope, surface condition, and congestion are compatible with the loads, the intensity and the machine size and type. Also, the layout should be examined to see whether the distances of moves can be shortened and whether lighter loads can be combined to make a heavier load.

There are two prime rules in material handling. The shorter the distance the cheaper the cost, and the greater the weight per move the cheaper the cost per unit. Thus, the cheapest move is a heavy weight moved a short distance and the most expensive is a light weight moved a long distance. Every effort in material layouts should be directed to loading up the machines and moving the loads short distances. If it is impossible to change distances and the loads are light, then an effort should be made to combine loads. Also, if light loads and long distances are unavoidable then they should be on the lowest intensity routes.

Material handling machinery can be divided into transport and sorting functions. In sortyards, log loaders are used primarily for sorting, and stackers and large front-end loaders for transport. Small front-end loaders are used for both transport and sorting. It is important not to use transport equipment for sorting tasks. Unfortunately, it is not uncommon to see large front-end loaders sorting small logs. Sorting equipment can be used to sort logs and also to bunch sorted logs for the transport equipment. Similarly, lower-capacity transport equipment can deposit bunches of logs into holding bunks until they accumulate into large bundles for transport by higher-capacity machines. Wherever possible, logs should be grouped together before they are moved. There is nothing that frustrates a designer or efficient foreman more than a 60-tonne stacker carrying three logs from one end of a sortyard to the other or the same stacker trying to pick up a log 2 metres long by 10 cm in diameter.

The initial layout for the sortyard should be evaluated and analyzed. Alternatives should be developed and compared. Different types and sizes of handling and transport equipment should be examined. The advantages and disadvantages of the different types should be weighed. For example, a small front-end loader can be used to unload a logging truck as well as a stacker and the loader is less expensive. However, the small loader takes more time to unload the truck and cannot be used to move bundles of logs. Hopefully, several alternative layouts with different types of material handling and transport equipment are compared and discussed. Only in this way will an economical, efficient layout and material handling system result.

The final layout must meet the constraints of the organization and the site. Although it should provide for efficient material handling, the layout should not use equipment which is too highly specialized. It should also provide an interesting place to work.

In summary, the principles of material handling are to:

- reduce or eliminate unneccessary movements and combine movements;
- increase the size, weight or quantity of material moved wherever possible;
- utilize gravity, if it can assist;
- standardize types and sizes of equipment;
- use equipment that can perform a variety of tasks unless specialized equipment is needed;
- select equipment to match all aspects of the material and flow in the system;
- minimize the ratio of dead weight to total weight on all moves;
- minimize the distance moved, particularly for light loads;
- maximize the load and minimize the distance on high intensity moves;
- make low intensity moves, if long distances must be covered;
- try to serve other functions along the route when a long distance is travelled; and
- pick up or put down the *whole* load.

For sortyards, these rules translate into:

- use of log loaders to sort and bunch logs;

- use of front-end loaders to transport bunches of logs; and
- use of log stackers or overhead cranes to transport bundles or loads of logs.

4. Log Storage and Inventory Theory

Large inventories in log sortyards are of concern to accountants and financial people in the forest products companies. Accountants have difficulty keeping track of the pieces and volume. Financial people don't like inventories because of the carrying cost. In contrast, production personnel like inventories. Inventories decouple the operations and allow surges in production to smooth out. The balance is where the costs of holding inventory equal the savings in production. Management scientists have been examining inventory behaviour and developing mathematical models to describe it since the early 1900's.

Inventories perform four functions to improve the efficiency of a sortyard. They are: surge leveler or buffer, decouple production phases, smooth seasonal fluctuation, and accumulate for lot sizes.

a) Surge Leveler or Buffer

A small amount of storage space at the unloading area can serve to level the surges in logging truck arrival rates. In most yards, there are two to four periods during the day when trucks are waiting to be unloaded. If there is no provision for surge inventories and all logs have to go to the grading area, then there will be excessive waiting times. In addition, the yard itself will become a stop-and-go type of operation with busy and slack periods. This has a negative effect on grading, scaling and sorting quality and can result in excessive log damage.

To determine the amount of volume needed in surge storage to prevent excessive truck waiting time, the processing rate is compared with the input rate as shown in the example (Figure VI-11). If from 7:00-8:00 a.m., trucks are arriving at 8 loads per hour and the yard can process 5 loads per hour, then 3 loads should go to surge inventory to be recovered from 8:00 - 9:30 a.m. when trucks are arriving at the rate of 3 loads per hour. Surge storage is most efficient if the loads are held intact in bunks for recovery. If the loads are put into storage loose, then the stackers cannot recover a full load.

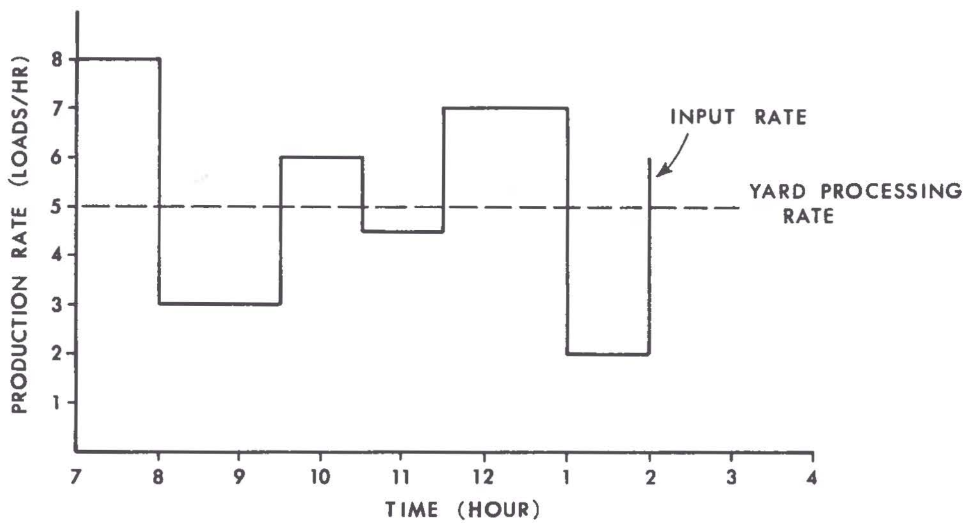


Figure VI-11. Production Rate Versus Time (Example).

Surge storage is necessary but should be minimal. Construction costs are expensive and using storage increases material handling.

b) Decouple Production Phases

When yard processes move from batch type to continuous, decoupling inventories are needed. This is readily apparent between the scaling area and sorting area when stationary log loaders are used. In order to protect the scalers from the yard machinery, whole bays of logs are scaled at once. If only one bay was allowed for scaling, then the scalers and sorting machine would operate on a stop-and-go basis. Consequently, at least two and usually three bays are used. Even with three scaling bays it is not uncommon to find scalers idle 40 percent of the time and the sorting machines idle 15 percent of the time. This idle time could be reduced if more scaling bays were used but would increase construction costs and travel distances for the machines. Other decoupling inventories are the unsorted log pile in front of the sorting machines and the bunks used to hold logs before they are bundled.

c) Smooth Out Seasonal Fluctuations

As described earlier, it is not uncommon to have seasonal variations in log production of 20 or 30 percent. The designer is faced with the problem of whether to design the yard for the average production rate or the peak seasonal rate. Designing for the peak seasonal rate will mean more men, land and equipment and result in off-peak layoffs for the crew, idle equipment and under-utilized investment. Designing for the average production rate will mean congestion, sacrificing quality for production and overtime work. The best solution may be to design for a production rate slightly greater than the average and allow for unsorted log storage. During the peak periods, the excess can go into storage to be recovered in the slack periods. Figure VI-12 shows a common production pattern and compares it with the processing rate.

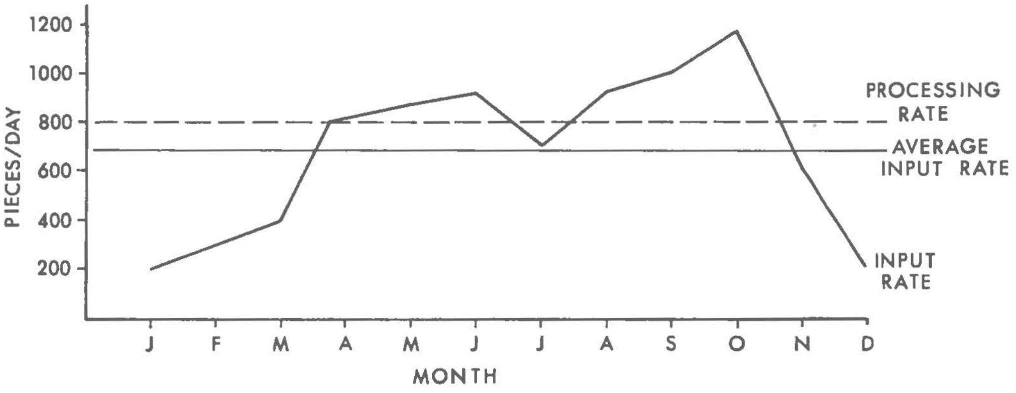


Figure VI-12. Pieces per Day Versus Months (Example).

As can be seen, if the production excess in August, September and October is put into storage, then it can be processed in January, February and March and a constant processing rate results. To decide the best alternative, the inventory associated costs of added land, material handling and log breakage will have to be compared with the costs of processing without inventory (overtime, loss in production efficiency, and the loss of scaling and sorting accuracy).

d) Accumulate for Lot Sizes

Another type of inventory is used on the output of the sortyard to accumulate logs for transport to market. Shipments usually contain only one log sort or are for one destination. As a result, lower volume sorts are stored until there is enough volume to make up the smallest acceptable shipment. How much area is needed for this storage? How long will it take to accumulate enough volume? The designer can estimate this by using the log production plans for the logging camp and the historical shipment averages from the sorting ground. This information can also be used to determine optimal size for the booming ground and storage area. Log storage between the sortyard and the booming ground is impossible to avoid. The costs that have to be balanced in order to determine the most economic amount of storage are: the inventory-related costs of storage area, interest on working capital, extra handling and log breakage, and the operational costs of extra booming, handling, towing and lower sales value.

This section has discussed ways that inventory can be used to assist the sortyard operator and how the inventory costs should be balanced with the benefits. Some inventories are unavoidable but they should not be allowed to build up and should be controlled.

5. Queuing Theory and Sortyards

An economic problem occurs when something has to be serviced and the demand for that service is irregular. If an inadequate service is provided, then waiting lines develop. If service is provided for peak periods, then idle time results.

To make an economic balance, estimate the amount of avoidable idle time on both sides of the equation and the cost of the time. It should be noted that not all idle time is avoidable. Obviously, when a truck is being unloaded, it is idle but the idle time is unavoidable. Truck unloading receives the most attention from yard operators but there are many other waiting lines occurring in the system that should not be overlooked.

The amount of waiting time depends on the probability of the need for service and the probability that the servicing facility is busy with other work. In order to determine the waiting time it is necessary to know the following:

- the number of functions requiring service and the machine time available to provide service. For example, which is preferable, one stacker full time for all trucks or two stackers on demand for all trucks?
- the priority system for providing service. For example, do we unload a truck as soon as possible or unload a truck when time is available?
- the distribution of service calls. For example, what is the distribution of logging truck arrival times?
- the distribution of service time to perform a task. For example, what is the variation in truck unloading time when using a stacker?

Arrival rates can generally be described by the bell-type curve shown in Figure VI-13.

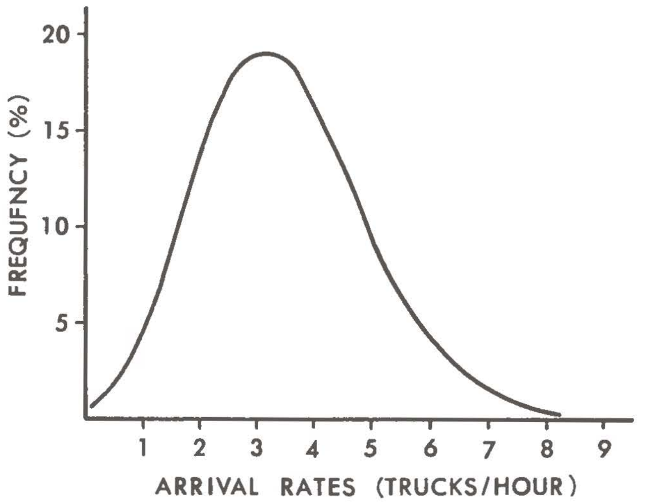


Figure VI-13. Distribution of Arrival Rates (Example).

The curve shows that for a certain percentage of the day the servicing machines will be idle and at other times they cannot keep up. The trick is to have other work for the servicing machines when they would normally be idle and also minimize the waiting time for the machines needing service.

The time required to perform a service can generally be described by the curve in Figure VI-14. The curve intuitively seems correct in that a few machines take a very long time to service and the majority take an average time.

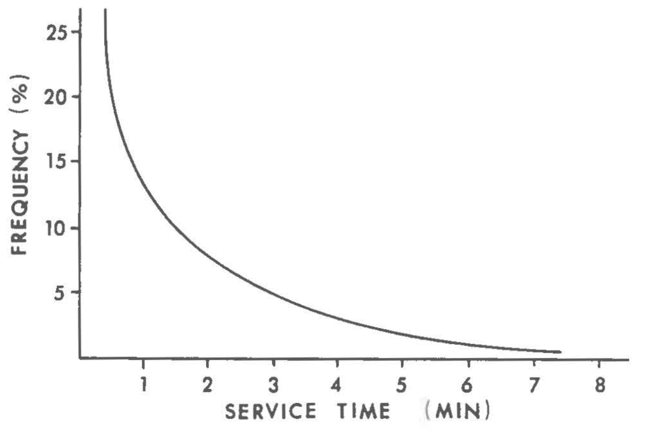


Figure VI-14. Distribution Time to Provide a Service.

The effect of varying arrival rates and servicing rates is shown in Figure VI-15. As can be seen from Figure VI-15, as the mean arrival rate approaches the mean service rate, the number of machines waiting for service increases rapidly. In practice, the mean service rate must always exceed the mean arrival rate or there will never be a stable system.

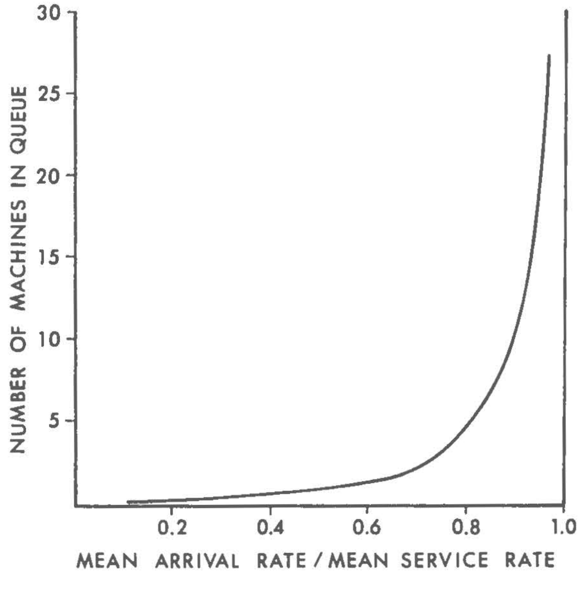


Figure VI-15. Effect of Varying Arrival to Service Rate Ratio (Example).

For a production system or sortyard with a large number (greater than 100) of functions to be serviced, such as a front-end loader performing multi-functional tasks, the following equations can be solved for estimates of waiting times, etc.

Lq = mean number of units in the waiting line

$$Lq = \frac{a^2}{u\,(u - a)}$$

where:

u = mean service rate

a = mean arrival rate

L = mean number of units in the system, including the one being served

$$L = \frac{a}{u - a} = Lq + \frac{a}{u}$$

Wq = mean waiting time

$$Wq = \frac{a}{u(u - a)} = \frac{Lq}{a}$$

W = mean time in the system, including servicing

$$W = \frac{1}{u - a} = Wq + \frac{1}{u} = \frac{L}{a}$$

In waiting line or queuing analysis, there are standard structures. The previous equations refer to a single channel, single phase case. Figure VI-16 indicates the four standard structures. The single channel, single phase case is seen in a sortyard with one unloading machine. The single channel, multiple phase case can be seen in smaller sortyards where one machine unloads, spreads, reclaims, sorts, forwards and dumps the logs.

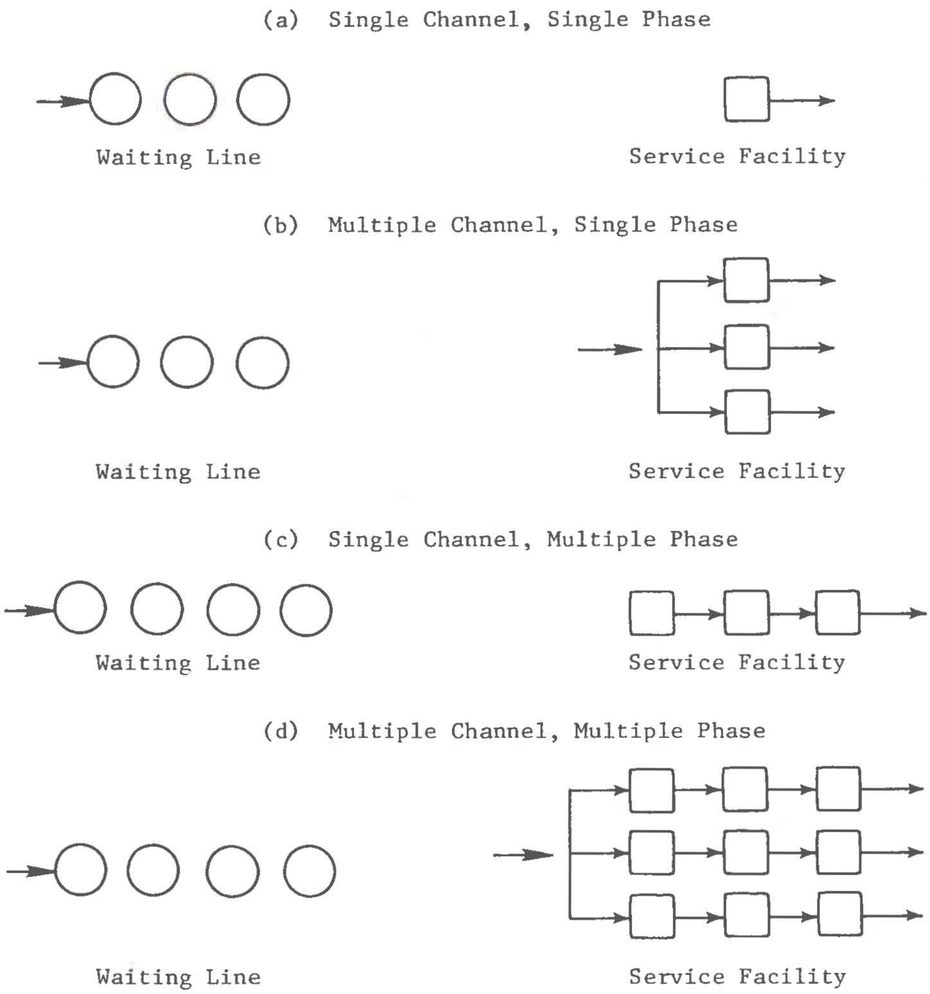


Figure VI-16. Four Standard Structures in Queuing Analysis.

When the number of channels is increased, there are disproportionate reductions in waiting times. This is mainly because the effective service rate is the product of the number of channels and the mean service rate. For example, the utilization factor, which is the ratio of the mean arrival rate to the mean servicing rate, is halved when a second channel is added. Figure VI-17 shows the effect.

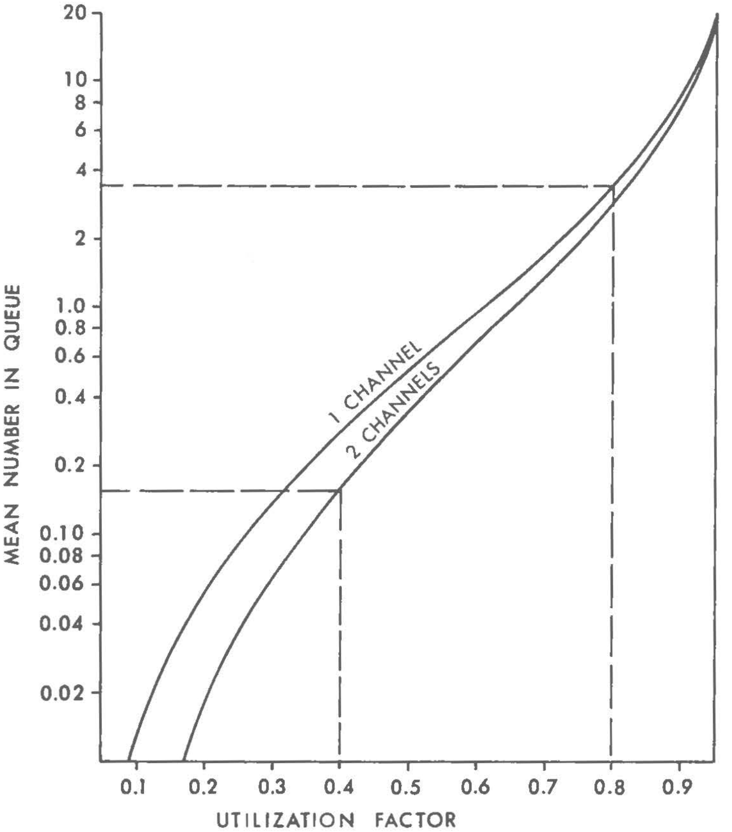


Figure VI-17. Effect of Number of Channels on Waiting Line.

As can be seen in the figure, after the utilization factor gets beyond 0.8, the number of units in the queue increases very rapidly and the addition of a second channel may reduce costs. However, the economics should be checked to see if total idle time cost is reduced. If it is not, then a single servicing channel or machine should continue to be used.

For a production system with a small number of units to be serviced (less than 100), such as simple truck unloading or forwarding bundles, then machinery handbooks have tables that give values to use in estimating waiting time and machine availability (Buffa, Modern Production Management). The equations for larger populations assume that the arrival of one unit does not affect the likelihood of the arrival of another unit. This assumption cannot be made in the case of smaller populations.

Regardless of whether the population to be serviced is large or small, the designer can use the concepts of queuing to decide how many servicing machines are necessary. Time studies can give a distribution of servicing time and arrival rates on existing systems.

In some cases, the way to shorten a waiting line may appear to be to add another service machine. However, through reassigning functions of other machines, changing the layout, improving the method, modifying priorities or adding decoupling inventories, it may be possible to increase the servicing time available. The key objective should be to minimize the cost of avoidable idle time, not the length of the waiting line.

B. SORTING SYSTEMS

1. Basic Systems

There are several basic sorting systems. Small yards handling less than 1 100 m^3/day use front-end loaders to perform all the machine functions. Above 1 100 m^3/day, stackers, front-end loaders and log loaders in various combinations are used and are often assigned to specific job functions.

Figure VI-18 shows typical small yard systems and Figure VI-19 shows large yard systems.

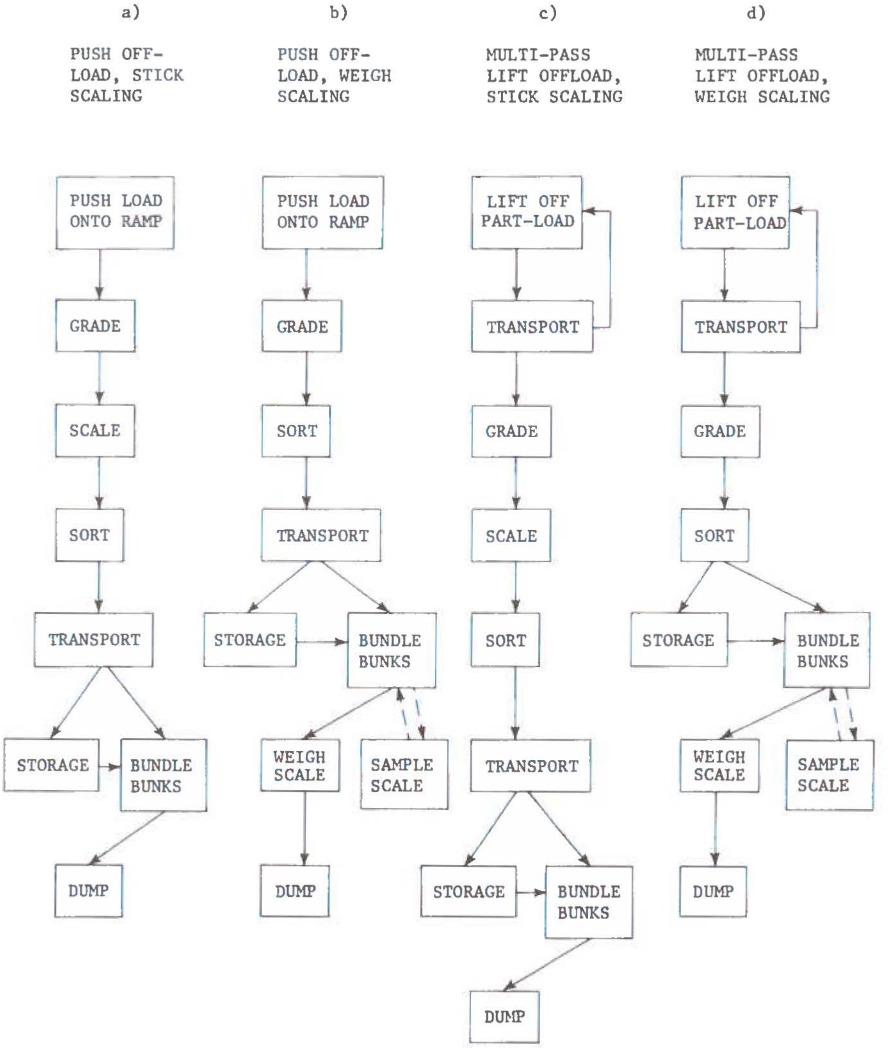


Figure VI-18. Sorting Systems in Small Yards (less than 1 100 m^3/day).

The flow diagrams in Figure VI-18 and VI-19 were simplified to illustrate a general flow of logs. A more detailed flow diagram is given in Figure VI-20 which shows all the operations that happen in System (c) in Figure VI-18.

A variation to System (a), shown in Figure VI-18, is where the logs are scaled after, not before, sorting. This requires more room and an extra material handling move but it is a way of checking the sorting.

Variations to the systems in Figure VI-19 include using sorting tables rather than grading and scaling bays or pulling a sorting trailer behind the mobile log loader. The systems can be further classified into sub-systems according to the scaling method (stick or weight scaling). For example, in Figure VI-19, System (a) would have scaling after sorting by the log loader rather than before sorting by the log loader if weight scaling was used. However, regardless of the level of detail, there are three basic systems used to sort logs in the larger sortyards.

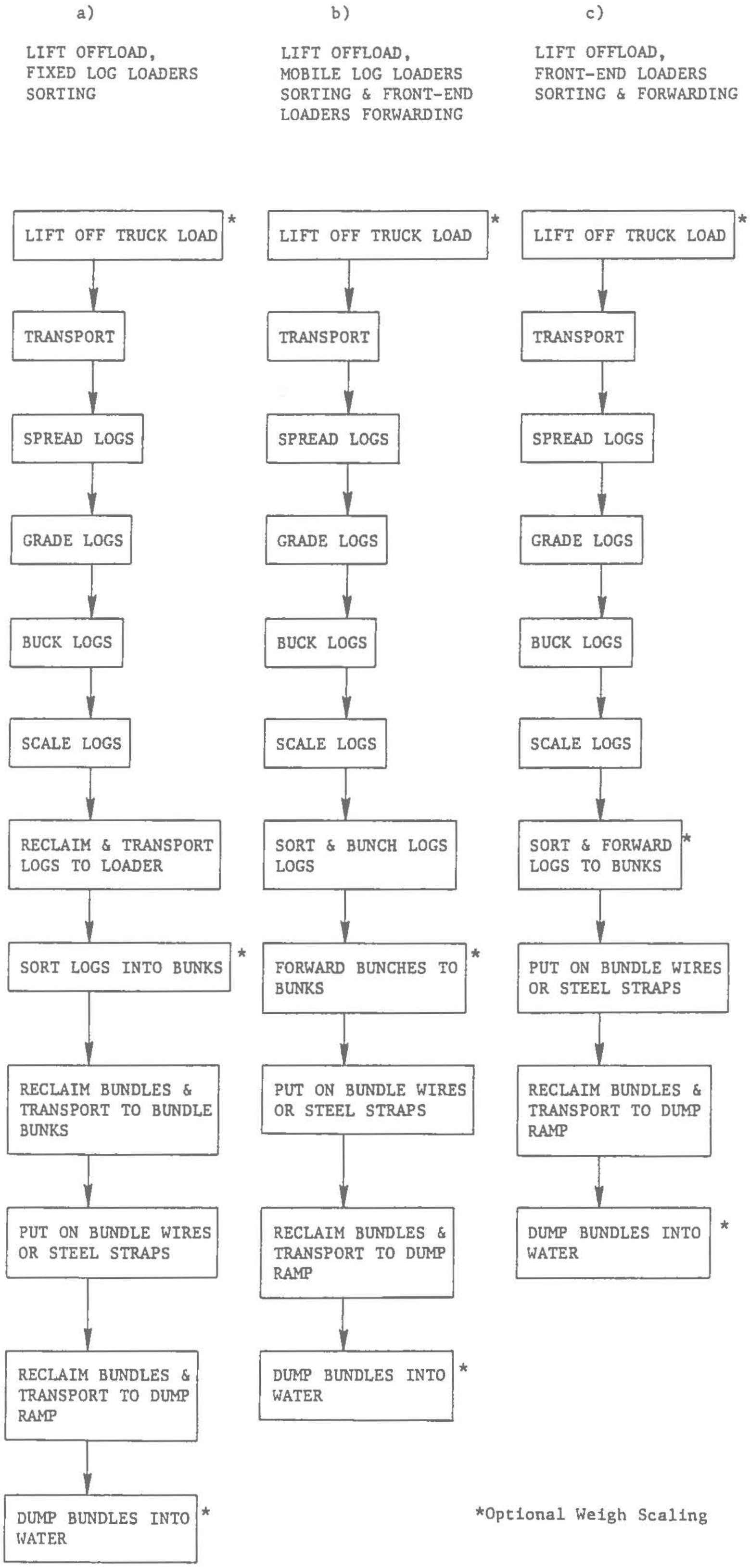


Figure VI-19. Sorting Systems in Large Yards (above 1 100 m³/day).

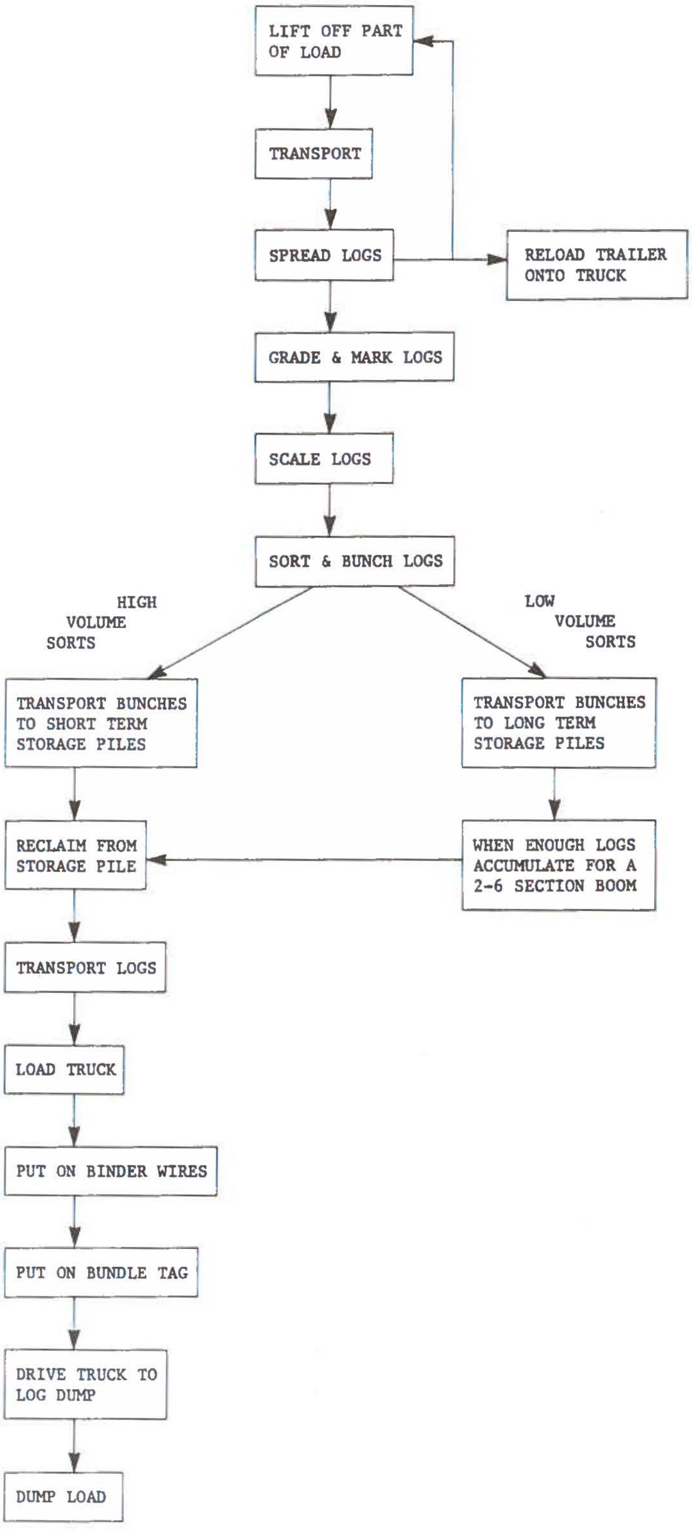


Figure VI-20. Detail of Multi-Pass Lift Offload, Stick Scaling (less than 1 100 m^3/day).

2. Flow Diagrams

Flow diagrams of proposed sorting systems can be used to analyze the system's efficiency and sequence. The level of detail required varies with the intensity of analysis but, for sortyard design purposes at least, each material handling operation should be included. The flow diagram can be used to focus the project team's attention on the sorting system and to question the need for each operation and the proper sequence of that operation relative to others.

The procedure usually followed when carrying out flow diagram analysis is detailed below:

a) Diagram the Sorting System

First, lay out a process flow diagram of the sorting system. Input from quantity-type analysis, material flow or processing, support service requirements, queuing theory, inventory analysis, sortyard location, etc. determine a preliminary sequence of operations and activity locations. A process flow chart can, therefore, be drawn. The process flow chart for a simple yard layout is shown in Figure VI-21.

b) Question the System

Question why each operation in the flow process chart is performed, what other ways it can be performed, where it should be performed and how much area is needed to perform it. The following asks these questions of the flow chart in Figure VI-21.

1

Weight scale - what are pros and cons of weight scaling? Is a weight scale needed? What type of scale (pit or platform)? Length and width of scale deck? Capacity of scale deck? Location and size of scale shack? What are agency regulations with respect to scale and scale shack?

2

Does truck need binders? What protection needed for drivers? What type of binder rack? What height and length of binder rack? Where should binder rack be located?

3

What distance from binder rack to truck unload area? What type of road surface? How wide should road be?

4

What type of unloading system? How much room to allow for unloading? What length and width for unloading area? What is length, turning radius, tail swing of unloading machine? What is normally the longest log to be unloaded? Any unique load sizes or shapes?

5

Are trucks self-loaders or do trailers have to be reloaded with another machine? Reload trailers with an unloading machine or with a trailer reload? What size for trailer reload?

6

Will trucks need water and fuel? Should station be next to trailer reload or at yard repair shop? Should all three facilities be together, paired or independent? Supply of water and electricity? Area required for station?

7

Can the truck drive straight out of yard or will it have to turn around? Will trailer be up or down as truck leaves yard? What area to allow for turnaround?

8

Where is storage? Surge or seasonal storage? Storage area gravel surfaced, asphalt surfaced or gravel/asphalt strip? How much storage needed? How long, high and wide are piles? Logs stored on yard

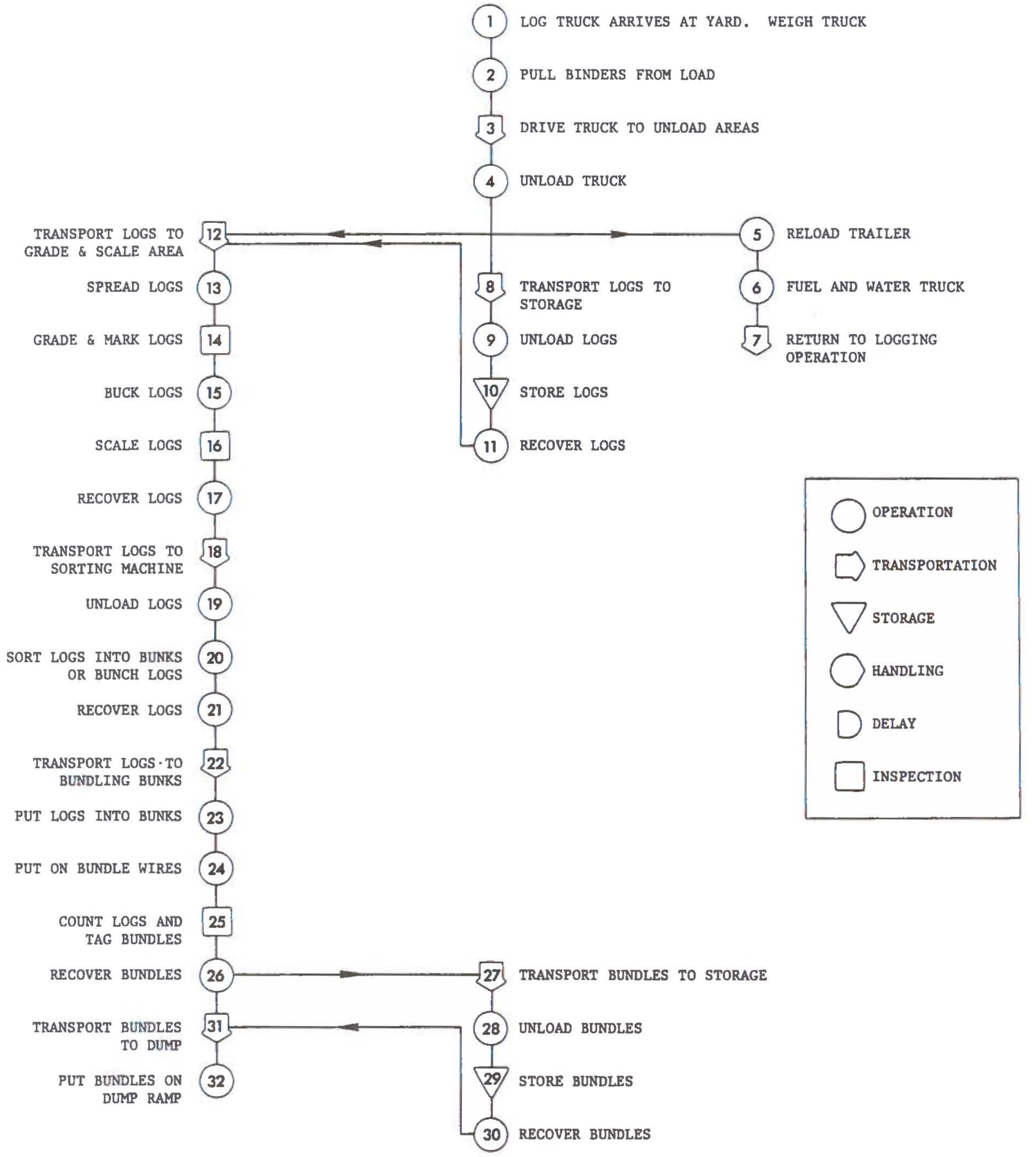


Figure VI-21. Process Chart of Sorting System.

surface or on top of brow logs? What type of storage configuration? How far is storage from truck unloading and grade and scale areas? How often do loads go to storage?

9 Storing loose logs or bundles of logs? Are storage back-stops going to be used? Are log butts always going to be on one end or are the logs going to be stored butt and top?

10 How long in storage? What is fire fighting system? Where is water source? Can area be accessed with fire fighting equipment? Porta Tanks? What about ambrosia beetle control systems? What about water drainage?

11 What machines are going to be used for log recovery? How are Jack-Strawed logs going to be reclaimed? How much log breakage? What is log recovery pattern - random, daily, or seasonal?

12 Where is grade and scale area? How far from truck unloading and log storage area? How many bays? What length and width of bays? What distance between bays? What is surface in area? Where is the scaler and grader shack? Where are paint, supplies, log tags, chainsaws, oil and gas stored? Where does the crew eat? How many people working in the area?

13 What is spreading technique? How much area should be allowed for spreading? Can unload machine operator see what he is doing when spreading? Spread logs on the ground or on brow logs? How and when is area cleaned of log debris? How many loads spread per bay? Will scalers be working near machine when it is spreading logs? What are safety conditions?

14 What are grading rules? How many graders? What configuration should logs be in for the graders? How is grade going to be indicated on log - tags, paint or log crayon? How long will graders take to grade a bay? What training and experience needed for graders?

15 Buck logs before or after grading? Who decides where log bucked? How many additional pieces are created by bucking? What is minimum-sized piece the machines can handle?

16 What type of scaling? How many scalers? Should logs be scaled and sorted or sorted and scaled? How fast can scalers scale a bay? What conditions do scalers need to work safely?

17 What machine will be used to recover logs? How long will it take to recover a bay of logs? How many logs can it reclaim at a time?

18 Where is sorting machine with respect to grading and scaling bay? How many logs per hour does sorting machine need to keep busy? Should logs go to sorting machine or to decoupling storage?

19 How big a pile of logs can be put in front of sorter? How should logs be aligned in front of sorter? Can sorting machine operator still see sorting marks on the logs after recovery and transport from grading and scaling bay?

20 How many bunks located around the sorter? What size of bunks? How much area allowed per bunk? How much area needed for bundle recovery from bunks? How much area for unsorted log pile? What is cycle time of sorter? What is maximum swing radius of sorter with a log in its grapple? What area for low-volume, sorted log bunches?

21 How much room is needed for manoeuvring and backing-up of bunk unloading machine? Will logs be loose in bunks or bundled? How will unloader know a bunk has to be unloaded? How many bunks to be unloaded per hour? How long to unload a bunk? How easily can bunks be moved? How are small bunches of logs moved - same machine as bunk unloading machine?

22 Where are bundling bunks? Are separate bundling bunks needed? How many bundling bunks? What width and length needed for bundling bunks?

23 What size and shape bundling bunks - same size and shape as sorting bunks? What area needed for machine entry and manoeuvre at bunks? How many people in the area?

24 Wire rope or steel bands? Where are wires or bands stored? Need a shack for crew and gear? Need electricity and compressed air? Safety of workers?

25 How many people? Where are supplies stored? How are records kept? How do people get up and on to bundle - do they need to?

26 What room needed for machine manoeuvre, back-up and tail swing? How does operator know when bundle ready for pick-up?

27 Where is storage? How many cycles to storage per hour? Bundles stored by sort or what? What is surface in storage?

28 How high are bundles stored? How are bundles piled?

29 How long in storage for each sort? What provisions for fire protection, ambrosia beetle control, drainage, etc.? What are lighting levels?

30 What technique for bundle recovery? What is breakage in recovery? How are loose logs from broken bundles handled? Is there a facility for rebundling loose logs? How much room needed for turning and tail swing?

31 How many log dumps? What is distance from dump to storage and bundling bunks? What type of dump? How many bundles per hour at dump? What room needed for approach, manoeuvre, back-up and swing for stacker? What area needed for dump?

32 How are bundles placed on dump? How is log debris cleaned from dump area? What is surface slope at dump area?

c) Modify the System and Yard Layout

Answering the foregoing questions and balancing the flow diagram, activity relationships and other non-flow relationships should result in a basic layout. Once a basic layout has been achieved it should be drawn up to scale on a location plan. The plan should include underground and overhead lines, buildings, shops, scale pits, etc. If there are some basic decisions to make that the designer feels uncomfortable making by himself, then alternative layouts should be made with the various undecided options included. The layout plans should be discussed and criticized by the rest of the people involved in planning, building and operating the sortyard. There are numerous considerations that probably will lead to modification of the yard layout. They include:

- alternative handling methods;
- amount and type of inventories;
- site conditions and conditions in the area surrounding the site;
- alternative material or process flows;
- safety considerations;
- location of personnel facilities and buildings and type of facilities and buildings;
- location and availability of utilities and services;
- organizational structure, controls and procedures;
- form or shape of layout of specific processing areas;
- flexibility;
- ease of construction; and
- ability to expand in the future.

After the modifications have been made to the layouts the alternatives probably will have been reduced to two or three systems. At this stage, the people who will build, operate, service and receive logs from the sortyard should again be canvassed for comments on the layout. If they can be encouraged to ask "check" type questions it will be of great benefit. Although "check" questions can be frustrating to the designer, they are invaluable for ensuring that every move, every step, every possibility has been examined and justified. The "what if...?", "what would happen...?", "why not...?", "did you think of...?" type checks will help to ensure an efficient system is chosen.

d) Evaluate the Systems and Layouts

Once the two or three alternative systems have been scrutinized by the people who will build, operate and service the sortyard it is necessary for the designer to rank the layouts and make a recommendation. The ranking can be based on a simple list of advantages and disadvantages, a weighted factor analysis or a weighted factor analysis and cost comparison. Considering the amount of capital involved in building and equipping the yard, the last ranking system should be used. A simple advantage/disadvantage list will not convince senior management of the best layout on a project such as this. A list of factors that should be considered for use in ranking the alternative layouts include:

- capability of expanding in future;
- layout can be easily changed;
- layout is flexible;
- log flow is efficient;
- equipment handles logs efficiently;

- storage areas used efficiently;
- available space is utilized effectively;
- supporting services are part of the layout and integrated efficiently in it;
- working conditions for the employees are good;
- the operation is safe and can be kept clean;
- impact on the environment is minimal;
- the mobile equipment is well utilized;
- grading, scaling and sorting quality is maximized and log damage is minimized;
- mobile equipment has adequate service facilities, parts and personnel;
- can be effectively supervised and controlled;
- can meet production requirements;
- secure from vandalism and pilferage; and
- enhances company's public image.

The designer should get direction from senior management on the weight that should be attached to each factor. Weights from 1 to 10 should be attached to the foregoing factors. Each factor should then be evaluated, for example, from 4 to 0 where:

4 = excellent
3 = good
2 = average
1 = fair
0 = problem, shortcoming, poor

The weights and evaluations for each factor should then be multiplied and the results totalled for each layout. As the designer probably has a preference for one design, the best way to eliminate bias is to evaluate factors by layout rather than layouts by factors.

e) Costs of the Alternatives

This involves determining the initial investment in site construction, building and structures, mobile equipment, parts and supplies, inventory, land acquisition and the annual operating and repair and maintenance costs. Any savings one layout has relative to another that result from efficiencies upstream or downstream from the sortyard should be included. The capital and net operating costs of the alternatives should be compared, combined with the weighted factor analysis and a recommendation made to management on what layout to choose.

Before project approval has been given, the designer should consider drafting the layouts and including them in the proposal for funds for the sortyard. Although senior management may not be interested in the details of the operation of the sortyard, they will want an idea of what it will look like, how big it is, how it fits into the surrounding area, etc. Acetate overlays on aerial photographs of the site are particularly effective.

3. Simulation

Computer simulation involves building a mathematical model that closely approximates a real situation. The computer is then used to solve the mathematical model to predict what would happen if the real situation was operational. Rather complex mathematical equations are involved and because of the large number of variables, a computer is used to activate and operate the mathematical model. A simulation model can be built and solved for existing and potential dryland sortyards. It is possible to predict how a yard will operate without building a yard. Depending on the type of model, it is possible for the user to interrupt and override the model or make changes in the decision rules within the model to predict the impact of the changes. For example, the effect on the logging truck queue of changing the decision rule for the stacker from unloading priority to

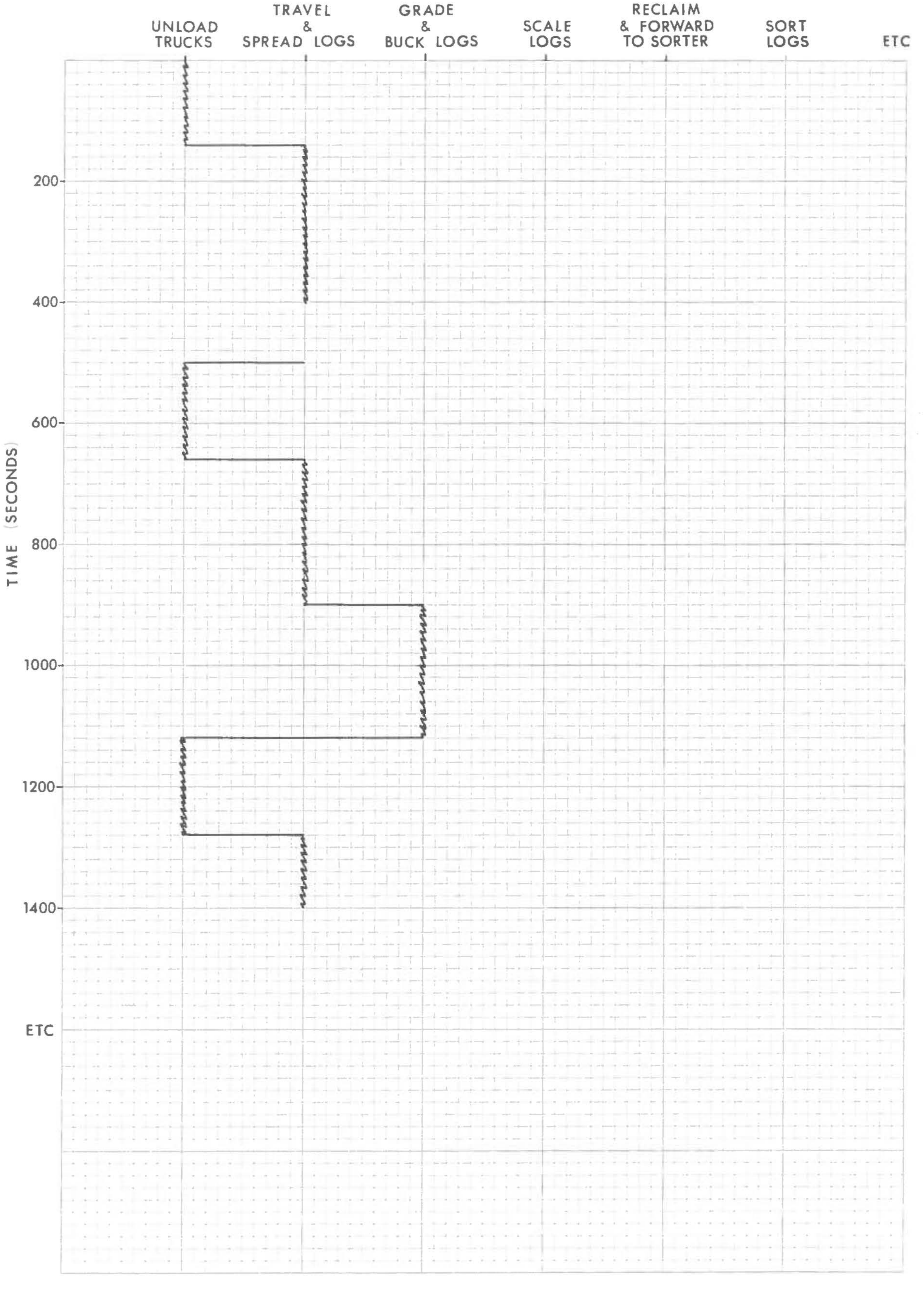


Figure VI-23. Layout of Graph Paper.

PART VII CURRENT PERFORMANCE OF SORTYARDS

keeping the sorting machines 90 percent utilized can be predicted. However, applications of simulation to sortyard analysis have been limited and usually are only found as classroom projects at universities. The reasons for this are that the setup time and expertise for building a simulation model are usually not available on a dryland sortyard project.

Manual simulation will also permit the project team to predict the performance of various dryland sortyard system proposals. A manual simulation is tedious and can not answer all the questions a computer simulation will but it will indicate whether a proposed system can or cannot process the volume of logs required. Once several of the proposals have been put through manual simulation analysis and it is proven that they can process the required volume of logs then capital, operating and maintenance costs can be attached to the proposals. The proposals can then be ranked on an economic basis prior to selection. If, in addition to practising good layout, material handling, queuing and inventory concepts, sortyard designers used manual simulation in the design of sortyards, then fewer under or over capacity yards would be built.

The information needed and the procedure to follow in making a manual simulation is:

a) Information Required

- Layout of yard
- Material handling flow system of yard
- Number of machines and men
- Cycle time for men and machines for various job functions
- Arrival rate and frequency of incoming log loads
- Species and grade distribution of incoming logs

b) Procedures to Follow

Using a roll of graph paper with a 10 squares to the inch grid, lay out a time scale on the y-axis and the material handling functions on the x-axis (Figure VI-22).

Initiate the simulation by assuming there are no logs in the yard and the first load of logs arrives. Indicate the unload time under the "unload trucks" function (Figure VI-22) by marking the length of time on the grid. If the next function is to travel to the grading and scaling bays and spread the logs, then mark the line across horizontally to that function. Next, mark down the grid under that function for a length equal to the time to travel and spread the logs.

If the graders and scalers work under the rule that a bay is not graded or scaled until it is full, then the grading and scaling function cannot start in the simulation until the bay is full. The simulation will indicate some idle time until the next load of logs arrives. When the load of logs arrives a horizontal line is shown from the spread function back to the unload function. The process is repeated until a bay of logs is full and the graders and scalers can go to work.

After a bay is full of logs, run a horizontal line across to that function and down it for a length equal to the time to complete the function. The unloading machine, if free and if scheduled to do this in the material handling plan, can reclaim the logs and forward them to the sorting machine. This function is indicated by a horizontal line to that function on the graph paper and then down that function for a length equal to the time to forward the logs to the sorting machine. If a truck load has arrived in the interim and unloading trucks is a priority, then this decision rule applies and the unloading machine will have to go back to the truck unloading area and there will be idle time at the grading and scaling area. This is indicated by a horizontal line from the grading and scaling function to the unloading function, a vertical line at the unloading function and a blank space on the grading and sorting function (Figure VI-23).

The foregoing process is repeated over and over again as more truckloads of logs arrive and the yard begins to fill up and all machines and men become active. At the sorter, an assumption is made that the logs arrive as indicated by the species and grade information and the various bunks fill up accordingly. At certain times in the simulation, there will be cases where one of the machines can go to several jobs. At these times, decision

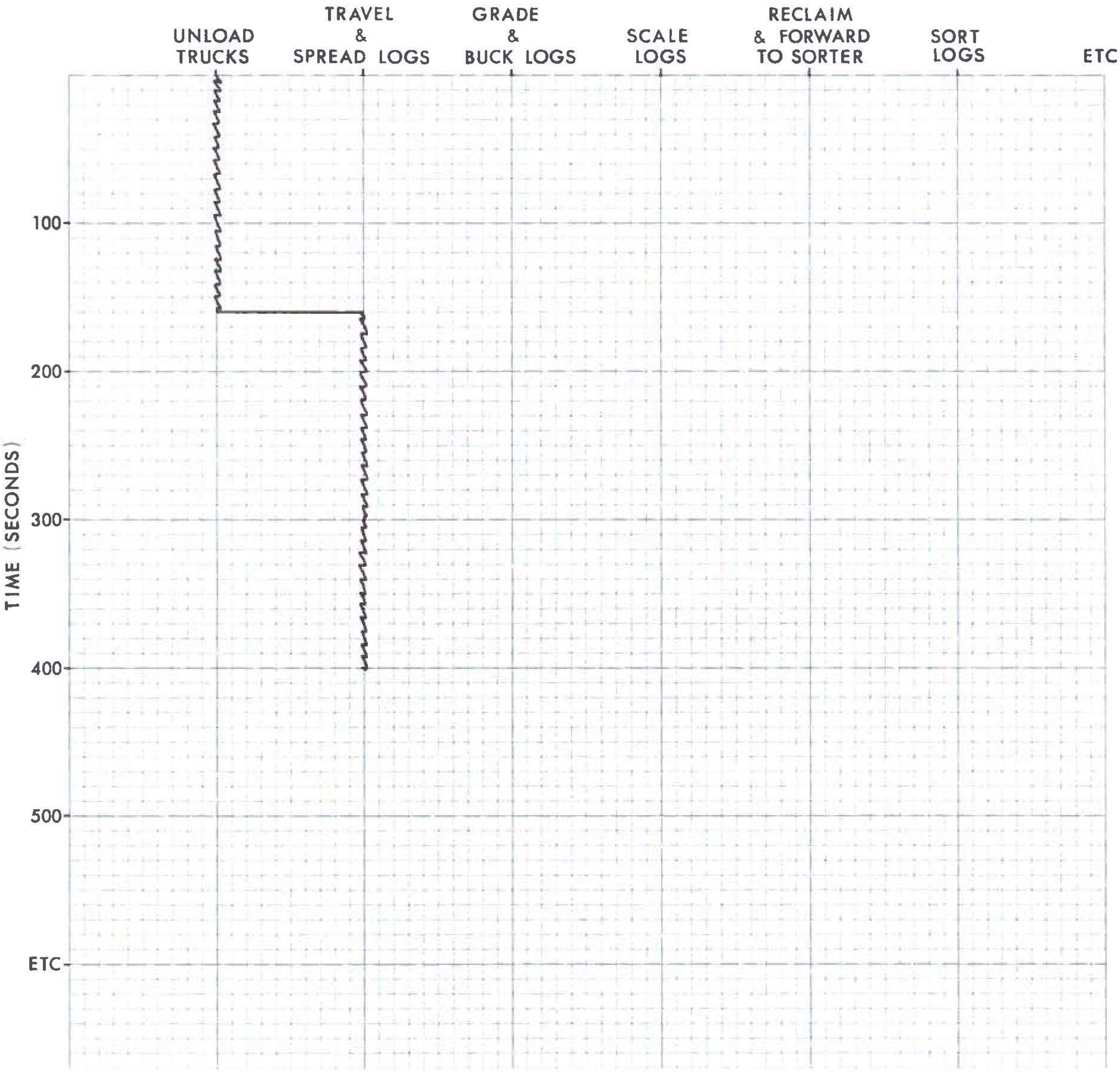


Figure VI-22. Layout of Graph Paper.

rules have to be applied and they should reflect what would happen in practice. Eventually, the machines and men either will or will not go into a rythmn or steady state condition. If a steady state condition does not happen then more manpower, equipment or storage will have to be added to the material flow plan or the material flow plan will have to be modified. Once the steady state condition is reached, the productivity of the yard can be calculated by measuring the time (y-axis) required to process a given volume of wood.

Manual simulation has its limitations relative to computer simulation in that it cannot easily examine several alternatives or scenarios. However, it is easy to set up and examine a few alternatives and it can tell you whether the system can or cannot process the amount of logs required. To be most effective, it requires a well-planned layout, material handling flow and machinery and manpower level. If this has not been done first, then time will be wasted revising the sorting system until it works.

PART VII CURRENT PERFORMANCE OF SORTYARDS

This section of the handbook documents the existing sorting systems, the costs, the productivities, the area requirements, the machine types, the manpower needs, and the advantages and disadvantages of different sorting techniques. While identical sorting systems usually cannot be applied in different locations, parts of them can. Awareness of what other people are doing successfully in their sortyards is an advantage when one is designing a new sortyard or contemplating changes to an existing one.

A. PRODUCTIVITY - SORTYARD

In a study for the Council of Forest Industries in 1979-80, FERIC documented the manpower, machinery, area and production in twenty-six different operations* on the coast of B.C. These data indicate the effect of yard size and sorted log storage on yard productivity.

1. Yard Size

The sortyards studied were grouped into four classifications based on the annual volume sorted. These data are shown in Table VII-1.

Table VII-1. Industry Averages - By Size Class.

Size Class (m^3/year)	0 - 170 000	170 000 - 453 000	453 000 - 736 000	736 000 - 1 416 000
Number of Yards	6	6	3	3
Average Number of Log Sorts	6.8	13	12.3	18
Average Annual Volume Processed (m^3)	96 760	319 070	516 367	1 136 575
Operating Shifts/Year	199	225	252	398
Piece Average (m^3/Piece)	1.44	1.30	1.93	1.50
Average m^3/Shift	486	1 418	2 049	2 856
Average Pieces/Shift	338	1 090	1 062	1 904
Total Land Area Used (ha)	1.57	7.98	8.93	7.95
Total Sorting Area Used (ha)	0.60	2.35	2.55	5.27
Number of Men	4.4	18.1	29.7	44.4
Manhours/Year	6 782	29 814	52 079	85 112
Pieces/Manday	79.02	65.72	41.04	71.17
Number of Sorting Machines	1.3	3.6	4.7	6
Pieces/Sorting Machine Hour	31.3	33.5	26.4	39.2
*Total Cost/m^3 ($)	3.55	4.33	4.10	3.31
*Total Cost/Piece ($)	5.12	5.64	7.89	4.97
*Total Capital Invested/m^3 ($)	5.20	8.85	7.70	6.11

*In terms of 1980 dollars.

It is evident that the smaller yards which do less sorting, have minimal log storage and use weight scaling more, often have the highest machine productivity, the lowest capital investment per cubic metre, lower than average total costs per cubic metre and piece, but lower than average manday productivities. The largest yards which do the most sorting, use stick scaling and have little sorted log storage, have the highest machine productivity, higher than average manday productivity, the lowest total costs per cubic metre and piece, and lower than average investment costs per cubic metre. The largest yards seem to achieve some economies of scale. The medium size yards may need more volume per shift, different sorting systems or less equipment and crew for the volume sorted in order to improve their productivity and costs.

*18 sortyards, 8 sorting and booming grounds

In determining these statistics, all personnel associated with the operation were included with the exception of mechanics, rehaul logging truck drivers, maintenance supervisors, debris disposal contractors, custom sorting crews, outside tugboat crews and clerical staff. All sorting equipment was included with the exception of contract debris disposal equipment, tugboat crews and clerical staff.

2. Sorted Log Storage

The 1979-80 study for the Council of Forest Industries showed that sortyards without sorted log storage were more productive than yards that included this function.

Table VII-2 shows two very similar yards with the exception that Yard A had sorted log storage and in Yard B the sorted logs were dumped directly into the water. As indicated, the manday and machine productivity in Yard A is lower because of the additional material handling steps required to put logs into storage and recover them rather than dumping them directly into the water.

Table VII-2. Effect of Sorted Log Storage.

	Yard A With Storage	Yard B No Storage
Average Annual Volume (m^3)	343 620	298 780
Average Annual No. of Logs	269 100	257 750
No. of Sorts	less than 15	less than 15
Scaling Method	Stick	Stick
Average Annual Shifts (8 hr)	235	237
Storage Area (ha)	7.2	1.2
Pieces Throughput/Storage Hectare/Year	37 375	214 790
Average Sorting Area (ha)	2.57	2.33
Pieces Throughput/Sorting Hectare/Year	104 710	110 620
Pieces/Manday	62.0	75.6
Pieces/Machine Operating Hr.	36.2	39.3

B. LAND AREAS

1. Overall Statement

The area required for sorting logs (the unloading, grading, scaling, sorting, bundling and dumping areas) increases with the volume sorted, the number of sorts and the pieces processed per shift. Figures VII-1, 2 and 3 show the results of a comparison of these variables with sorting area.

Figure VII-3 has particular significance to coastal sortyard operators. Area requirements increase by a factor of about 0.3 for an increase in the number of pieces. Piece size is diminishing as more second growth stands are harvested and more area or more operating hours will be needed to sort the same volume.

2. Unloading Area

If the truckloads are pushed off onto ramps, then a 10-metre wide strip should be allowed in front of the ramps for the truck and front-end loader (Figure VII-4).

Another 10 metres should be allowed for the ramps and still another 10-metre wide strip at the end of the ramps for spillover of the logs. Thus a 30-metre wide strip is required and about 25 metres of length should be allowed for each ramp. If a log stacker lifts off the loads, then a 38-metre wide strip should be allowed for the truck and the backup and turn of the stacker. The strip extends across the grading and scaling bays. If front-end loaders lift off the loads, then only 28 metres of width is necessary because of the smaller turning radius but the same length is required. If trucks are lift unloaded at varying locations within the yard, the same area will be required but will not be specifically allocated. Unless the trailer is reloaded by the unloading machine, then about 38 metres of width will be needed for turning the truck and trailer around.

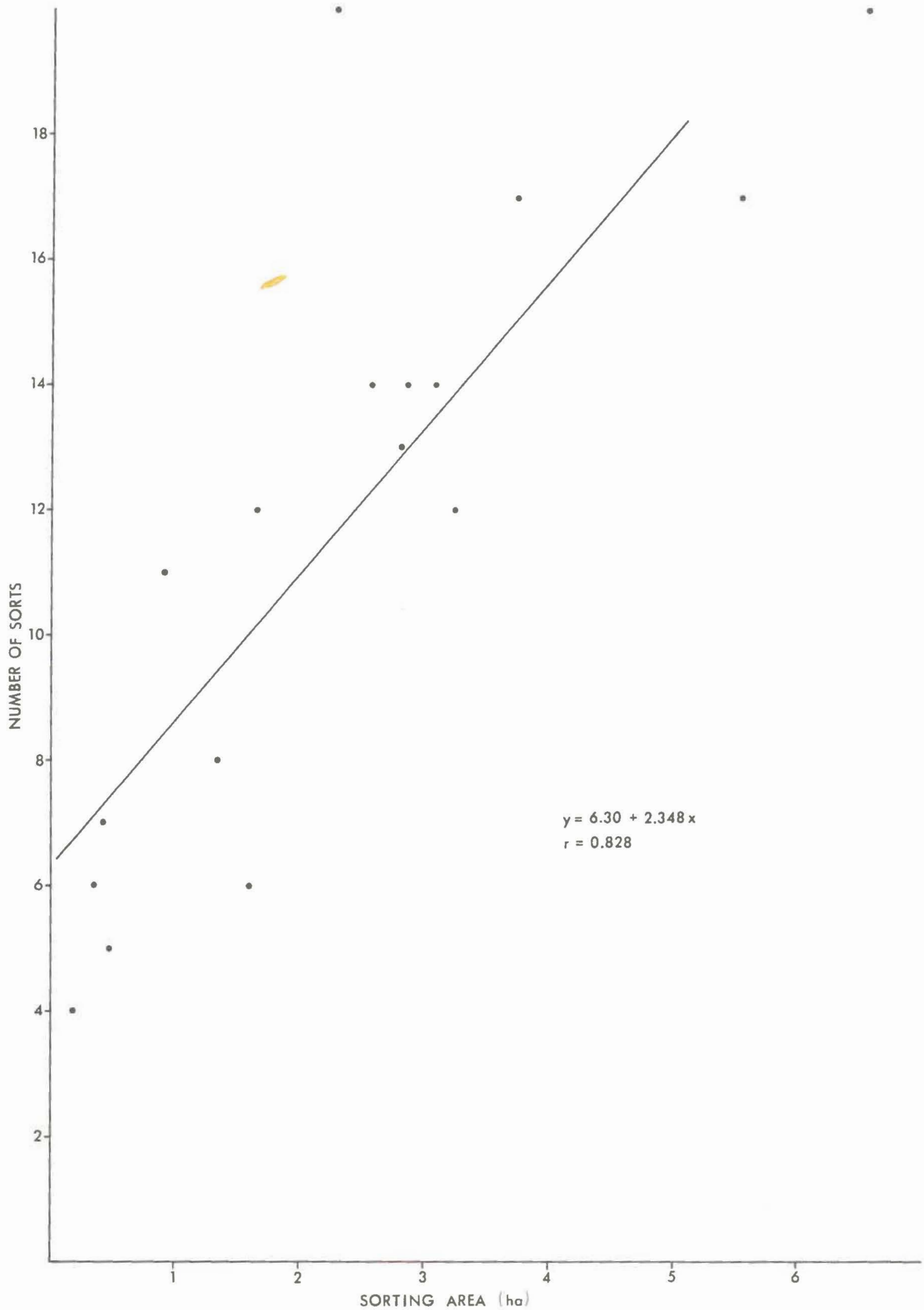


Figure VII-1. Hectares Required for Sorting Versus Number of Sorts.

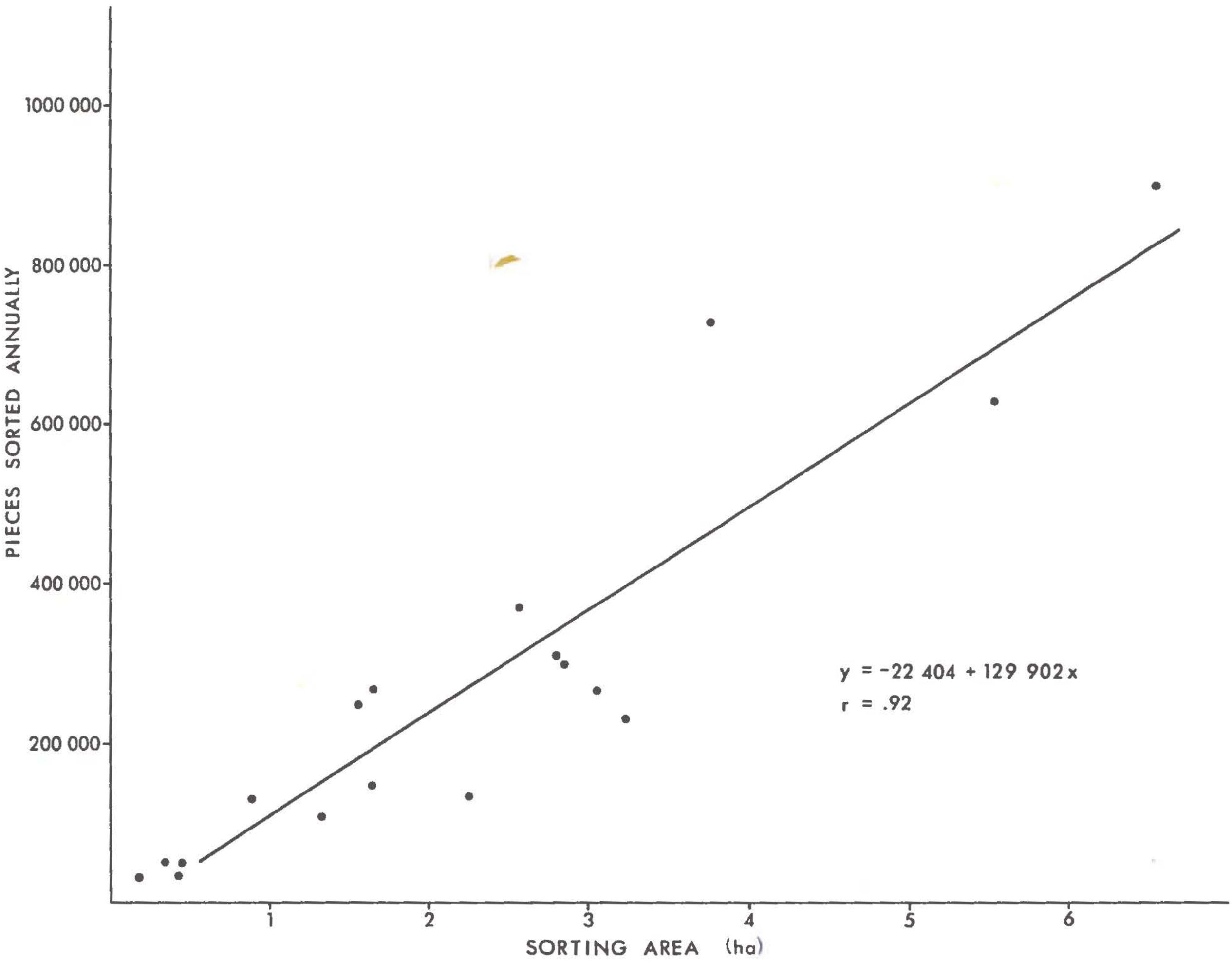


Figure VII-2. Hectares Required for Sorting Versus Annual Volume Sorted.

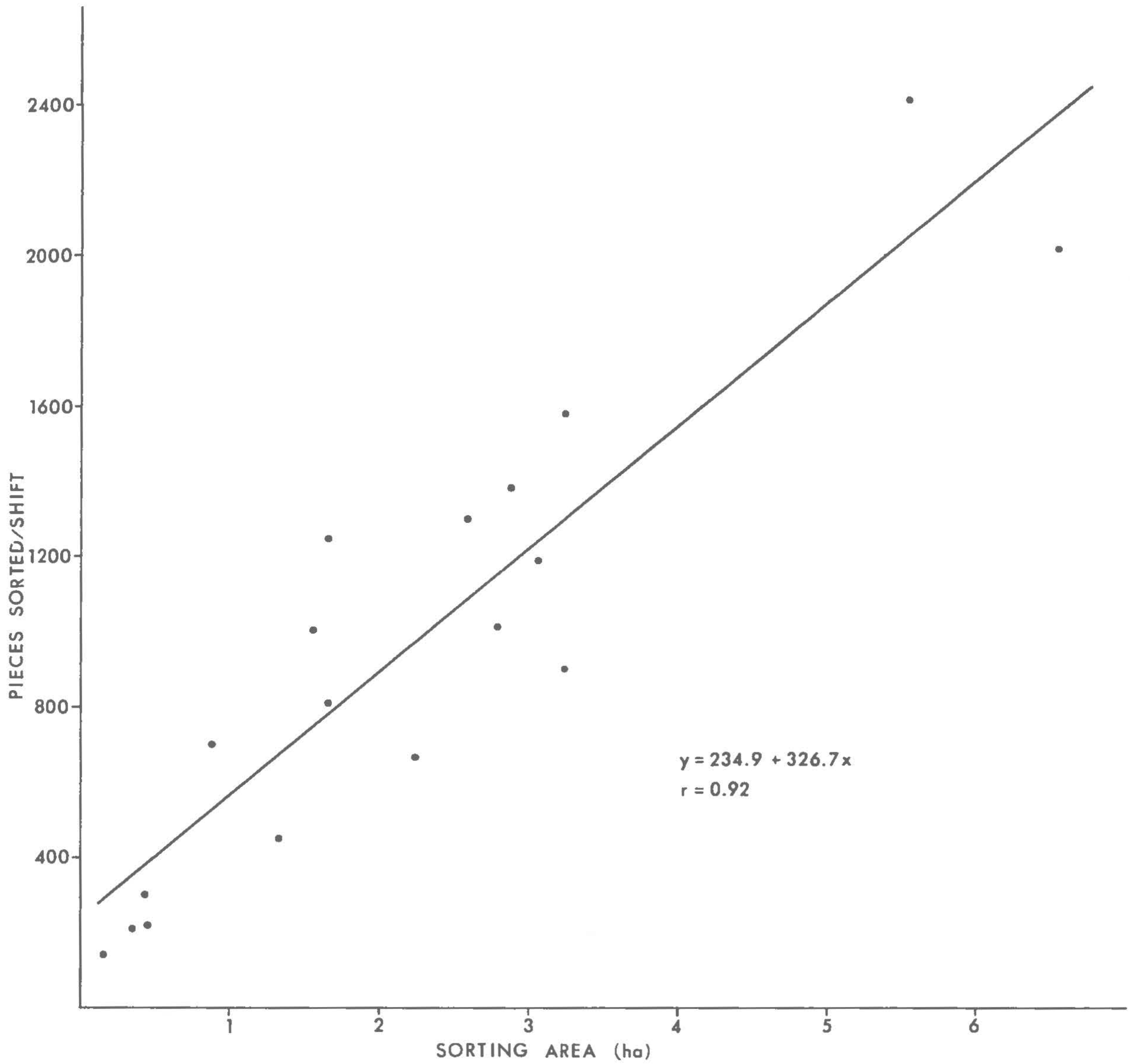


Figure VII-3. Hectares Required for Sorting Versus Pieces Sorted per Shift.

Figure VII-4. Push Unloading.

3. Weight Scales

The length of the area needed for the weight scales will be determined by the length of the logging truck and load. The width of the area needed will be determined by the length of the longest log, plus an allowance, that a front-end loader or stacker may carry onto the scale. Thus about 23 metres of width should be allowed. Allowances should also be made for the weighmaster's office and parking of personnel vehicles. If the scale pit is open on one side for cleaning, the down ramp may require an extra width allowance.

4. Grading and Scaling Bays

If logs are sorted in the bay after scaling, then a strip 38 metres wide should be allowed for the logs and travel corridors. If the logs are not sorted in the bay then a 30-metre wide strip is adequate. To estimate the length of the strip, multiply the number of logs by 0.76 metres. The number of logs can be determined by dividing the volume of the loads to be spread in each bay by the average piece size of the logs. Grading and scaling bays should be used as a decoupling inventory between the sorting machines and the logging trucks. The number of bays required depends upon the number of sorts, pieces and system.

5. Forwarding and Travel Corridors

Corridor layout requires a balance between economizing area and minimizing cycle times. If the corridors are narrow, twisty, or have sharp turns, the machines cannot operate as efficiently as if they are wide and straight with gentle turns. The width of a corridor is determined by the length of the logs (plus a 3-metre safety allowance) and whether or not there will be one way or two way loaded traffic. For one way loaded traffic, corridors should be about 23 metres wide. If the machines turn in the travel corridors, then turning radius has to be added to the log length.

6. Stationary Log Loader

Stationary log loaders usually have six or nine sets of bunks arranged around three quadrants of a circle. If large bundles are made (50 m^3) it may be difficult to arrange nine bunks around the loader. The fourth quadrant is used for the unsorted log pile (Figure VII-5).

A 38-metre diameter circle should be allowed for the log loader and sorting bunks. In addition, a free area is required for the stackers to deliver and remove logs. The net result will be an 84-metre diameter circle.

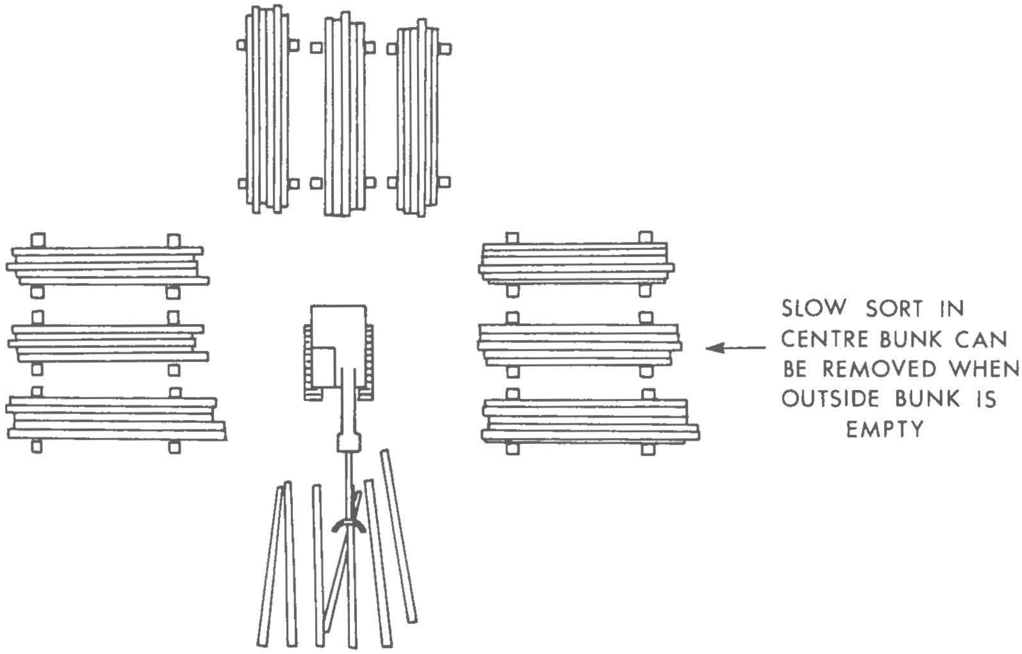


Figure VII-5. Stationary Log Loader Layout.

7. Sorting Bunks

A sorting bunk with working space requires a rectangular area 15 metres by 6 metres. Specialty bundles of poles and boomsticks may require extra space. Figures VII-6, 7 and 8 show some different designs of sorting bunks.

Figure VII-6. Sorting Bunks.

Figure VII-7. Sorting Bunks.

Figure VII-8. Sorting Bunks.

8. Bundling Areas

If a mobile bundling machine is used, the only area necessary is a place to store materials. At a stationary location, in addition to the 15 by 6 metre area for the bunks, space will be needed for supplies and tools adjacent to the bunks. If bundle wires are used, an additional area of 11 or 12 metres should be allowed for unrolling wires. Provision should be made for a small building for the personnel near the bundling station.

9. Dump Ramp

The area allowance for the dump ramp will depend on whether the logs are bundled at the dump. If so, in addition to a travel corridor, a rectangular area of 6 by 15 metres will be needed for the bundling bunks as well as an area for bundling supplies. The travel corridor need only be 14 metres wide as only one loaded machine will use the ramp at a time. The length of the corridor will depend on yard layout but the minimum should be enough for the stacker to back up and turn around (15 metres).

10. Storage Areas

The volume of wood that can be stored in a given area varies with pile height, layout of the piles, log size and length of the pile. For storage decks (as shown in Figure VII-9) where pile height is 4.6 metres, the logs are sorted and bundled, and the pile length is greater than 60 metres, a storage density of 7 700 m^3/ha can be achieved. For loose logs, unsorted logs and shorter pile length the density will be lower. Incoming log storage usually is of this type and the density is of the order of 4 200 m^3/ha. In the log storage area, space between the decks must be allowed for men and equipment to gain access in case of a fire. The total volume that can be stored in a log pile will be only 60 percent of the space occupied.

Figure VII-9. Storage Decks.

To ensure that the potential storage is achieved, it is important for operators to pile the logs carefully. Recovering the logs from poorly piled storage will be less efficient and may cause log damage.

11. Boomstick Boring

Some dryland sortyards bore their boomsticks on land. Usually, it is done in a corner of the yard where it does not interfere with the other operations. As the boring machine must have access to both ends of the 20 metre boomsticks, an area 30 metres wide should be provided. The total depth of the boomstick area will depend on a variety of factors but 1.1 metres of depth should be allowed for each boomstick.

12. Miscellaneous Areas

In addition to allowing areas for the functions that are directly related to sorting, area also has to be allowed for activities or services that are indirectly related to sorting. These include maintenance shops, lunchrooms, offices, employee parking, fuel storage, trailer reload, repair parts inventory, tire storage, boom gear storage, etc. Space must be allowed for these items in the planning phase because they are essential to the smooth and efficient operation of the yard.

C. WATER AREA REQUIREMENTS

1. Booming Ground Design

The new dryland sortyard will require a new booming ground or modification to the old sorting and booming ground. Booming grounds have been built for years but the introduction of log bundles has introduced some changes in equipment and design.

Location of the booming ground, the sortyard and the dump ramp are interdependent. Ideally, the booming ground should be located in deep water so that environmental impacts are minimized and operations can be conducted at all tide levels. Also, it should be located so that water currents and the prevailing winds assist booming.

After allowance for a bullpen, the distance from the dump ramp to the booming pockets should be minimized in order to reduce the time spent pushing the bundles into the pockets. The layout of the booming ground should be centred around the dump ramp. A typical layout for a booming ground at a medium to large sized sortyard is shown in Figure VII-10.

Figure VII-10. Typical Booming Ground Layout.

If there is a river or stream entering near the booming ground, this can be used to advantage because the fresh water wash will reduce the incidence of marine borer infestation.* Any booming ground on the coast of B.C. should include a barge ramp for unloading and loading heavy equipment and a float and boathouse for boat tie-up, fueling and minor repairs. Fuel tanks must be enclosed inside concrete cribbing to prevent fuel entering the water.

The type of booming ground built will depend mainly on the water depth. In shallow locations (less than 3 metres of water at 0 tide), piling and dolphins are normally used to contain the standing boom (Figure VII-11). In deeper water, either a system of skylines and deadmen (Figure VII-12) or counterweighted lines and deadmen (Figure VII-13) will be used to secure the booming ground.

The best way to tell which of the latter two systems is being used is to look for the bobbers or floats. If floats are seen, then it is an inverted skyline type booming ground. There is disagreement as to which is the best type of system. The skyline proponents say that their system is easier to repair in case of failure, whereas the counterweight proponents say that their system is also easy to repair and the initial construction cost is much less. The counterweight system proponents also say their system maintains its alignment better and that when completed booms are pulled out of the pockets they have less tendency to hang up on the standing boom.

*See Bibliography for reference material on marine borers.

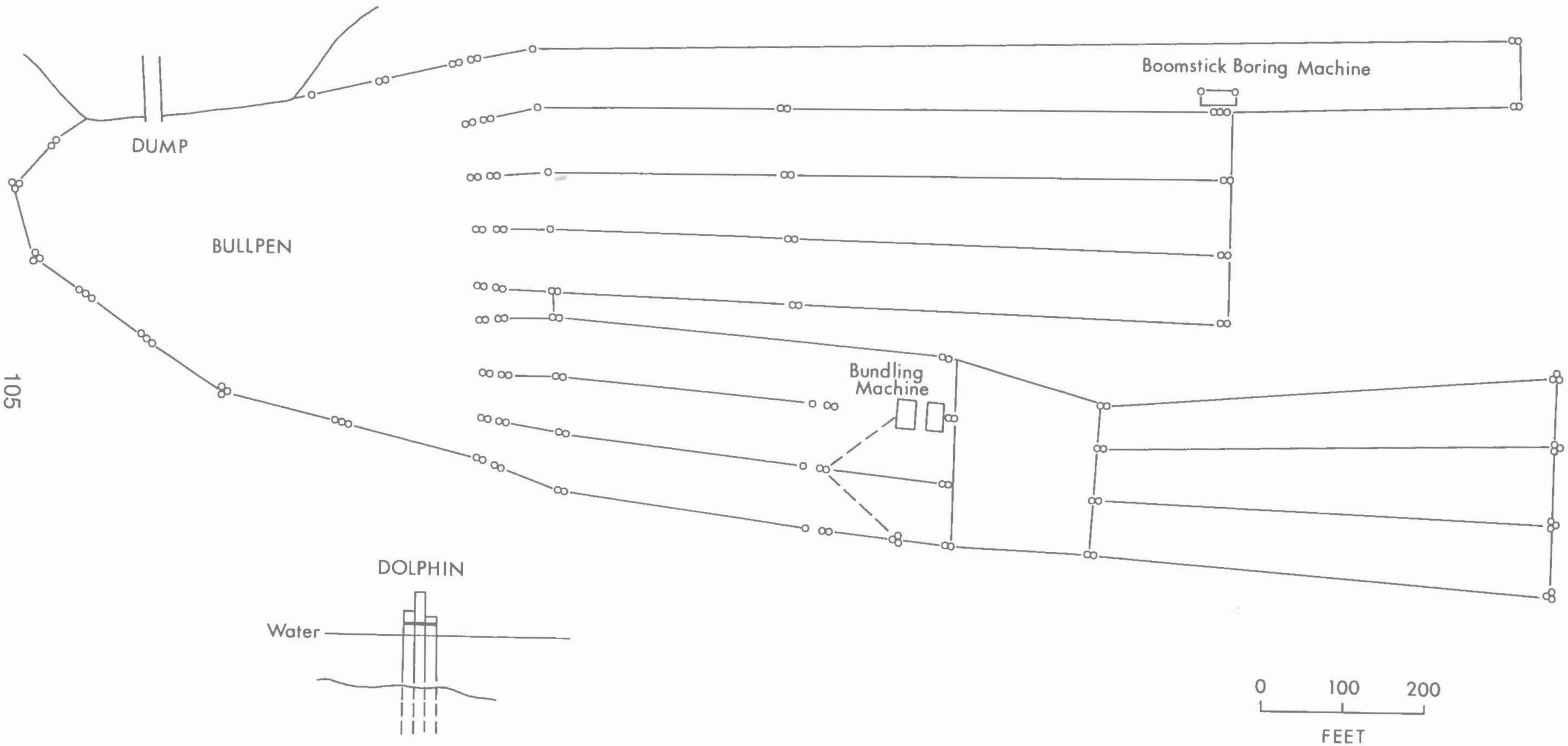


Figure VII-11. Dolphin Type Sorting and Booming Ground.

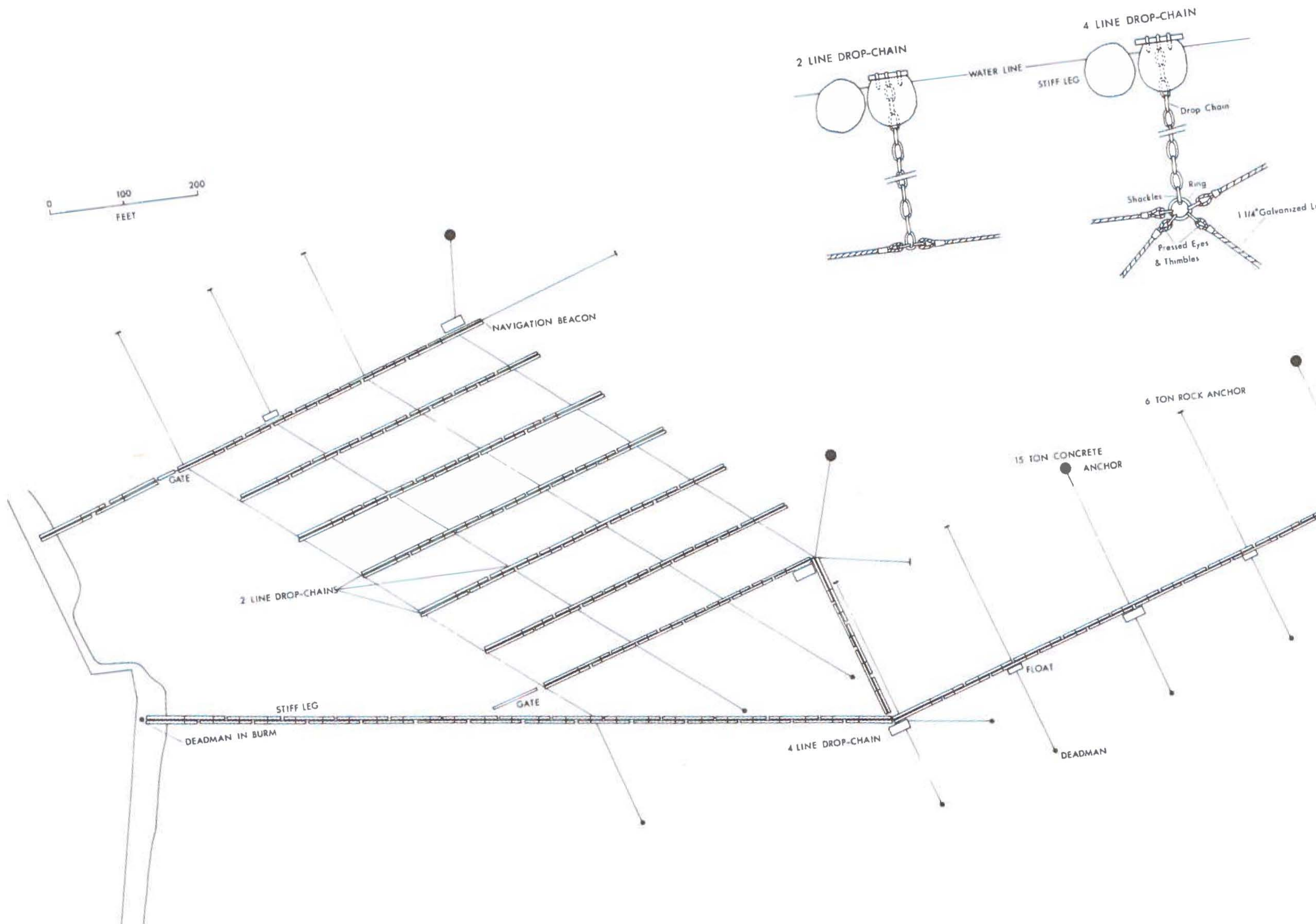


Figure VII-12. Inverted Skyline Booming Ground.

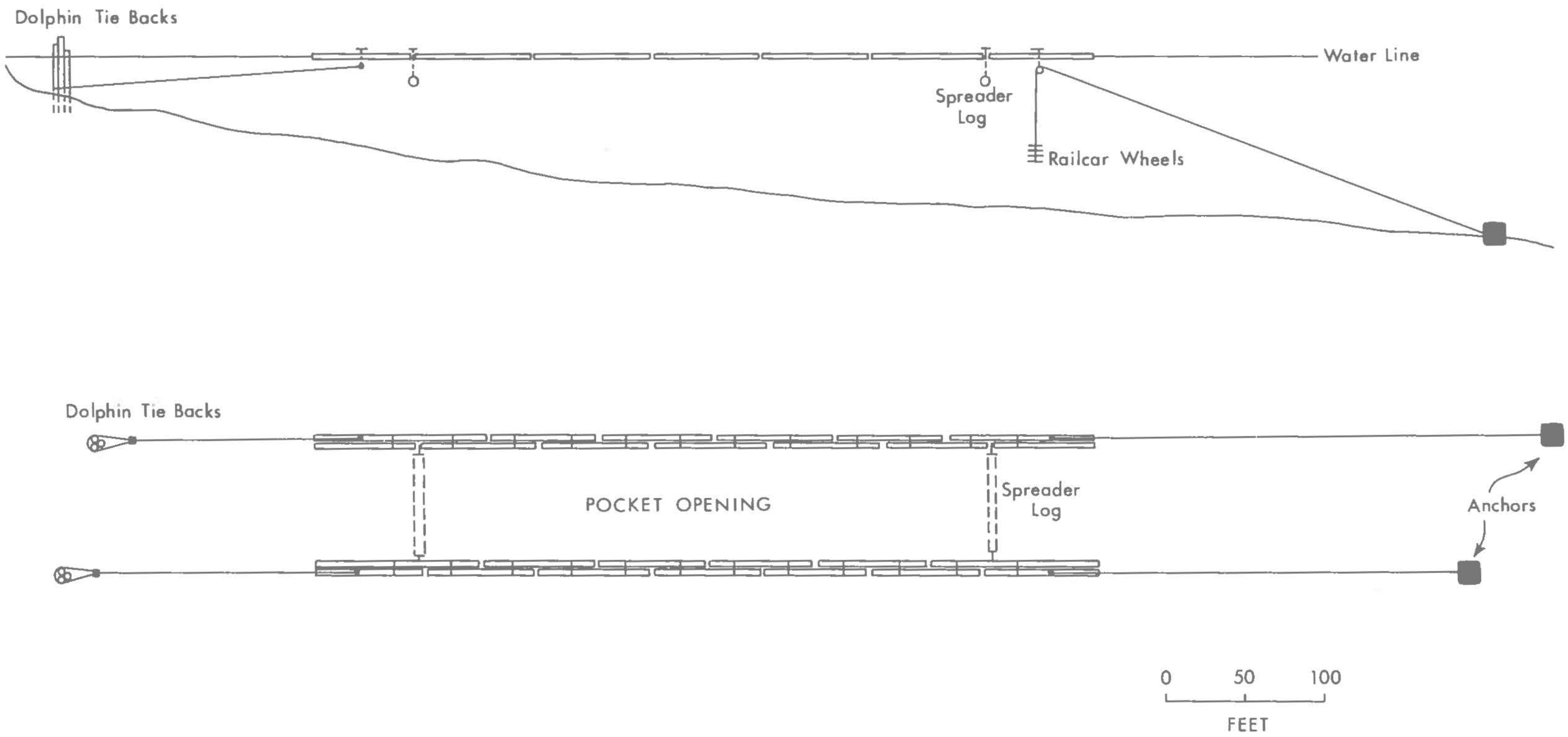


Figure VII-13. Counterweighted Booming Ground.

There have been some developments that have changed the design and operation of booming grounds. One change occurred when the boomboat manufacturers began mounting the swifter winch on the boomboat. Previously, the swifter machine was mounted on floats (Figure VII-14) and the unit moved up and down the outside of the pockets in alleyways.

Figure VII-14. Swifter Machine.

With the boat mounted swifter winch, these alleyways are not necessary because the machine can get between the standing boom and boomsticks of the boom. Thus the booming ground can now fit into a smaller area. Another change has occurred with the introduction of a larger boomboat designed to push bundles rather than logs. One booming ground was able to replace six of the smaller boats with two of the bigger boats. A further change was made in order to overcome problems caused by tides. This change involved placing two counterweighted boomsticks at the stowing end of the pockets. The sticks act like swinging doors. Once a bundle is pushed through them, it is impossible for the bundle to get out of the pocket. Consequently, when the tide changes, the bundles no longer float out of the pockets into the bullpen. A recent change has been the introduction of reinforced concrete standing boomsticks (Figure VII-15). Wooden boomsticks are becoming more difficult to obtain and their cost is increasing. In teredo infested areas, a boomstick's life can be less than six months. The concrete boomstick makes sense economically where there is a teredo problem and boomsticks are in short supply.

2. Bullpen

The bullpen area of a booming ground is the area from the shoreline to the pockets used for assembling the boom. In sorting grounds it is the area where the truckloads of logs are sorted but in booming grounds it is mainly a dumping area for the sortyard. If it is not going to be used as an inventory area to decouple the sortyard production rate from the booming ground production rate, then area requirements will be minimal. The length will be determined by the room needed for manoeuvring the bundles from the dump area to the booming pockets. The width will be determined by the number of booming pockets (Figure VII-16).

If the bullpen is used to decouple the yard from the grounds, then allowances will have to be made for temporarily storing the bundles. The average number of bundles to be held can be calculated by determining the difference in production rates of the sortyard and the booming ground, or if the number of pockets does not equal the number of sorts, then the number of bundles needed to make a boom in the lower volume sorts. Bundles that are floating free in the bullpen will occupy about 185 m^2 of space, although their actual physical dimensions are only about 85 m^2.

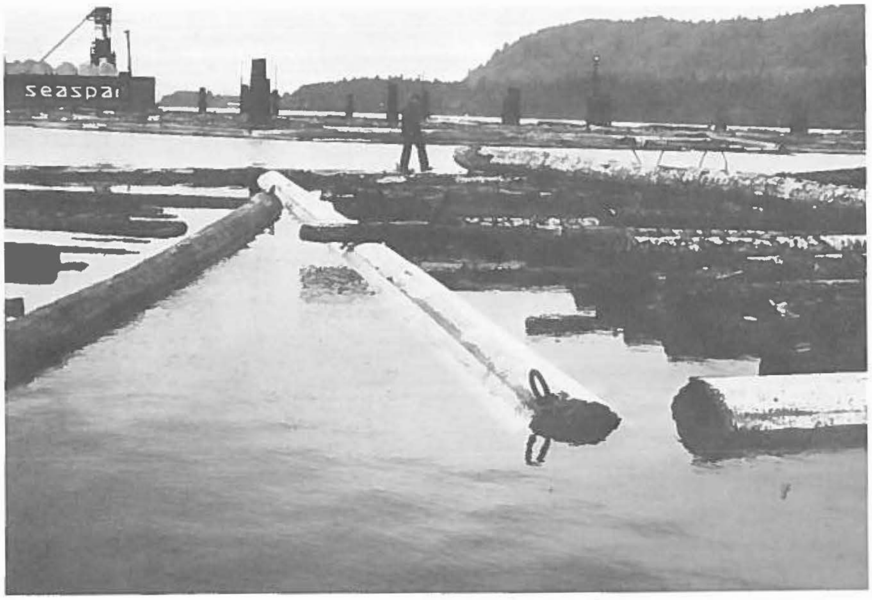


Figure VII-15. Concrete Boomstick.

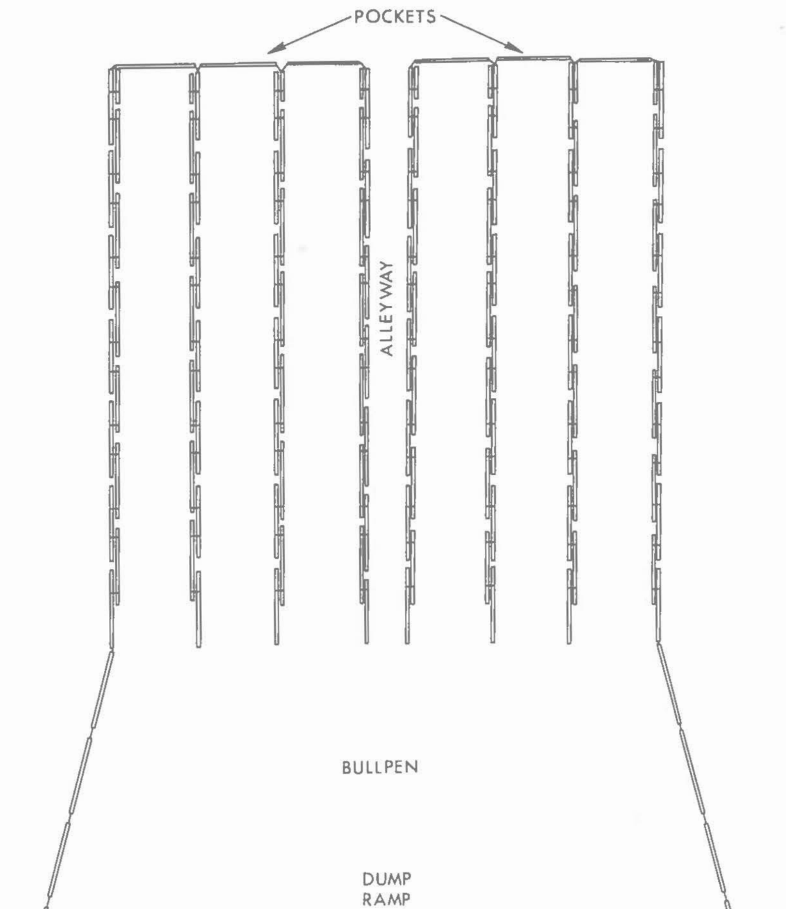


Figure VII-16. Area of Bullpen.

3. Pockets

The booming ground pockets are used to restrain the boomsticks as the bundles are being pushed in to make up the boom. The length of a pocket is determined by the number of sections in the boom plus one. Booms on the B.C. coast are normally four to nine sections long. Twenty-two metres of length should be allowed for each section and 22 metres of width when calculating area requirements. At least one alleyway will be needed for boats to get through the booming ground from the bullpen to open water. Normally, an alleyway will be 6 metres wide. If a swifter winch on a float is going to be used for pulling swifter wires, then an alleyway every second pocket will be needed. Common layouts for booming ground pockets are given in Figures VII-17 and 18.

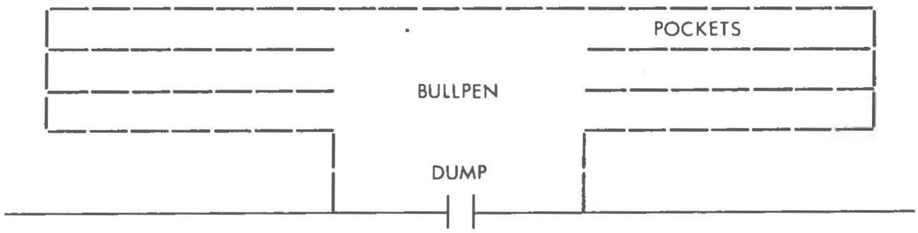


Figure VII-17. Common Booming Ground Layout.

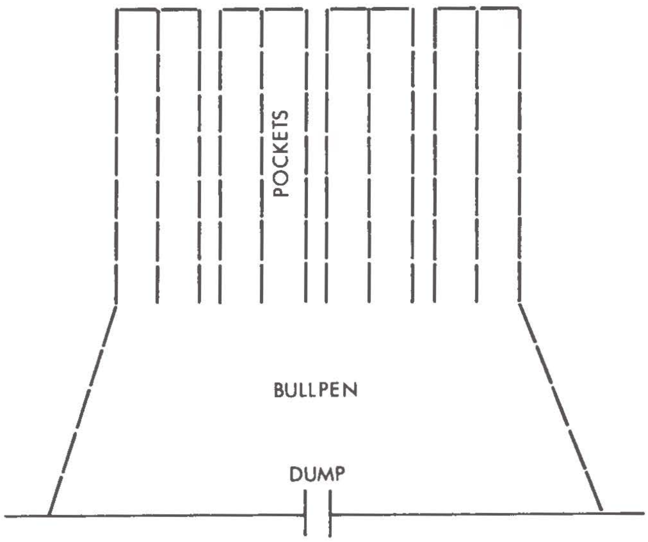


Figure VII-18. Common Booming Ground Layout.

The booming ground in Figure VII-17 is more common where exposure to tides and winds is a problem. It does not extend out far and thus is less exposed to winds and tides. The booming ground in Figure VII-18 is common where there is shallow water, and it extends further out from shore.

4. Storage Grounds

Storage grounds are always needed. They allow enough booms to accumulate to make up a tow, allow one destination mill towing, avoid towing during periods of bad weather and provide storage during poor market conditions. If possible, they should be located out of the path of storms, strong tides and prevailing winds. If they can be located near a fresh water wash, then the effect of marine borers is minimized.

As with the pockets, an area 22 metres wide by 22 metres long should be allowed for every section of boom that has to be stored. There is no area allowance for alleyways. In a study conducted by FERIC on area utilization, it was found that the section average for bundle booms was 260 m^3/section and an average 4 770 m^3 of bundled logs could be stored in a hectare of water storage grounds. Species, log size and bundle size cause variations of up to plus or minus 15 percent.

5. Miscellaneous Area Requirements

The booming ground area should include space for a barge ramp for shipping and receiving heavy equipment, a small repair shop for marine equipment and a wharf for boats. In addition, floats should be used for storing and transporting boom gear such as swifter lines and boomchains.

D. PRODUCTIVITY - TRUCK UNLOADING

1. Unloading Methods - Small Yards (< 1 100 m^3/day)

In small yards front-end loaders do all the functions. One front-end loader can process about 500 m^3/day where 10-12 sorts are made and the logs are stick scaled. Fewer sorts and weight scaling will increase this productivity. The machine size preferred is a 3.8 m^3 capacity (980-size) front-end loader. However, when two loaders are required, a 3.1 m^3 machine (966-size) may be used for sorting and bunching and a 3.8 m^3 machine for forwarding and unloading.

The truck unloading methods used are simple but require skilled operators. The push unloading method (Figure VII-19) is the quickest of the two methods but requires the unloading ramp to be carefully matched to the height of the truck bunks. It also requires good coordination between the truck driver and the machine operator when the truck stakes are tripped. The multi-pass lift unloading method (Figure VII-20) is safer than the push unloading method because no one has to be near the load when it is removed from the truck. However, unless the area where the logs are spread is relatively close to the truck, it can be time consuming as it can take 5 or 6 cycles to unload an off-highway logging truck. Consequently, it is necessary to bring the loaded trucks into the middle of the yard which adds to yard congestion.

Figure VII-19. Push Unloading Method.

Figure VII-20. Multi-Pass Lift Unloading Method.

Most of the small sortyards are contractor operated. The relatively low volume of log throughput prohibits the use of log stackers and asphalt surfaces. Lack of an asphalt surface reduces productivity and increases machine operating and repair costs. Most contractors operate their yards on a straight-through basis to minimize material handling and log storage. They are paid for volume sorted so their yards are designed to operate at a minimum cost.

2. Unloading Methods - Large Yards (> 1 100 m^3/day)

At a production level of about 1 100 m^3/day, stackers are introduced into the yards for unloading trucks, forwarding and dumping bundles into the water, and sorting bunks are used. The production level at which it becomes economic to use stackers depends on the material flow, yard layout, towing method, amount of log storage, transport distances, etc. Above 1 500 m^3/day log throughput, a second log stacker may be used, particularly if logs are stored on land.

There are exceptions. One yard processes over 2 000 m^3/day and uses one 5.4 m^3 capacity (988-size) front-end loader for multi-pass unloading of the trucks and a mobile log loader for loading sorted logs back onto the logging trucks for the trip to the booming ground. In another yard an existing mobile A-frame was overhauled to avoid the purchase of a 54.4 tonne stacker. The disadvantages are that more front-end loader capacity is required, the logs are handled more with increased chance of log damage, log bundle size is limited to about 11 cubic metres and the chance of logging truck queues is increased because of the lack of mobility of the A-frame unloading machine. However, if these disadvantages do not outweigh the added cost of a log stacker, then it is the correct system for the yard.

The size of the incoming off-highway truckloads often exceeds the capacity of the stackers. In many operations, load weights average 70 tonnes but may be as high as 90 tonnes. This did not cause a problem when A-frames were used but it does to a 54.4 tonne capacity log stacker. Consequently, unless modifications are made, the stacker cannot unload the trucks in one cycle. One such stacker modification is shown in Figure VII-21. The stacker grapple is enlarged and although the stacker cannot lift any more, it can enclose a larger load and pull it onto a ramp. The result is that the truck is unloaded in one cycle. Without stacker modifications the quickest unloading method is to enclose as much of the load as possible and pull it off the truck (Figure VII-22). The stakes on the logging truck must be modified so that they swing down as the load is pulled through and then return automatically to the upright position. The slower but most common method is to pierce part of the load, close the grapple and then lift it over the stakes (Figure VII-23).

Figure VII-21. Modified Stacker Unloading.

Figure VII-22. Pull Unloading Method.

Lift unloading requires skilled operators to prevent log damage. Because even a 54.4 tonne stacker cannot lift the entire load, some operations purchase 40.8 tonne capacity stackers to reduce their capital investment. However, this alternative sometimes limits the size of sorted log bundles and may result in higher than necessary booming and towing costs.

Most of the large yards are operated by the integrated forest companies. They are usually asphalt surfaced and use log stackers to unload trucks.

Figure VII-23. Lift Unloading.

3. Truck Unloading Time

Table VII-3 shows the truck in-yard time for the different unloading systems, machines and truck sizes.

Table VII-3. Truck Unloading - In-yard Time (FERIC Technical Note TN-70).

	SYSTEM*						
	A	B	C	D	E	F	G
Number of Truck Cycles	38	37	39	36	42	51	31
Time (Minutes)							
Remove Load Binders	1.1	0.7	0.6	1.4	1.6	0.8	0.2
Unload Truck	0.9	3.8	1.8	1.1	0.3	3.1	3.3
Reload Trailer	3.5	1.2	4.3	2.9	2.7	4.5	6.5
Wait Unloader	0.7	0.2	0.4	2.8	1.2	0.7	1.8
Wait in Queue	0.2	1.1	0.7	2.6	1.1	2.0	2.5
Water Truck	1.5	1.3	1.0	—	1.7	—	—
Weight Scale	—	—	—	0.4	0.3	—	—
Yard Travel	2.5	1.3	2.0	2.2	1.2	1.9	2.6
Other Delays	2.5	0.7	2.8	1.8	0.1	—	5.7
TOTAL	13.0	10.3	13.6	15.3	10.3	13.0	22.6

*System A - Push unload with Cat 988. Highway size logging trucks. Cat 988 also sorts, forwards and dumps logs.

System B - Multi-pass, lift unload with Cat 966 & 980. Highway logging trucks. Cat 980 & 966 also sort, forward and load out logs.

System C - Push unload with Cat D8. Highway and off-highway size trucks with various size trailers.

System D - Single and multi-pass, lift unload with 54.4 tonne LeTourneau stacker. Highway and off-highway trucks with various sized trailers. Stacker also forwards and loads out logs.

System E - Single-pass, lift unload with 45.4 tonne LeTourneau stacker. Highway size trucks. Stacker also forwards and loads out logs.

System F - Single and multi-pass, lift and pull unloading with 45.4 tonne and 54.4 tonne LeTourneau stackers. Highway and off-highway size trucks with various size trailers. Stackers also forward and load out logs.

System G - Single and multi-pass, lift and pull unloading with 54.4 tonne Raygo stacker. Highway and off-highway size trucks with various size trailers. Stackers also forward and remove logs from storage.

As can be seen from Table VII-3, the unloading time for the truck is a small portion of the total in-yard time for the truck. Reloading the trailer either by the unloading machine or with a stationary trailer reloader (Figure VII-24) is usually the greatest single element of the trucks in-yard time. Most yard operators strive for a truck in-yard time of less than 10 minutes.

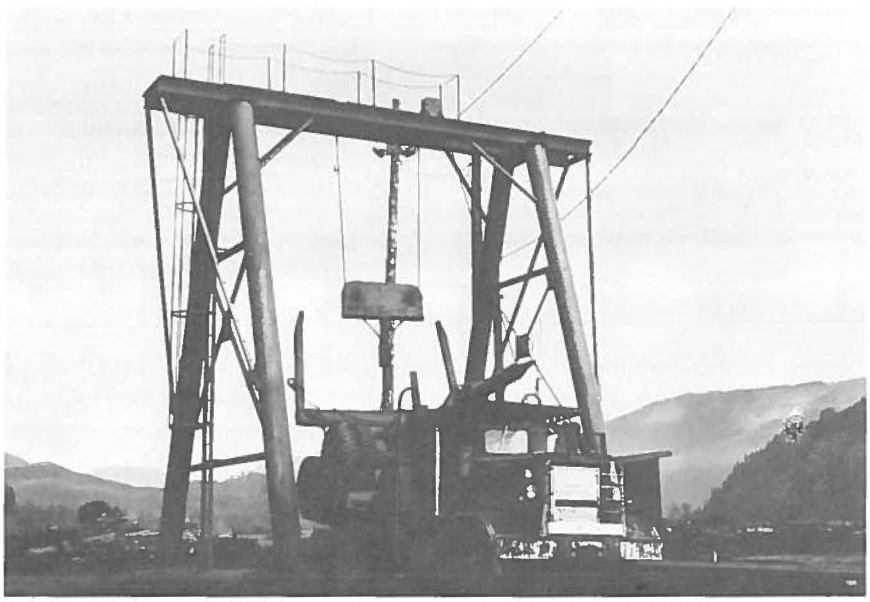


Figure VII-24. Stationary Trailer Reload.

Although the truck unloading time will vary with unload machine type, load size, yard layout, etc., some results of a truck unloading study done in 1981 by B.A. McMorland of FERIC are presented here (Tables VII-4 & 5) for reference purposes.

Table VII-4. Average Unloading Cycle Times in Yards Studied.

Function	**Time (min.)**	**%**
Wait in line	4.4	26
Reload trailer	3.9	23
Unload truck	3.1	18
Yard travel (truck)	2.1	13
Remove binders	1.0	6
Water-up	0.5	3
Weigh in/out	0.4	2
Other delays	1.5	9
	16.9	100

The study included all sizes of logging trucks found on the B.C. coast. It concluded that on an average basis, the longest time element was wait-in-line but on a yard-by-yard basis the longest time element was reload trailer. While it may not reduce the truck unload cycle time, the use of a trailer reload rather than the unloading machine to reload the trailer may reduce the cycle time of the unloading machine.

McMorland also classified his data by truck size and unloading method (Table VII-5).

Table VII-5. Average Truck In-Yard Time for Each Operation.

Truck Size	Unload Method	Average Truck Cycle Time (min.)	Unload Equipment
mixed	single pass — lift	7.6	A-frame
	single pass — push	10.8	Cat D8
highway only	multi-pass — lift	9.6	966 FEL
	single pass — lift	10.2	54.4 tonne stacker
	single pass — push	10.5	980 FEL
mixed	single & multi-pass — lift	11.3	40.8 tonne stacker
	single & multi-pass — pull	13.0	40.8 & 54.4 tonne stacker
	single & multi-pass — lift	13.5	54.4 tonne stacker
off-highway only	single & multi-pass — pull	16.9	54.4 tonne stacker
	multi-pass — lift	23.5	40.8 & 54.4 tonne stacker
	multi-pass — lift	28.9	988 FEL

In the majority of cases, truck in-yard time increased with truck size but, within a truck size class, the unload method, yard layout and unload machine affected truck in-yard time. The exception to the rule that increased truck size means increased in-yard time was the single-pass unloading systems. In single-pass unloading systems, the unload method is the prime factor in determining truck in-yard time.

It was mentioned earlier that selection of the unloading method and machine affects other areas of the sorting system as well as truck unloading time. This is illustrated in Table VII-6 which shows the time distribution of a 54.4 tonne capacity log stacker that is primarily used for truck unloading using the single pass, lift unloading method.

Table VII-6. Time Distribution of 54.4 Tonne Capacity Truck Unloading Stacker (FERIC Technical Note TN-64).

Function	Events Observed	%
Travelling - empty	49	14.9
Unloading trucks	42	12.8
In log storage area	36	10.9
Travelling - loaded	30	9.1
Spreading logs for grading	28	8.5
Reclaiming graded logs	27	8.2
Loading trucks for rehaul	14	4.3
Emptying sort bunks	3	0.9
Other	13	4.0
Idle - no wood	72	21.9
Idle - coffee/lunch	7	2.1
Idle - other	8	2.4
TOTAL	329	100.0
Total Elapsed Time	16 hours 22 mins.	

As can be seen from Table VII-6, the stacker was only in the truck unloading area 12.8 percent of the time. Location of the grading and scaling area with respect to the truck unloading area, frequency of truck arrivals, log unloading machine and method, log input volume versus log processing capacity, sorting system, etc. have a great impact on the time distribution of the unloading machine.

Tables VII-7 to VII-9 show the effect of truck size and the unload method on the truck unloading time. The data are from B.A. McMorland's time studies.

Table VII-7. Effect of Truck Size on Unloading Time.

Unload Method	Multi-pass, lift unloading		
Unload Machine	CAT 988B		
Truck Bunk Size (m)	3.0 - 3.7	4.0	4.3
Cycles Observed	30	9	3
Average Unload Time (min)	5.6	6.3	9.4
Average Passes to Unload	5.8	5.7	8.0
Unload Method	Multi-pass, lift unloading		
Unload Machine	40.8 tonne Raygo		
Truck Bunk Size (m)	3.0 - 3.7	4.0	4.3
Cycles Observed	13	6	4
Average Unload Time (min)	3.7	5.2	5.2
Average Passes to Unload	2.1	2.7	2.5

As the bunk width increases, the unload time increases, particularly if the unloading method changes from a single pass to multi-pass (Table VII-8).

Table VII-8. Effect of Changing Unloading Method on Unloading Time.

Truck Bunk Size (m)	3.0 - 3.7	
Unload Machine	54.4 tonne LeTourneau	
Unload Method	Multi-pass Lift	Single pass Lift
Cycles Observed	7	25
Average Unload Time (min)	2.7	0.7
Average Passes to Unload	2.0	1.0

Table VII-9 compares unloading times for similar size trucks with different unload methods.

Table VII-9. Effect of Unload Method on Unloading Time.

Truck Bunk Size	4.0 m		
Unload Method	Multi-pass Lift	Multi-pass Lift	Multi-pass Pull
Unload Machine	988B	40.8 tonne Stacker	54.4 tonne Stacker
Cycles Observed	9	6	14
Average Unload Time (min)	6.3	5.2	4.0
Average Passes to Unload	5.7	2.7	2.2

As Table VII-9 illustrates, a multi-pass pull system is quicker than a multi-pass lift. The time studies showed conclusively that truck unloading time was minimized when the load was removed in one pass.

4. Unloading Machine Time Distribution

The distribution of the unloading machine's time varies significantly with yard layout, material flow and other equipment (Table VII-10).

Table VII-10. Distribution of Unloading Machines' Time.

	Unloading Machine					
	45.3 t Stacker	54.4 t Stacker	54.4 t Stacker	54.4 t Stacker	988B	988B
Yard	A	B	C	D	E	F
Observed Time (h)	14.2	13.7	15.1	11.5	9.9	17.9
Time Distribution (%)						
Unloading	29	59	31	32	67	13
Sorting	36	—	5	—	9	49
Forwarding	19	13	29	38	11	7
Other	3	3	5	—	6	15
Delay/Idle	13	25	30	30	7	16

As Table VII-10 shows, time distributions vary widely between yards for the unloading machines. However, in a yard with one stacker, the time distribution generally will be 30 percent unloading, 30 percent dumping and 40 percent forwarding and other. If two stackers are used, then the unloading stacker time is usually 60 percent unloading and 40 percent forwarding and other. Similar relationships hold in yards with one or two front-end loaders.

E. PRODUCTIVITY - SORTING MACHINES

Front-end loaders and both mobile and stationary log loaders are used for sorting.

1. Mobile Log Loaders

Mobile log loaders which sort and bunch in the yard are usually crawler mounted. Rubber tired machines move faster but require outboard jacks for stability during lifting. Setting the jacks offsets the time saved.

The log loader may sort and bunch all logs in the deck area and behind itself in the travel corridor (Figure VII-25) or it may leave one sort unbunched, in the deck (Figure VII-26).

After the deck has been sorted, front-end loaders will push the remaining logs to the sorting bunks and load them into the sorting bunks. The system used will depend on the log size, number of sorts, and the time available for forwarding. In some yards, the mobile log loaders are used for decking logs. Log loaders can deck to a height of 8 to 10 metres whereas front-end loaders are limited to 3 to 4 metres and log stackers to 5 to 6 metres. The mobile log loaders may also load trucks if other machines are busy. If trucks are frequently loaded from storage rather than from the sorting area, then rubber-tired log loaders should be considered.

The size and type (not make) of log loader to select is important because of the high duty cycle and because the machine is moving much of the time. It may be sorting all the production from a logging division, whereas the loaders in the woods handle only a portion. The swing, lift and travel components must be able to withstand continuous operation with minimal breakdown. In yards which process relatively small logs, the question arises whether they should use a smaller loader. The answer is only yes if the machine has swing and travel capabilities and components to withstand the duty cycle. Small logs reduce the lift capacity requirement but may increase the requirement for swing and travel.

On the coast of B.C. several similar makes of log loaders of 1 m^3 capacity are used. No one brand seems to dominate. The differences occur mainly with the attachments. Machines with live heels, rather than heel racks on the boom, are popular because of their speed but they have more hydraulic circuitry and moving parts and, therefore, require more maintenance. Scissor-type grapples are preferred to the grapples with closing cylinders exposed to damage.

Figure VII-25. Sorting and Bunching in the Deck.

Figure VII-26. Sorting and Bunching.

2. Front-end Loaders

There are three distinct sizes of front-end loaders in use in sortyards on the coast of B.C. The most common has a capacity of 3.8 m^3 and others 5.4 m^3 and 3.1 m^3. The comparison of the machines is given in Table VII-11.

The 3.1 m^3 machine is good for sorting because of its physical size, speed and the capacity of its log grapple. Its load capacity limits it for forwarding. The 5.4 m^3 machine is best for forwarding bunches of logs, truck unloading and loading. Its grapple is too big for sorting small logs. The 3.8 m^3 machine is in-between and sorts, forwards, loads and unloads.

Table VII-11. Comparison of Characteristics of Front-end Loaders.

Size Class	3.1 m^3 (966)	3.8 m^3 (980)	5.4 m^3 (988)
Lift Capacity (kg)	4 700	7 000	9 600
Speeds (km/h)			
1st Forward	6.8	6.5	6.4
2nd Forward	12.2	11.4	11.5
1st Reverse	8.2	7.4	7.4
2nd Reverse	14.7	13.0	13.2
Clearance Circle (m)	13.5	15.6	17.0
Hydraulic Cycle Time (s)	11.6	12.7	16.9
Overall Length (m)	6.8	8.6	10.4

When front-end loaders are sorting, there are two systems in common use. In one system, the front-end loader works from the end of the grading and scaling bay and sorts the logs into piles (Figure VII-27). In order to reduce congestion, logs in low volume sorts or large logs are usually taken directly to sorting bunks. Once the deck has been sorted the remaining bunches are forwarded to the sorting bunks. In a second system, the front-end loader moves along the side of the deck and pulls out the logs (Figure VII-28). Usually the operators will pick the high volume sorts first. After these have been bunched and forwarded, the process is repeated until the bay is emptied. This system is used when, because of yard layout, the log flow has to be from right to left (Figure VII-28) rather than top to bottom.

Figure VII-27. Front-end Loader Sorting.

Figure VII-28. Front-end Loader Sorting.

3. Stationary Log Loaders

The stationary log loaders used are the same types and sizes as the mobile loaders. The difference in material flow is that the graded and scaled logs are brought to the loader for sorting. All loaders used in this application are crawler mounted. Pedestal mounts fix the loader to one location and reduce the flexibility of the yard. With crawler mounted loaders it is easier to substitute another machine in cases of extended breakdowns.

The standard layout for a stationary log loader sorting system is shown in Figure VII-29. As can be seen from the figure, unsorted logs are laid out in front of the loader and then sorted into six bunks located around the loader. If there are more than six sorts, the lower volume sorts are bunched for removal by a front-end loader.

Figure VII-29. Stationary Log Loader Sorting System.

This system has worked best where the average log size is relatively large (1.6 m^3/piece or greater) and the number of major sorts is relatively small (6). Some operations converted from this system to the mobile log loader system because of lack of forwarding capacity. The key to the success of this system is getting the logs to, and the bundles away from, the log loader as quickly as possible. In the operations where the stationary loaders are serviced adequately, relatively high sorting rates have been achieved (1 670 pieces/shift actual, 2 700 pieces/shift potential).

Two variations of the stationary log loader system are in operation. One locates the loader next to a mechanically operated grading deck which moves the logs to the loader (Figure VII-30). The loader makes four sorts into bunks and bunches the remainder of the sorts for forwarding to other bunks by a front-end loader. It has had an observed production rate of 1 200 pieces/shift with an estimated potential of 1 660 pieces/shift. Another system involves supplying logs and removing bundles with a portal crane (Figure VII-31). Use of the overhead crane has allowed ten, rather than six, bunks to be located around the loader. Both these systems are still sensitive to logs being delivered and bundles being removed quickly or production is restricted.

Figure VII-30. Stationary Log Loader and Mechanically-Operated Grading Deck.

Stationary log loader systems require one more transport step than the mobile log loader systems. This factor must be considered when evaluating sorting systems because it will require additional transport time. When choosing a stationary system, the designer is usually obligating the sortyard owner to purchase a log stacker.

Figure VII-31. Stationary Log Loader Serviced by Portal Crane.

4. Sorting Machine Productivity

Detailed timing studies were made on machines in different sorting systems by FERIC. The sorting systems chosen for study were ones where the front-end loaders or log loaders were primarily used for the sorting functions. The results are summmarized in Table VII-12.

Table VII-12. Summary of Sorting Machine Productive Capacity (FERIC TN-64).

System	Number of Sorting Machines	Total Pieces Sorted	Total Study Time (PMH)	Observed Pieces Per Shift	Productive Time Total Time	Sorting System Productive Capacity (Pieces/Shift)
A - Three front-end loaders	3	2 410	48.54	1 192[1]	0.79	1 508[2]
B - Two stationary log loaders	2	5 048	48.48	1 666	0.62	2 698
C - Front-end loader and mobile log loader with trailer	2	2 385	43.16	884	0.57	1 542
D - Front-end loader and mobile log loader	2	2 313	53.16	847	0.74	1 139
E - Front-end loader and stationary log loader at sorting table	2	2 314	31.00	1 194	0.72	1 662

[1] $\frac{2\ 410 \text{ pieces}}{48.54 \text{ PMH}}$ X 8 hr X 3 machines = 1 192 pieces/shift

[2] 1 192 pieces/shift ÷ 0.79 = 1 508 pieces/shift

Tables VII-13 to VII-17 give the time distributions of the machines in each of the five sorting systems.

Table VII-13. Time Distribution - System of Three Front-end Loaders (FERIC TN-64).

	966C Loader		966C Loader		980B Loader	
	Minutes	**%**	**Minutes**	**%**	**Minutes**	**%**
1. Productive Time:						
A. Sort & Forward	734.5	75.1	659.5	68.2	462.0	47.7
B. Reload Trucks	39.0	4.0	59.0	6.1	61.5	6.4
C. Debris Cleanup	56.5	5.8	55.0	5.7	156.0	16.1
D. Travel Empty	1.5	0.1	2.0	0.2	15.5	1.6
Productive Total	831.5	85.0	775.5	80.2	695.0	71.8
2. Non-Productive Time:						
A. Idle (No Wood)	36.0	3.7	32.0	3.3	104.0	10.7
B. Idle (Coffee/Lunch)	88.0	9.0	133.0	13.8	124.0	12.8
C. Idle (Other)	22.5	2.3	26.0	2.7	45.0	4.6
Non-Productive Total	146.5	15.0	191.0	19.8	273.0	28.2
Grand Total	978.0	100.0	966.5	100.0	968.0	100.0

Table VII-14. Time Distribution - System of Two Stationary Log Loaders (FERIC TN-64).

	Chapman 1825 Loader (#1)		Chapman 1825 Loader (#2)	
	Minutes	**%**	**Minutes**	**%**
1. Productive Time				
A. Sorting & Bunching	1 097.5	70.8	692.5	51.0
B. Forwarding	—	—	—	—
C. Debris Cleanup	5.0	0.3	1.5	0.1
D. Travel Empty	—	—	—	—
Productive Total	1 102.5	71.1	694.0	51.1
2. Non-Productive Time				
A. Idle (No Wood)	262.0	16.9	240.5	17.7
B. Idle (Coffee/Lunch)	2.5	0.2	—	—
C. Idle (Other)	184.0	11.9	423.5	31.2
Non-Productive Total	448.5	28.9	664.0	48.9
Grand Total	1 551.0	100.0	1 358.0	100.0

Table VII-15. Time Distribution - System of Front-end Loader and Mobile Log Loader with Trailer (FERIC TN-64).

	Travelling Log Loader (5800 T.L. Linkbelt)		988B Loader	
	Minutes	**%**	**Minutes**	**%**
1. Productive Time:				
A. Sort & Bunch	720.5	55.8	—	—
B. Forward Bunches	—	—	544.5	41.9
C. Forward Bundles	—	—	49.0	3.8
D. Travel	68.0	5.3	—	—
E. Unload Trailer	6.0	0.5	—	—
F. Debris Cleanup	—	—	96.0	7.4
Productive Total	794.5	61.5	689.5	53.1
2. Non-Productive Time:				
A. Idle (No Wood)	228.5	17.7	350.5	27.0
B. Idle (Coffee/Lunch)	237.0	18.4	223.5	17.2
C. Idle (Other)	31.0	2.4	35.0	2.7
Non-Productive Total	496.5	38.5	609.0	46.9
Grand Total	1 291.0	100.0	1 298.5	100.0

Table VII-16. Time Distribution - System of Front-end Loader and Mobile Log Loader (FERIC TN-64).

	Barko 550 Loader		980 Loader	
	Minutes	**%**	**Minutes**	**%**
1. Productive Time:				
A. Sort & Bunch	1 065.0	72.6	—	—
B. Forward	—	—	1 207.0	70.1
C. Debris Cleanup	—	—	99.5	5.8
Productive Total	1 065.0	72.6	1 306.5	75.9
2. Non-Productive Time:				
A. Idle (No Wood)	188.5	17.8	188.5	10.9
B. Idle (Coffee/Lunch)	195.5	13.3	209.5	12.2
C. Idle (Other)	18.5	1.3	17.5	1.0
Non-Productive Total	402.5	27.4	415.5	24.1
Grand Total	1 467.5	100.0	1 722.0	100.0

Table VII-17. Time Distribution - System of Front-end Loader and Stationary Log Loader at Sorting Table (FERIC TN-64).

	980 Loader		245 Loader	
	Minutes	%	Minutes	%
1. Productive Time:				
A. Sort & Bunch	—	—	667.0	72
B. Forward	625.0	67	—	—
C. Debris Cleanup	33.5	4	11.5	1
Productive Total	658.5	71	678.5	73
2. Non-Productive Time:				
A. Idle (No Wood)	122.5	13	112.0	12
B. Idle (Coffee/Lunch)	149.0	16	139.5	15
C. Idle (Other)	—	—	—	—
Non-Productive Total	271.5	29	251.5	27
Grand Total	930.0	100	930.0	100

In the systems where the sorting machines also unload the trucks and dump sorted logs into the water, the time spent sorting would be considerably less than the times shown in Tables VII-13 to VII-17. FERIC studied some of these systems as part of the work on truck unloading times and the results are given in Tables VII-18 and VII-19.

Table VII-18. Time Distribution - System of Two Front-end Loaders (No Stackers) - Load Out Trucks.

	Cat 966C		Cat 980B	
	Time (hr)	%	Time (hr)	%
1. Productive Time:				
A. Unloading Trucks	3.0	21	0.9	6
B. Sorting	4.2	29	3.9	27
C. Loading Trucks	1.8	13	5.8	40
D. Other	0.7	4	0.3	2
Productive Total	9.7	67	10.6	75
2. Non-Productive Time:				
A. Idle (No Wood)	2.7	19	1.8	12
B. Idle (Coffee/Lunch)	1.0	7	0.7	5
C. Idle (Other)	1.1	7	1.1	8
Non-Productive Total	4.8	33	3.6	25
Grand Total	14.5	100	14.2	100

Table VII-19. Time Distribution - Two Front-end Loaders (No Stackers) - Dump Bundles into Water.

	Cat 988B		Cat 988B	
	Time (hr)	%	Time (hr)	%
1. Productive Time				
A. Unloading Trucks	2.4	13	2.2	13
B. Sorting	8.7	49	5.3	31
C. Forward Bundles to Storage or Dump Ramps	1.2	7	2.0	12
D. Other	2.6	15	2.2	13
Productive Total	14.9	84	11.7	69
2. Non-Productive Time				
A. Idle (No Wood)	0.5	3	0.8	5
B. Idle (Coffee/Lunch)	1.9	10	1.6	9
C. Idle (Other)	0.6	3	2.8	17
Non-Productive Total	3.0	16	5.2	31
Grand Total	17.9	100	16.9	100

The productive capacity makes no allowance for idle time so the actual productivity obtained will be somewhat less than given in Table VII-20. In the study on the five sorting systems, the idle time varied from 21 to 43 percent, with an average of about 30 percent. With a normal amount of idle time (20 percent) and accounting for the difference in the number of sorts, the sorting systems on the average will give the following productivities (Table VII-20).

Table VII-20. Expected Average Productivities.

	System	Pieces/shift
(1)	Three front-end loaders sorting and forwarding to bunks	1 200
(2)	Two front-end loaders sorting and forwarding to bunks	900
(3)	Two stationary log loaders sorting, stacker forwarding	1 900
(4)	One front-end loader forwarding, mobile log loader sorting and bunching	900
(5)	One front-end loader forwarding, mobile log loader sorting, bunching and bunking sorts	1 250

It should be remembered that the sorting systems that include front-end loaders have more flexibility because the front-end loaders can be used for unloading, spreading, reclaiming, transporting and dumping as well as sorting. In some of the smaller yards (less than 700 pieces per day) two front-end loaders will unload, spread, sort and bunch, forward and load out all the logs. Because of the lack of mobility and multiple-piece carrying capability, a front-end loader and mobile log loader combination could not achieve this. Log loaders can sort smaller pieces and build a better bundle of logs than front-end loaders and have a valuable role to play in that situation. Stationary log loaders achieve high sorting production rates, but more transporting equipment time is needed relative to mobile log loaders because an extra material handling move is made. The mobile log loader systems where sorted logs are put into trailer bunks require more area than the mobile log loader systems that only sort and bunch logs.

F. MACHINERY SELECTION

Selection of the correct size, type and make of machines for the sortyard has a significant impact on potential productivity and costs. In addition, the sorting system will have a major influence on the type and size of machines needed. Also, selection of one type of machine will affect the other machines in the yard. Consequently, the machinery selection is an important but complex process. The Canadian Pulp and Paper Association has published a report entitled "A Checklist for Logging Machine Concept, Performance, Design, Maintainability and Support Services" (second Edition) which has a detailed list of factors to consider when choosing a machine. It also has a ranking system which allows comparison amongst different makes of machines.

1. General to Specific

The selection of a particular machine moves from general to specific. Initially, there will be several sortyard designs with different machine sizes and types. Calculations will have to be made with each plan change to ensure that the machines can still do the job expected of them. If not, more machines or different machines will be needed. Eventually, the number of system layouts is reduced to two or three alternatives. At this stage, a detailed analysis should be made of cycle times, travel routes, carrying capacities, etc. to ensure that the number, type and size of machines are adequate to process the log volumes required. Finally, one alternative is chosen. Throughout the process, salesmen will have described their equipment and field visits will have been made to see the various machines in operation. However, now a decision must be made not only on size and type, but also make. This decision is important and both operating and maintenance people must be involved. Ideally, a spread sheet will be prepared which compares the operating, maintenance, support and cost features of the various makes to provide specific details for a logical decision.

2. System Compatibility

Each sorting system and layout will demand certain machine performance levels for the various functions. For example, a machine must be able to unload a logging truck, spread the logs and return to the truck in six minutes or less. Or, a machine must be able to sort logs into an average of 12 sorts at a rate of 100 pieces per hour for eight hours per day and 210 days per year.

Generally, the simplest way to determine if a machine will satisfy the demands is to visit existing sortyards. The yard operators will provide the information necessary to establish productivities. It is important to ask specific questions to establish the reliability of information. Proud people tend to remember the best days and not the worst or average days. It is also important to establish that the system or phases of it are comparable to those proposed. As an example, the phase of recovering logs from the scaling bay and forwarding them may be comparable, but not the total system from unloading to dumping.

If the new sorting system or layout is unique, then it will be impossible to use productivities from existing sortyards and they will have to be built up from basic time elements. Most machinery companies can supply information on machine travel speeds and hydraulic cycle times as well as carrying capacity, tipping loads and turning radius. Some companies publish handbooks that contain the following detailed information on equipment performance:

- machine cycle times, turning radius, carrying capacity;
- detailed yard layout and travel distances;
- sorting system sequence;
- production volume in pieces;
- required sorts;
- load arrival frequency and rate; and
- required bundle size.

With this information it is possible to assemble cycle times for the machines and to establish the number and size of machines required. Allowances should be made for operator delays, equipment breakdown and service time, and for idle time caused by discontinuity in log flow into and within the yard. Manual simulation described in an earlier section can be used here.

3. Machine Maintenance

Maintainability, or the speed and ease with which machine parts and components can be serviced and repaired, is often overlooked in machine selection. Too frequently we look at a machine from the viewpoint of what it will do for us rather than what it will do to us. The maintenance staff must be involved in assessing the maintainability of the machines recommended before the decision is made on size, type and make. Incorrect selection of size and type, as well as make, can result in maintenance problems, high costs and downtimes, and reduced crew morale.

To assess maintainability, break the machine into components or assemblies (e.g. driveline, engine, cooling system, hydraulic system, etc.). The maintenance units should be subdivided until all troublesome areas are identified. Some of the major characteristics of the maintenance units that should be evaluated are:

- accessibility;
- required tools, equipment and facilities;
- ease of handling;
- quality of fasteners and connectors;
- troubleshooting aids; and
- required maintenance skills and experience.

4. Reliability

Reliability is a high level of mechanical availability and a low level of repair time and cost. It results from a good machine design, quality components and high manufacturing standards. It is necessary in a sortyard where the machine duty cycle demands are heavy and the costs of downtime are high.

Reliability can be assessed in the same way as maintainability by breaking the machine down into components or units. Again, both operating and maintenance personnel should be involved in the assessment. Experience from other parts of the operation should be interpreted in reference to the severe duty application likely in the sortyard. For example, dusty conditions in a sortyard may shorten the engine life relative to the logging application. However, the basic question to answer in evaluating maintainability is,"Is the component or part designed and built to have a reasonable life before failure?"

5. Total Cost

When comparing machines of the same type and size, the initial purchase price should be only one consideration. The costs of repair parts, maintenance labour, and operating supplies must be established. Equipment suppliers can give estimates of these costs which must be modified to the site or application. Other yard operators can supply their historical costs but these costs should be questioned. For example: how severe is the application? Is there evidence of operator abuse? What are the maintenance standards? Another important factor to evaluate in determining the total cost of the machine is the likely life of the machine. For example: will it operate 8 000 or 12 000 hours before repair costs and mechanical availability justify replacing it with a new machine or undertaking a total overhaul? The total cost should be divided by the life of the machine to determine the average cost per hour. The machines should then be ranked in order of cost per hour.

6. Standardization

Although not as important in equipment selection as the other factors, standardization should be considered. It is much easier to find competent operators for a common machine in the industry. Similarly, it is easier for mechanics to diagnose and repair breakdowns on familiar machines. Also, an equipment supplier is more likely to have replacement parts for a machine where there are many units in use rather than one or two. The same principles apply within a single operation.

7. Purchasing

Along with the operational and maintenance people, the Purchasing Department and equipment coordinators should be involved early in the machine selection process. They can contribute by collecting quotations and machinery specifications and by screening sales presentations. Usually, they have industry contacts that can advise on experience with particular machines and suppliers. Also, when a decision has been made on a machine, they are experts at preparing purchase orders that ensure that the machine and attachments received are the ones purchased.

They can be used to negotiate consignment parts inventories and mechanic and operator training as part of the purchase agreement. As well, they can establish the supply of spare parts needed for the machines. Once the machine is in use, their experience in the selection and purchase process can be used when discussing warranty problems. They understand the legalities of purchasing and can act as a buffer between the supplier and the operators and can provide an independent viewpoint.

G. SCALING & GRADING

1. Scaling Systems

The two main scaling systems used on the coast are piece-by-piece stick measurement and weight scaling. Sometimes, on lower grade sorts, the top or visible logs in the bundle will be stick scaled and the average scale applied to the piece count for the bundle, or only a portion of the logs will be measured in the scaling decks and an average applied to all pieces. Both stick scaling and weight scaling are used by the Ministry of Forests and companies to determine log grade and volume for stumpage payments and marketing purposes. In some yards, one scale serves both purposes while in others, each organization scales separately.

Weight scaling reduces the time needed for scaling as only a percentage of the logs must be scaled to maintain the volume-weight ratios. From a material handling point of view, it is best. However, many people purchasing or trading logs will not accept the weight scale. If a company uses weight scaling for marketing, then the Forest Service must agree to weigh the logs (for stumpage charges) after sorting or the logs will have to be weighed twice.

Platform, bunk or suspended scales are used for weight scaling. The platform scales require permanent installation so their location has to be well planned. Bunk scales are most common in sortyards that do not have log stackers. They are normally used as the bundling bunks and are located at the top of a dump ramp. The Forest Service has detailed specifications on the weight scales, weight indicators and buildings and must approve the installation.

Stick scaling determines the net volume after deductions for defect, and grade of the log. For marketing and stumpage scaling, the scalers must have a licence. Normally, B.C. Ministry of Forests scalers will scale the logs after they are graded and bucked but before they are sorted. If the company wishes to use the scale information for marketing, then a boom cutoff or log tag system will be used. In the boom cutoff system, the scalers either maintain separate scale sheets for each sort, or maintain a single scale sheet and enter the information as the logs are scaled. When a boom of a particular sort has been completed the scale sheet is "cutoff" or completed. The cutoff system assumes that all the logs between the scaler and boom have been counted and that all the logs are in the correct sort. Check scales and inspections by log traders ensure that gross errors do not occur. In many yards, the supervisors continually check the sorting accuracy and log count.

In the log tag system, a pre-numbered tag is attached to the end of every log before scaling. The scaler enters the scale information alongside the tag number on his scaling sheet or into an electronic recorder. After the logs have been sorted and bundled, the log tags are removed and bundle tags are attached. When the bundles are put into a boom, the boat operators remove a tag from each bundle. Thus, with the bundle tags, the log tags and the scale sheets, it is possible to tell the grade and scale of each log in each bundle and of each log in the boom. Usually, all this information is entered into the computer and the computer sorts out and calculates the volume and grades in the boom. This system is costly to operate but, with adequate care, is more accurate than the boom cutoff system. It is normally only used by sortyards processing high value logs or selling on the open market.

2. Scaling Productivity

B.C. Ministry of Forests scalers will scale an average of 450 pieces per day when scaling all logs and 300 pieces when sample scaling. Contract or company scalers will average 600 pieces per day.

In some sortyards scalers will only scale a full bay of logs. Consequently, at the beginning or near the end of a shift, there will be times when the machines cannot sort logs even though there are logs in the yard. Yard operators can overcome this by overlapping schedules for scalers and machine operators.

3. Grading Systems

Grading systems vary with the size of the yard. In the smaller yards (400 m^3/day) the sorting machine operator may do the grading. In some cases, a handyman will indicate the sort only on the valuable logs or those difficult to classify. In the larger yards, all logs will be inspected, graded and marked. In some yards, the graders will indicate where a log should be cut to upgrade it.

The graders work in the grading and scaling bays with the scalers. The sort is usually indicated on the log with spray paint. Specific marks have significance to the sorting machine operators. Some yards assign a specific colour to each grader so that if errors are made, they can be traced back to him. Other marking systems include coloured tags or crayon marks. Regardless of the system, the mark must be visible and remain on the log until it reaches the sorting machine operator and it must not include plastic or steel nails which would affect the pulp mill or sawmill.

The training and experience required by the graders will depend on the detail in the sorting specifications and the importance of quality to the company. If the majority of the logs are going to company mills which can accept a wide range of grades, then highly trained graders may not be necessary. However, if a significant portion of the logs are to be traded or sold, then an expert grader will be needed. One coastal company which sells logs uses fully licensed scalers experienced in cubic, metric and fbm scaling as graders.

4. Grading Productivity

The productivity of graders was measured using random sampling observations. Graders and scalers may cause a production bottleneck because they must finish before the logs can be sorted. As Table VII-21 shows, the idle time of graders is high. Observations made in sortyards during the studies indicate that scalers and graders have similar work patterns, thus the productivities shown in the table can be used for scalers.

Table VII-21. Time Distribution of Graders.

	Sortyard				
	Yard A	Yard B	Yard C	Yard D	Yard E
Time Distribution (%):					
Grading	66.4	51.9	56.0	41.3	36.0
Idle	33.6	48.1	44.0	58.7	64.0
Total	100.0	100.0	100.0	100.0	100.0
Pieces Graded/Grader/8 Hour Shift	1 178	784	446	456	597

Accurate grading and marking is needed for accurate sorting. The productivity of graders varies with number of log sorts, log variability, the sorting system and the amount of detail in the log grade specifications. An average grading rate in a sortyard making ten main sorts is 450 pieces per shift, although it can go as high as 800 pieces per shift where there are 5 or 6 main sorts or contractor graders are used. Because of the batch-process nature of grading, the idle time of graders will be relatively high and can vary from 30 - 65 percent.

H. OTHER MAJOR EQUIPMENT

In previous sections, major equipment commonly found in B.C. coastal sortyards, such as stackers, front-end loaders and log loaders, were discussed. Other major pieces of equipment which duplicate or perform complementary functions will be detailed in this section. In many cases, this equipment has been built for special uses or to solve unique problems.

1. Overhead Cranes

As mentioned in Part II, overhead cranes have not gained acceptance on the B.C. coast for general use within a sortyard complex. However, a detailed discussion of overhead portal cranes is contained in Part X.

For several years, an overhead crane (Figure VII-32) has been used by Crown Zellerbach Canada to load bundles of sorted logs from a sortyard onto small log barges for delivery to the converting plants. The crane has a capacity of 40 tonnes and is able to load an average 4000 tonnes of logs in a six hour period.

Figure VII-32. Overhead Crane Barge Loader.

2. Binder Racks

Binder chains or wires must be used on highway or off-highway truck loads where more than 1/3 of the diameter of a log extends above the trailer stakes. For safety, the log load must be restrained when the driver removes the binders. The stacker can enclose the load with its grapple but this takes time and can lead to excessive truck queues. An alternative is to use a rack that shields the driver from the load when he removes the binders (Figure VII-33). The simplest are wood pilings driven into the ground while more complex ones have been made from steel with hydraulic cylinders that push a plate against the load.

Figure VII-33. Binder Rack.

3. Sorting Bunks

Several designs of sorting bunks are used in coastal sortyards. The type varies with the severity of application. When a large volume of wood is handled, then 30 m^3 capacity bunks, ruggedly built from steel plate and lined with reinforced concrete are used (Figure VII-34). They can cost $10 000 per pair. At the other extreme are the bunks used to accumulate low volume sorts. These can be built out of 15 cm steel I-beam or pipe attached to a concrete base or from piling driven into the ground.(Figure VII-35)A cheaper solution may be to spike surplus railway car or logging truck bunks to brow logs.

Figure VII-34. Heavy Duty Sorting Bunk.

Figure VII-35. Light Duty Sorting Bunk.

The sorting bunk stakes should have an outward taper so that the logs can be removed without binding. Some bunks have straight bases and others have curved bases. The latter tend to reduce the stress where the stake attaches to the base and reduce maintenance. They also form a rounder bundle of logs so that bundle wires are tighter.

In yards where separate bunks are used for putting on bundle wires, it is important to ensure that the inside measurements of the second bunks are greater than those of the first bunks.

The spacing and height of the bunk stakes is important since the stacker must be easily able to enclose the logs. In addition to calculating a cross sectional area within the bunk that will give a certain log volume, it is important to estimate the average log length and the percentage of voids accurately. On the coast of B.C., a bunk full of large logs will contain more volume than the same bunk full of small logs, so a compromise design is necessary.

4. Dump Bunks

Dump bunks are installed near the water for bundling and dumping into the water without lifting the bundle. This is achieved by counterweights, springs, trips and hydraulics. The counterweight, trip and spring methods require that a machine push the bundle. These systems are relatively inexpensive and have low maintenance costs. The hydraulic systems are more expensive and require more maintenance but do not require a machine to dump the bundle. Figures VII-36 to 39 show examples of dump bunks.

Figure VII-36. Counterweight Dump Bunks.

Figure VII-37. Spring Dump Bunks.

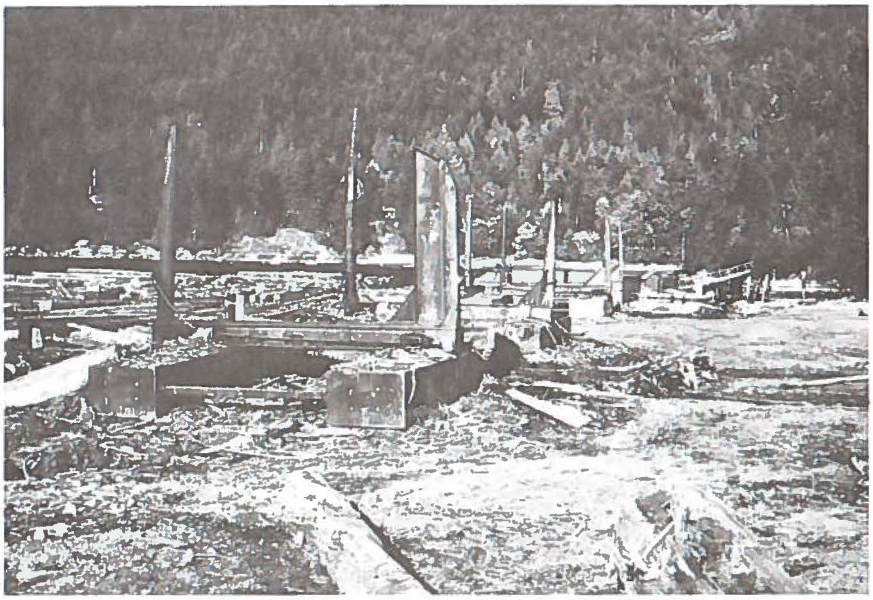


Figure VII-38. Trip Dump Bunks.

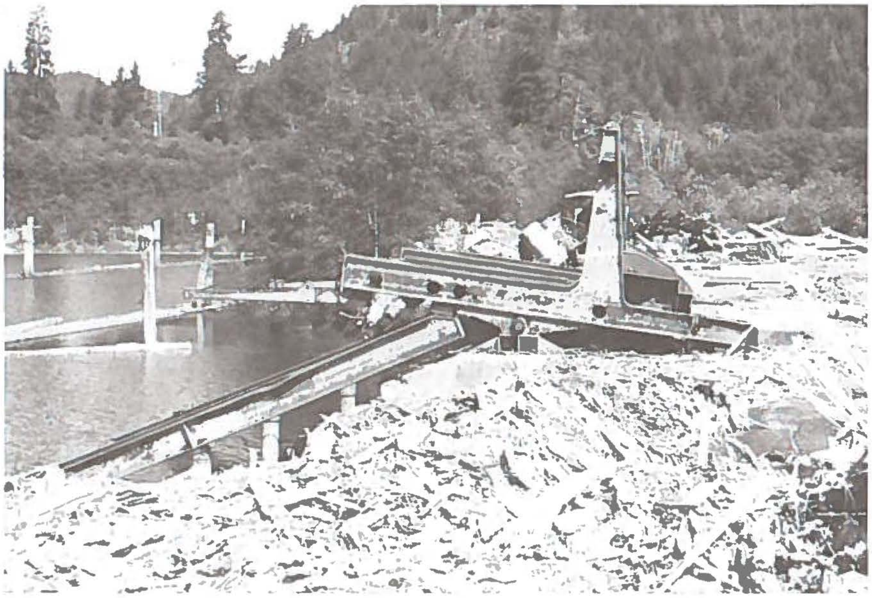


Figure VII-39. Hydraulic Dump Bunks.

5. Dump Ramps and Machines

As A-frames are associated with sorting grounds, so dump ramps are associated with sortyards. The simplest dump ramps are a pair of logs set at a steep angle (Figure VII-40). They are usually replaced annually because of wear and marine borers. In some cases, they may be capped with steel to extend their life but this may damage the bundle wires. If the ramps are too steep, the bundle wires or bands may break when the bundle hits the water or the debarking of the logs is so great that bark build-up at the base of the dump requires constant dredging. In order to minimize the cost, some sortyard operators lash the top of the ramp, tie it back to deadmen and allow the end to float free with the tide. In the larger yards, dump ramps are usually made from steel I-beams mounted on piling and with concrete abutments (Figure VII-41). At locations with shallow water where bark build-up is a problem, mill chain may be added to the surface to control the rate of descent of the bundle and permit a steeper angle (Figure VII-42).

Figure VII-40. Dump Ramp - Logs.

Figure VII-41. Dump Ramp - Steel.

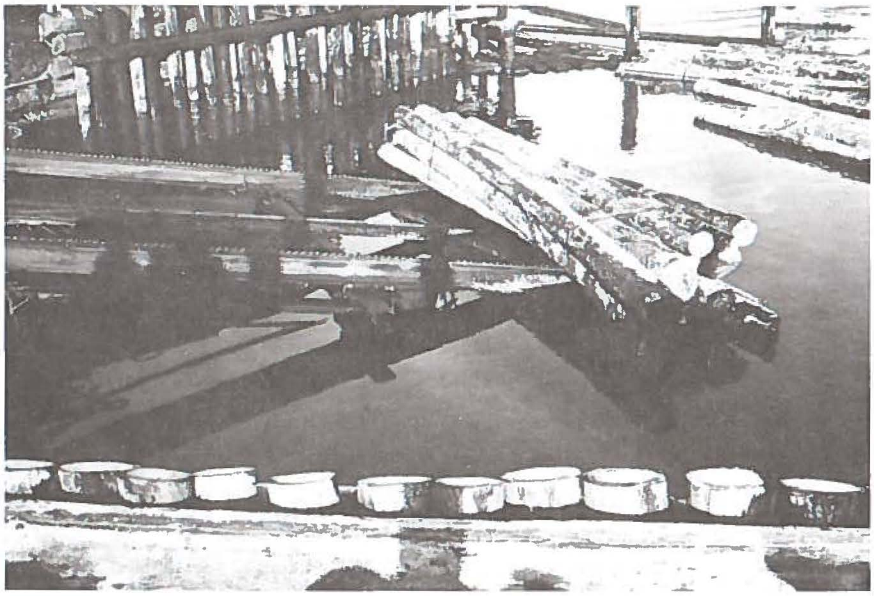


Figure VII-42. Controlled Rate Dump Ramp.

Some operations use dump machines to put bundles into the water. One example is a cradle running on wheels on a railed ramp. The movement of the cradle is controlled by a cable from a powered winch (Figure VII-43). With this system there is no bark removal and bundle survival is 100 percent. Another system uses a stiff-leg derrick (Figure VII-44). The derrick can swing, raise and lower its boom. Bark removal is non-existent and the machine is quick. However, the derrick is expensive (over $500 000) and requires a skilled operator and possibly a ground man to hook the cables.

Figure VII-43. Cable Controlled Carriage.

There are several key factors in the selection and design of dump ramps. These are:

- they must withstand the duty cycle;
- the bundle must survive the dump into the water; and
- in shallow water, bark removal must be minimized by reducing the slope.

Figure VII-44. Stiff-Leg Derrick.

6. Boomstick Boring Machines

For a variety of reasons, some sortyards bore boomsticks on land rather than in the water. In the smaller yards, a chainsaw-powered auger will be used. In the larger yards, two types of hydraulically-powered augers mounted on mobile carriers are used. One is a simple, side mounted boom arrangement (Figure VII-45). The unit is relatively inexpensive but only two or three boomsticks can be bored before the machine is moved.

Figure VII-45. Side Mount Auger.

best when they are installed and monitored before the ambrosia beetles become a major problem. PMG/Stratford Projects offers ambrosia control programs and monitoring.

6. Lighting

Yard lighting is needed for security and for illumination when the yard is operated at night.

Night lighting of sortyards, where high levels of vertical and horizontal incidence are needed to grade and scale logs accurately, is difficult. This, combined with the exposure to weather and the darkness of asphalt surfaces, makes design of night lighting systems unique. Grading and scaling quality will suffer from poor lighting and the expected cost savings of a sortyard may not be achieved.

Light for security is relatively straightforward and advice can be obtained from the company's insurance department or security organizations. The Workers' Compensation Board sets minimum standards for illumination but these standards are for employee safety and are not designed as operational standards. The lighting suppliers have computer programs to determine lighting requirements. However, the yard designer should provide the location of the lighting poles and the number of lights per pole and have the supplier calculate the illumination level. Another approach is for the designer to tell the supplier the illumination levels he requires in each area and the location of the poles and have the supplier specify the number of lights. The cost of lights and hardware is essentially the same between suppliers, so selection of a supplier is based on delivery time and the number of lights.

There are a few rules the designer can follow in establishing the night lighting system. They are:

Illumination Level

In areas where machinery and people are not together and the activity level is low (e.g. log storage areas) 16 lx* is adequate. In areas where both machinery and people are working or machinery activity is medium (e.g. travel corridors, truck unloading, dump ramp, bundling area) 53 -108 lx is sufficient. In areas where both machinery and people are working, the machinery activity is high, or visual inspection takes place (e.g. grading, scaling and sorting areas), the illumination level should be 160 - 215 lx.

Location

Place lights as high as possible. This reduces glare and increases the horizontal incidence of light. A high level of vertical incidence of light is meaningless if a log grader can only see the sides of logs and not the ends.

Light Spectrum

Try and use lights that do not shift the spectrum of light. Certain types of log defect are no longer visible or change colour when exposed to some types of night lighting.

Maintenance

To reduce maintenance costs, mount the light ballasts at the bottom of the pole rather than the top. Separate the illumination and security lighting circuits so only one system has to be on at one time.

Inspection

Check the night lighting system after it has been installed to ensure that design lighting levels have been achieved. This can be done using a light meter and working on a grid system. Both vertical and horizontal incidence should be measured. This information also can be used to check how much the lighting level is deteriorating with time so relamping can be planned.

A high intensity light has been modified from military application to industrial application. It promises to be cheaper than conventional night lighting systems. At present, a model is being developed that can withstand outdoor and winter conditions. If the VORTEK light is successful, it may be possible to illuminate a yard adequately from only two locations. However, the VORTEK light still must follow the rules of conventional lighting and be located as high as possible to reduce glare and shadows.

*lx = lumen which is a measure of the time rate of flow of light.

J. SORTYARD COSTS

Any evaluation of sortyard systems must be based on costs and net revenue as well as productivity.

Components of costs are determined by the accounting system which must be clearly understood before any meaningful comparisons can be made between different companies or divisions within a company. For sortyard design, it is more important to build up a realistic series of standard costs to evaluate and compare rather than to collect costs from existing operations. The estimated cost can then be compared with costs from existing yards, adjusted to the standard cost basis.

The following section lists standard costs which were valid in the Fall of 1982. Variations are indicated where site conditions have a significant effect.

The total cost is broken into operating costs and ownership costs.

1. Operating Costs

Operating costs include labour, supervision, supplies and services, rehaul costs from sortyard to tidewater, custom sorting costs at sites other than the sortyard, and equipment and facility repairs.

a) Operating Labour

This includes the hourly rate for a particular job plus 35 percent for fringe benefits. Machine operators' rates include 0.7 of an hour, at overtime rates, for machine servicing. For example, the IWA rate for a stacker operator is \$16.32 per hour. The hourly rate charged to the job should be \$16.32 x 1.35 = \$22.03 per hour. To account for machine servicing, the \$22.03 should be adjusted by:

$$\frac{0.7 \times \$22.03 \times 1.5}{8} = \$2.89$$

$$\$2.89 + \$22.03 = \$24.92$$

Local conditions, labour supply, etc. can result in different rates between locations for similar jobs. Excluding these differences, the rates used for sortyard jobs are given in Table VII-22.

Table VII-22. Wage Rates of Sortyard Jobs (I.W.A. - Fall 1982).

Job	Base Hourly Rate ($)	Hourly Rate Incl. Fringe ($)	Overtime Hourly Rate to Use ($)
Machine Operator	16.32	24.92	33.05
Head Bundler	13.67	18.45	27.68
Bundler Helper	13.53	18.27	27.41
Hydraulic Auger Operator	13.81	21.09	27.96
Log Grader	14.87	20.07	30.11
Licenced Scaler/Grader	15.83	21.37	32.06
Utility Man	14.55	19.64	29.46
Head Boomman	14.87	20.07	30.11
Second Boomman	14.24	19.22	28.83
Boomman	13.67	18.45	27.68
Boomboat Operator	14.24	21.75	28.83
Log Dump Operator	14.24	21.75	28.83

If B.C. Forest Service scalers are used in the sortyard, the rate for straight time is \$17.96, for time and one-half \$26.94 and for double time \$35.92. The scalers are paid portal to portal and after 7 1/2 hours are on overtime rates. Scalers' expenses of 5-6 percent of wages are charged.

b) Supervision Costs

Standard costs for wages and fringe benefits average $55 000 per year for each salaried supervisor and $35 000 for each clerical person.

c) Equipment Operating and Repair Costs

The average costs that will occur over the life of the machines should be used. Usually, company equipment cost records on existing similar equipment in the logging division cannot be used because the duty cycle in the sortyard is more severe than in logging. However, equipment distributors can give estimates from their experiences in other sortyards. Table VII-23 is an estimate of operating and repair costs of common equipment.

d) Supplies and Services Costs

i) Bundling Materials

Steel Banding

Table VII-24. Costs for Steel Banding.

Width (in)	Thickness (in)	Cost/m^3 Bundled ($)
1 1/4	0.050	0.25
1 1/4	0.057	0.28
1 1/4	0.065	0.32
2	0.044	0.35
2	0.050	0.38
2	0.065	0.49

Table VII-24 is based on 28 to 31 m^3 bundles, 2 bands per bundle, 2 seals per band and no recycling (source Acme Steel, Fall 1982).

Continuous Wire

Table VII-25. Continuous Wire Cost.

Diameter (in)	Wraps	Cost/m^3 Bundled ($)
9/32	Single wrap	0.12
9/32	Double wrap	0.18
3/8	Double wrap	0.19

Table VII-25 is based on 28 to 31 m^3 bundles, 2 wires per bundle, 2 seals per wire and 3 trips per wire before the wire is discarded (source Wire Rope Industries, Fall 1982).

Bundle Wire

- 45 m^3 bundle
- 2 wires per bundle
- 5/8 inch wire, 42 feet long
- the costs used are the actual costs incurred and reflect initial cost, shrinkage, repairs, handling and transportation
- cost is $0.18 per m^3 sorted
- source Jack Pacey, Canadian Forest Products, Fall 1982

Table VII-23. Equipment Operating and Repair Costs* - 1982.

Machine Type	R & M Parts & Labour ($/hr)	Fuel ($/hr)	Lubes, Greases, Supplies ($/hr)	Tires ($/hr)	Grapple Repairs ($/hr)	Total Cost ($/hr)
Sidewinder (15 ft)	3.94	6.55	—	—	—	10.49
Dozer Boat (15 ft)	5.82	9.44	—	—	—	15.26
Swifter Winch	0.98	3.63	0.20	—	—	4.81
Boomstick Borer	0.66	2.39	1.00	—	—	4.05
235 Size Log Loader						
- paved yard	27.73	12.71	2.34	—	12.46	55.24
- unpaved yard	29.02	12.71	2.34	—	12.46	56.53
245 Size Log Loader						
- paved yard	41.06	16.35	3.00	—	12.46	72.87
- unpaved yard	43.00	16.35	3.00	—	12.46	74.81
L90 Size Stacker						
- paved yard	25.48	11.59	1.64	5.66	2.00	46.37
- gravelled yard	29.03	11.59	1.64	8.10	2.00	52.36
- mud yard	29.03	11.59	1.64	13.32	2.00	57.58
L120 Size Stacker						
- paved yard	28.98	15.44	1.80	10.23	2.00	58.45
- gravelled yard	31.03	15.44	1.80	12.60	2.00	62.87
- mud yard	31.03	15.44	1.80	20.71	2.00	70.98
2694 Size Stacker						
- paved yard	18.60	12.71	1.64	5.66	2.00	40.61
- gravelled yard	18.60	12.71	1.64	8.10	2.00	43.05
- mud yard	18.60	12.71	1.64	13.32	2.00	48.27
2794 Size Stacker						
- paved yard	40.47	14.53	1.80	10.23	2.00	67.03
- gravelled yard	40.47	14.53	1.80	12.60	2.00	71.40
- mud yard	40.47	14.53	1.80	20.71	2.00	79.51
966 Size Front-end Loader						
- paved yard	14.24	9.08	0.96	2.98	2.62	29.88
- gravelled yard	16.72	9.08	0.96	4.40	2.62	33.78
- mud yard	16.72	9.08	0.96	7.24	2.62	36.62
980 Size Front-end Loader						
- paved yard	17.10	12.71	1.12	4.98	2.62	38.53
- gravelled yard	20.16	12.71	1.12	6.91	2.62	43.52
- mud yard	20.16	12.71	1.12	11.39	2.62	48.00
988 Size Front-end Loader						
- paved yard	21.65	19.98	1.48	5.78	2.62	51.51
- gravelled yard	25.55	19.98	1.48	8.22	2.62	57.85
- mud yard	25.55	19.98	1.48	13.54	2.62	63.17
Banding or Watering Truck	1.31	1.08	1.00	0.34	—	3.73
A-Frame Dump & Marine Railways	—	10.30	2.00	—	—	12.30

* Source from equipment and supplies distributors.

ii) **Boom Gear**

Swifter Logs, Boomsticks and Wires

A cost of $0.05 per m^3 of logs sorted should be allowed for the purchase, shrinkage, culling and transportation of swifter wires. On West Coast-style log booms, a 50 percent premium should be added to the $0.05/$m^3$ for heavier, swifter wires, more wires, lag bolts, clamps and brackets. The cost of swifter logs and boomsticks will depend on company policy.

Boomchains

A cost of $0.04/$m^3$ of logs sorted should be allowed for boomchains. The cost includes purchase, shrinkage, culling and transportation.

iii) **Miscellaneous Supplies and Services**

Chainsaws

Chainsaws used by the buckers should be charged at a rate of $20 per day for maintenance and fuel.

Personal and Safety Equipment

A charge of $200 per man per year must be allowed to cover personal, safety and miscellaneous supplies.

Electricity

Electricity charges can be significant in yards with night lighting and maintenance shops. Local B.C. Hydro offices can give assistance in estimating the electricity charges.

Repair Material - Standing Booms

The repairs to a standing boom will vary with the volume throughput, size of the booming ground, teredo infestation and exposure to severe weather conditions. However, under normal conditions, the estimates in Table VI-26 can be used (cost of replacing a stick is charged at $200 per stick for labour and material).

Table VII-26. Estimate of Standing Boom Repair.

Size Class of Boom (m^3/year)	Number of Sticks Replaced	Cost of Repair ($)
0 - 170 000	20	4 000
170 000 - 453 000	40	8 000
453 000 - 736 300	50	10 000
736 300 - 1 416 000	75	15 000

Debris Disposal

Debris disposal costs in landfills increase with the distance from the sortyard to the landfill site. A reasonable cost is $0.15/$m^3$ of logs sorted. A longer haul distance of 2-4 km can raise this cost to $0.20/$m^3$ of logs sorted. Use of a FERIC pipe burner will cost about $0.10/$m^3$ of logs sorted. Some sortyards are paying $0.15/$m^3$ of logs sorted for contractors to haul sortyard debris away for processing into hogged fuel. The company does not receive revenue from the hogged fuel but preserves their landfill sites for future emergencies or avoids the environmental problems associated with landfills.

Dredging

The need for dredging will vary with the log volume dumped, the severity of the dumping, the depth of water at the dump site and the tidal current at the dump site. The cost of dredging is composed of the cost of getting the dredge to the site and its return, the dredging time and the disposal cost of the dredgeate. However, for the small, medium and larger size sortyards with reasonable depths of water at the dump site (10 metres at zero tide) an annual allowance of $7 500, $10 000 and $15 000, respectively, should be allowed for dredging. The dredging may not be needed every year, but the allowance should be made annually.

Log Marking

Tags, paint or chalk used for marking the grades on the logs cost approximately $0.02 per piece for coloured paper, $0.04 per piece for spray paint and $0.005 per piece for log chalk.

Asphalt Surface Repairs

Average experience in coastal sortyards indicates about $5 000 per hectare per year should be allowed for repairs to the asphalt surface. In more remote locations the cost may be considerably higher.

Gravelled Surface Repairs

An allowance of $3 000 per hectare per year should be made for ongoing repairs and annual resurfacing of gravel surfaced yards.

Other Operating Costs

- sorting table operation and repair;
- poly rope as temporary swifter lines;
- piledriver repairs;
- replacement of lights in night lighting systems;
- bonuses to attract workers to isolated locations;
- crew transportation and crew travel time allowance;
- foreshore lease costs;
- crew accommodation; and
- overhead charges for accounting, warehouse, maintenance, computer services, log marketing expenses, towing, divisional management, etc.

Costs for these items should be calculated from first principles for individual cases.

e) Rehaul Costs

Yards not located next to tidewater reload the sorted logs onto logging trucks or railway cars for transport to the booming ground. The incremental costs associated with the rehaul should be charged to the yard. The normal transportation costs, including road amortization and maintenance, should be deducted and charged to the logging function.

f) Custom Sorting Costs

Some log sorts accumulate at such a slow rate, or are of such high value, that they are combined with other high value sorts into a boom and sent to custom water sorting grounds. The cost for sorting, bundling and booming varies from $2.20/m^3$ for a ten way sort to $1.40/m^3$ for a two way sort.

g) Equipment and Facilities Repair

i) Weight Scale Repairs

Weight scales and associated printers and readout devices must have high availability to prevent bottlenecks. An allowance of $2 000 to $3 000 per year should be made for servicing and repair.

ii) **Trailer Reload Repairs**

Trailer reloads are essentially maintenance free but an annual allowance of $500 should be made.

iii) **Repairs to A-Frame Dumps and Dump Ramps**

The repairs to the dump machines will depend on the volume processed per year and the construction materials used. Maintenance of the engine, winches and gears and line replacement on A-frames will average about $5 000 to $15 000 per year. Repairs to dump ramps can vary from $3 000 to $30 000 per year. Repair costs in this area are very site specific.

iv) **Repairs to Marine Railway**

Allow $30 000 to $35 000 per year for repairs to the winches, carriage, railway and for replacement of lines.

v) **Repairs to Log Bunks**

Allow $1 000 per year per set of bunks for repairs and replacement.

vi) **Repairs to Mobile Auger**

Amount will vary with the type of machine and its use.

2. Ownership Costs

Ownership costs can be subdivided into machine and facility costs.

a) Machine Costs

Equipment suppliers can assist in estimating equipment ownership costs by giving the economic life and expected resale value of their equipment. The annual ownership costs can be calculated using the following formulae:

Annual ownership costs = R + I

$$R = \frac{P - T}{Y}$$

where R = annual cost of loss in resale value
P = initial purchase price (taxes included)
T = trade-in value
Y = the years for the trade-in value to be reached (economic life)

$$I = \frac{(P + T)}{2} \quad \frac{i}{Y}$$

where I = annual cost of interest and insurance
P = initial purchase price (taxes included)
T = trade-in value
Y = the years for the trade-in value to be reached (economic life)
i = interest and insurance costs expressed as a percentage

Table VII-27 gives annual ownership costs for equipment commonly used in sortyards (costs as of Fall 1982).

Spare machines should be charged to the operation at single shift rates. Machines that consistently work longer than 8 hours should have their annual ownership costs increased proportionately to reflect a shorter life in years.

b) Facility Costs

The facility costs will vary widely depending on local conditions and the size and quality of the structures. Major expenditures should be calculated from first principles. As a guide, the following costs are those being

Table VII-27. Annual Ownership Costs for Equipment.

Machine Type	Purchase Price ($)	Economic Life (hours)	Annual Cost of Loss in Resale Value ($)	Annual Interest & Insurance Cost @ 20% ($)	Annual Ownership Cost ($)
Superwinder (18 ft)	56 500	9 000	8 475	6 215	14 690
Sidewinder (15 ft)	41 000	9 000	6 150	4 510	10 660
Dozer Boat (15 ft)	70 000	9 000	10 500	7 700	18 200
Swifter Winch	19 500	15 000	3 250	1 462	4 712
Boomstick Borer	13 000	9 000	2 167	975	3 142
235 Size Log Loader	473 000	9 000			
- single shift			55 183	61 490	116 673
- double shift			126 133	56 760	182 893
245 Size Log Loader	673 000	9 000			
- single shift			79 683	87 490	161 173
- double shift			179 467	80 760	260 227
L90 Size Stacker	510 000	13 500			
- single shift			39 667	66 300	105 967
- double shift			81 600	61 200	142 800
L120 Size Stacker	635 000	13 500			
- single shift			49 389	82 550	131 939
- double shift			101 600	76 200	177 800
2694 Size Stacker	520 000	13 500			
- single shift			40 444	67 600	108 044
- double shift			83 200	63 000	146 200
2794 Size Stacker	625 000	13 500			
- single shift			50 711	81 250	131 961
- double shift			100 000	99 000	199 000
966 Size Front-end Loader	235 000	9 000			
- single shift			27 416	30 550	57 966
- double shift			62 667	28 200	90 867
980 Size Front-end Loader	345 000	9 000			
- single shift			40 250	44 850	85 100
- double shift			92 000	41 400	133 400
988 Size Front-end Loader	490 000	9 000			
- single shift			57 167	63 700	120 867
- double shift			130 667	58 800	189 467
Banding/Watering Truck	13 000	9 000	1 733	1 170	2 903

experienced in average conditions in the Fall of 1982.

i) **Site Preparation**

- blasting job: $128 400 per ha
- fill job: $192 700 per ha
- cut and fill job: $96 300 per ha
- cut and fill job on old, levelled site: $64 200 per ha
- clear and expand on old, levelled site: $32 100 per ha

ii) **Water Piping Systems**

Underground water supply systems for drinking water, ambrosia beetle control, fire protection and dust suppression are expensive. Also, a good supply of water is needed and if drawn from an existing system where peak supply is limited, a reservoir tank may be necessary. Since excavation and backfilling is expensive, all lines should be put into the same trench and as many uses as possible should be made from one line.

iii) **Night Lighting**

This will vary with lighting levels required in the yard. It can reach $250 000 for a 10 ha yard working on a double shift basis and requiring 215 lx.

iv) **Offices, Buildings and Shops**

The least expensive shop required to service stackers and loaders will cost about $200 000 to build and equip. A foreman's office, lunchroom, and scalers office can easily cost $50 000. Small buildings for storage, personnel, etc. will average $7 000 - $10 000 each.

v) **Bunk & Truck Scales (installed)**

- bunk scales, bunk and printer: $44 000
- 91 tonne platform scale and printer: $80 000
- 159 tonne platform scale and printer: $120 000
- load cell and printer: $14 000

vi) **Trailer Reload**

- steel frame, electric motor and hoist, 18 tonne capacity installed: $36 000

vii) **Dump Bunks**

- Steel shell, concrete lined, tripping stakes:

  17 m^3 size: $ 7 050/set
  20 m^3 size: $ 8 500/set
  23 m^3 size: $ 9 800/set
  28 m^3 size: $11 550/set
  51 m^3 size: $15 000/set

viii) **Dump Ramps**

These can vary from $2 000 for a short ramp constructed from logs, to $90 000 for a short ramp that has hydraulically actuated bunks, to $200 000 for a long ramp constructed from steel I-beams.

ix) **A-Frame Dumps**

- steel A-frame dump, 30 metre sticks, 136 tonne capacity, winch and motor included: $365 000
- same but with 45 tonne capacity: $275 000

x) **Debris Burners**

- pit burner: $78 000
- FERIC pipe burner: $13 000

xi) **Crushed Base & Asphalt Surface**

- asphalt and crushed base hauled from paving company plant — 20 cm depth of 1.9 cm minus crushed base and 15 cm depth of asphalt, 4 ha paved area — $19.00/$m^3$ for crushed base, $110.00/$m^3$ for asphalt, cr $20.36/$m^2$ for both at specified depth.

- asphalt plant and crusher moved to site — same crushed and asphalt specifications — \$20.60/m^3 for crushed base, \$115.60/m^3 for asphalt, or \$21.56/m^2 for both at specified depth.

xii) Crushed Base & Rolled Concrete

- rolled concrete plant set up at site — 20 cm depth of 1.9 cm minus crushed base and 30 cm depth of rolled concrete, 4 ha paved area — \$20.60/m^3 for crushed base, \$60.00/m^3 for concrete, or \$22.12/m^2 for both at specified depth.

xiii) Sorting Bunks

- steel shell, concrete lined:

  17 m^3 size: \$ 6 000 per set
  25 m^3 size: \$ 8 600 per set
  48 m^3 size: \$12 300 per set

xiv) Compressors, Hoses & Crimpers

About \$5 000 should be allowed for a two station, steel banding or continuous wire bundling system.

xv) Booming Grounds

- anchor and line standing boom - \$700 per stick used in the standing boom.
- dolphin type boom - \$1 000 per stick used in the standing boom.

3. Annual Facilities Costs

In order that a realistic sorting cost is determined, site preparation costs should be written off over 20 years and other facility costs over 15 years.

4. Total Costs

The total cost of log sorting is equal to

$$\left.\begin{array}{l} \text{operating labour} \\ + \text{ supervision costs} \\ + \text{ supplies and services costs} \\ + \text{ equipment repair costs} \\ + \text{ custom sorting costs} \\ + \text{ rehaul costs (incremental)} \end{array}\right\} \text{operating costs}$$

$$\left.\begin{array}{l} + \text{ equipment costs} \\ + \text{ facilities costs} \end{array}\right\} \text{ownership costs}$$

5. Total Capital Invested

The equipment and facilities costs that are annualized to add to the operating costs in order to estimate total costs, can also be used to determine the total capital needed to build the sortyard.

K. USING STANDARD COSTS

1. Standard Costs of Sorting Systems

Using the foregoing standard costs, it is possible for the designer to compare and contrast the costs of the various sorting system alternatives available to him. As an example, two different sorting systems are compared for a hypothetical sortyard. The sorting systems and method for establishing the costs are:

Option X

Average daily production is 700 pieces (825 m^3) and the yard operates 170 days/year. The system proposed uses two front-end loaders, a grader/scaler, a handyman, two boommen and a bundler. The yard has some sorted log storage. Figure VII-50 is a flow diagram of the system.

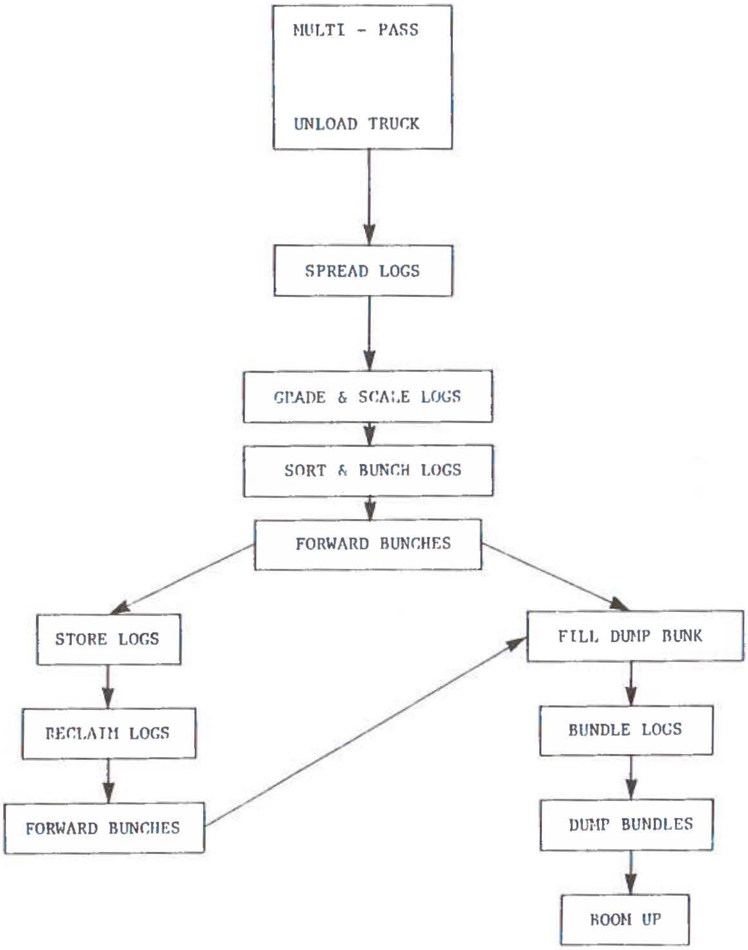


Figure VII-50. Flow Diagram of Option X.

Material handling, yard layout and man/machine simulation analysis has indicated the following areas, manhours and machine hours are needed.

Sorting area = 0.89 ha (asphalt)
Storage area = 0.77 ha (gravel)

Total 1.66 ha

Manpower
2 machine operators = 19 hr/day
scaler = 9 hr/day

handyman	=	8 hr/day
bundler	=	8 hr/day
boom crew	=	16 hr/day

Machinery

front-end loaders	=	19 hr/day
boomboat	=	8 hr/day

The costs are calculated as:

Labour

3 loader operators @ 8 hr @ $24.92*/hr x 170 days	=	$101 674
2 loader operators @ 1 1/2 hr @ $33.05/hr x 170 days	=	16 866
1 scaler @ 8 hr @ $17.96/hr x 170 days	=	24 426
1 scaler @ 1 hr @ $26.94/hr x 170 days	=	4 580
1 bundler @ 8 hr @ $18.45/hr x 170 days	=	25 092
2 boat operators @ 8 hr @ $21.75/hr x 170 days	=	59 160
		$231 798/yr

*includes fringe benefits

Supplies and Services

Repairs to dump ramp and dump bunk	=	$ 3 000
Bundle wires - $0.18/m^3 x 140 000 m^3	=	25 200
Swifter wires - $0.05/m^3 x 140 000 m^3	=	7 000
Boom chains - $0.04/m^3 x 140 000 m^3	=	5 600
Paint - $0.04/pc x 700 pcs x 170 days	=	4 760
Asphalt repairs - $5 000/ha x 0.89 ha	=	4 450
Repair material for standing boom - 20 sticks @ $200	=	4 000
Electricity - $70/mo x 12 mos	=	840
Safety supplies - 7 men x $200/man	=	1 400
Dredging - $7 500/yr	=	7 500
Chainsaws - $20/day x 170 days	=	3 400
Debris disposal - $0.15/m^3 x 140 000 m^3	=	21 000
Resurfacing gravelled areas - $3 000/ha x .77 ha	=	2 310
		$90 460/yr

Machinery and Equipment Repairs

1 980 @ 9.5 hr @ $38.53 @ 170 days	=	$ 62 226
1 966 @ 9.5 hr @ $29.88 @ 170 days	=	48 256
Boomboat @ 8 hr @ $10.49 @ 170 days	=	14 266
1 Swifter winch @ 4 hr @ $4.81 @ 170 days	=	3 271
1 Boring auger @ 50 days @ $25/day	=	1 250
		$129 269/yr

Equipment Ownership Costs

1 x 980	=	$ 85 100
1 x 966	=	57 966
Boomboat	=	10 660
Swifter winch	=	4 712
Boring auger	=	3 142
		$161 580/yr

Facilities Ownership Cost

Site preparation - \$96 300/ha x 1.66 ha	=	\$159 858
Asphalt paving & crushed base - 0.89 ha	=	181 200
Booming ground - 100 sticks @ \$700/stick	=	70 000
Offices - \$25 000	=	25 000
Dump ramp - \$17 000	=	17 000
Dump bunks - 2 @ \$9 800 each	=	19 600
Underground piping - \$12 000	=	12 000
		\$484 658

$$\frac{\$353\ 058}{20 \text{ years}} + \frac{\$131\ 600}{15 \text{ years}} = \$26\ 426/\text{yr}$$

Total Costs

Labour	=	\$231 798
Supplies & Services	=	90 460
Machinery Repairs	=	129 269
Equipment Ownership	=	161 580
Facilities Ownership	=	26 426
Total		\$639 533/yr
Cost/m^3	=	\$ 4.57
Cost/piece	=	\$ 5.37

Option Y

Option Y has the same production volumes to process and uses the same manpower but because of a different sorting system, works fewer hours annually and uses different sized equipment. Figure VII-51 is a flow diagram of the system.

An analysis of the sorting system has indicated the following area, machines and people are needed.

Sorting area	=	0.70 ha (asphalt)
Storage area	=	0.77 ha (gravel)
Total		1.47 ha

Manpower

2 machine operators	=	18 hr/day
scaler	=	9 hr/day
handyman	=	8 hr/day
bundler	=	8 hr/day
boom crew	=	16 hr/day

Machinery

front-end loaders	=	18 hr/day
boomboat	=	8 hr/day

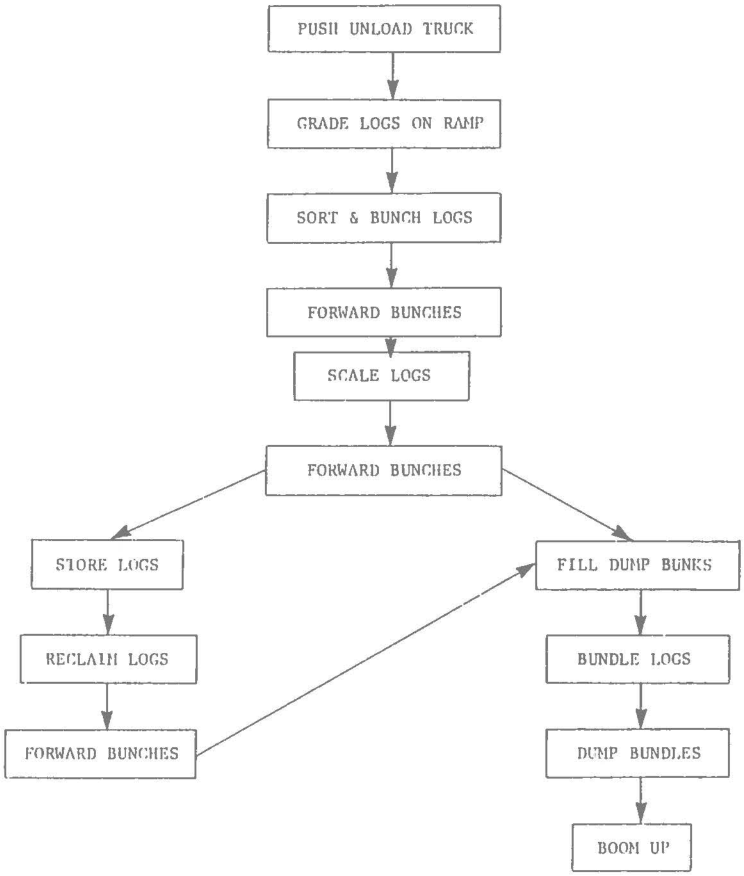


Figure VII-51. Flow Diagram of Option Y.

The costs are calculated as:

Labour

2 loader operators @ 8 hr @ $24.92*/hr x 160 days	=	$ 63 795
2 loader operators @ 1 hr @ $33.05/hr x 160 days	=	10 576
1 scaler @ 8 hr @ $17.96/hr x 160 days	=	22 989
1 scaler @ 1 hr @ $26.94/hr x 160 days	=	4 310
1 utilityman @ 8 hr @ $19.64/hr x 160 days	=	25 139
1 bundler @ 8 hr @ $18.45/hr x 160 days	=	23 616
2 boat operators @ 8 hr @ $21.75/hr x 160 days	=	55 680
		$206 105/yr

*includes fringe benefits

Supplies and Services

Repairs to dump ramp and dump bunk	=	$ 3 000
Bundle wires - $0.18/m³ x 140 000 m³	=	25 200
Swifter wires - $0.05/m³ x 140 000 m³	=	7 000
Boom chains - $0.04/m³ x 140 000 m³	=	5 600
Paint - $0.04/pc x 744 pcs x 160 days	=	4 760
Asphalt repairs - $5 000/ha x .70 ha	=	3 500
Repair standing boom - 20 sticks x $200	=	4 000
Electricity - $70/mo x 12 mos	=	840
Safety supplies - 7 men x $200/man	=	1 400
Dredging - $7 500/yr	=	7 500
Chainsaws - $20/day x 160 days	=	3 200
Debris disposal = $0.15/m³ x 140 000 m³	=	21 000
Resurfacing gravelled area - $3 000/ha x .77 ha	=	2 310
		$89 310/yr

Machinery & Equipment Repairs

2 x 966 @ 9 hr @ $29.88/hr @ 160 days	=	$ 86 054
1 Boomboat @ 8 hr @ $10.49/hr @ 160 days	=	13 427
1 Swifter winch @ 4 hr @ $4.81/hr @ 160 days	=	3 078
1 Boring auger @ 50 days @ $25/day	=	1 250
		$103 809/yr

Equipment Ownership Costs

2 x 966	=	$115 932
Boomboat	=	10 660
Swifter winch	=	4 712
Boring auger	=	3 142
		$134 446/yr

Facilities Ownership Cost

Site preparation - $96 300/ha x 1.47 ha	=	$141 561
Asphalt paving & crushed base - 0.70 ha	=	142 520
Booming ground - 100 sticks @ $700/stick	=	70 000
Offices - $25 000	=	25 000
Dump ramp - $17 000	=	17 000
Dump bunks - 2 @ $9 800	=	19 600
Underground piping - $12 000	=	12 000
		$427 681

$$\frac{\$296\ 081}{20 \text{ years}} + \frac{\$131\ 600}{15 \text{ years}} = \$23\ 577/\text{yr}$$

Total Costs - Option X and Option Y

	X	Y
Labour	$231 798	$206 105
Supplies & Services	90 460	89 310
Machinery Repairs	129 269	103 809
Equipment Ownership	161 580	134 446
Facilities Ownership	26 426	23 577
Total	$639 533/yr	$557 247/yr
Cost/m^3	$ 4.57	$ 3.98
Cost/piece	$ 5.37	$ 4.68

Option X Versus Option Y

Sorting Option Y requires less investment and has a lower cost of sorting than Option X. On a purely financial basis, sorting Option Y should be chosen. However, Option Y uses push offloading which may cause more damage to the logs and logging truck trailers than Option X's multi-pass lift unloading, which can also handle surge volumes better. In Option Y, the logs are graded as they are in the pile at the unloading ramp, rather than when they are spread out as in Option X. This may result in poorer grading and thus, poorer sorting. On the other hand, in Option Y the logs are scaled after sorting so the effects of inaccurate grading and sorting can be rectified by resorting. Option X scales before sorting so the chance of correcting missorting is lower. On the whole, the lower sorting cost, lower capital investment and greater potential for sorting accuracy of Option Y indicates that this system should be chosen. The unload machine operator will have to be watched closely so that log and trailer damage is minimized.

2. Standard Costs by Yard Functions

When a sorting system is developed it is usually costed in total, as specified by the designer. However, rarely are the individual functions in a yard separated out and examined to determine if the costs of that function are worth the benefits or if that function can be performed more economically by using a different technique or method. If it is decided to carry out such an examination then great care must be used when allocating costs. Also, care must be used in determining whether certain costs will cease or will continue if a certain function is deleted or changed. For example, a different bundling system may require less hours per day for the bundler, but will the pay be less per day or will their utilization just decrease?

As an example of costing by function, the costs of stick scaling versus weight scaling for a hypothetical sortyard will be compared.

The comparison is:

Case A - Weight Scaling - Sortyard has to process 1 200 pieces per day into 10 main sorts. The plan is for the Ministry of Forests to weigh incoming truckloads. Logs destined for outside sales or trading will be stick scaled (1/3 of total volume) and logs destined for company mills will be weight scaled. A sample scaling area will be established for sampling at an average frequency of 1 load in 15.

Case B - Stick Scaling - Same production as Case A. The plan is to spread loads for grading, bucking and scaling, sort logs and then load sorted logs onto trucks for transport to booming ground or put sorted logs into storage. No sample scaling area is needed.

Analysis of the sorting system indicates the following equipment and manpower will be needed:

Stacker & stacker operator
Three front-end loaders & operators - 9.5 hr/day
Grader
Three MOF scalers
Bucker
Handyman
Total yard area - 7.1 ha

Case A Versus Case B

The differential operating costs and investments for Case A versus Case B are:

Additional Investment Case A

100 tonne capacity weight scale	=	$ 80 000
Site - 1 ha for sample scale	=	32 100
		$112 100

Operating Costs Case A

Plus: Weighmaster - 210 days x $21.75/hr x 8 hr	=	$36 450
Company scaler - 210 days x $21.37/hr x 8 hr	=	35 902
Part time BCFS Sample Scaler - 53 days x $17.96/hr x 8 hr	=	7 615
Repairs to weight scale	=	2 000
Subtotal		$81 967
Minus: Three BCFS scalers - 3 x 210 days x $17.96/hr x 8 hr	=	$ 90 518
Reduced operating time and repairs		
3 x 210 days x 1.5 hr x $33.05	=	31 232
3 x 210 days x 1.5 hr x $38.53	=	36 411
Subtotal		($158 161)
ANNUAL NET SAVINGS		$ 76 194

Although Case A will require an additional investment of $112 100, the annual operating cost savings relative to Case B are $76 194. The main portion of the saving results from removing the bottleneck caused by the stick scaling system. In this example a weight scaling system will save the sortyard about $0.30 per piece.

3. Other Cost Comparisons

There are other things besides the sorting functions within the sortyard that should be compared on a cost basis to establish what is most economical for the company. These include:

- comparison of the costs of off-site, custom sorting of low volume or high value sorts versus the costs of on site sorting and storage and, shipping and selling one and two section booms;
- cost comparison of presorting in the woods landing versus no sorting in the landing with respect to effect on sortyard costs;
- cost comparison of providing more unsorted log storage to level seasonal production peaks versus adding more machinery or working overtime;
- cost comparison of storing sorted logs in the water versus storing on land;
- cost effect and comparison of different sorting machine type and size combination; and
- cost effect of locating sortyard inland and resultant cost of hauling sorted logs to tidewater.

PART VIII DESIGN AND CONSTRUCTION

PART VIII DESIGN AND CONSTRUCTION*

A. SURVEY AND PLANS

The preliminary survey used to select the site and provide the justification is not adequate for final approval, construction bids or specific designs. More accurate site surveys, yard designs and engineering plans are necessary once the choice is reduced to one site.

1. Site Survey

The site survey should include the sortyard, foreshore area, potential sources of construction materials, access road locations, and sites for disposal of waste construction materials and sortyard debris.

The survey of the sortyard site should include topographic and geotechnical grid surveys which will produce a contour map. Depending on the site, the contour intervals will vary from 0.30 metre (flat) to 1 metre (steep) and the scale from 1:1000 to 1:500. A transit, leveling rod and steel or nylon chain should be used. A closed traverse should be made around the perimeter of the site and the stations permanently fixed and identified so that this and future surveys can be compared. The site itself should be surveyed on a 10 metre by 10 metre grid. The geotechnical survey should be on the same scale as the topographic survey and may be done at the same time. It should identify stumps, depth of topsoil or overburden, type and depth of mineral soil and rock.

The survey of the foreshore area should also include topographic and geotechnical information. It should be made from a baseline at the shore which is tied to the sortyard survey. The standards should be the same for both surveys. If possible, the geotechnical survey should determine the type and depth of fine surface material, type of subsurface material, depth to rock, type of underwater debris and should identify any predominant tidal drift or self-cleansing action of the water. A weighted chain and a 0.64 cm diameter metal rod will help in both phases of the survey.

Similar topographic and geotechnical surveys should be made of borrow pits, roads and waste and spoil sites. The level of detail of the surveys will depend on the information required by the engineer for the construction program, agency approval and estimating costs and material volumes.

The actual survey may be conducted by company staff or by an engineering or surveying company. In either case, it is necessary for the project team and the project engineer to specify the requirements of the survey, the degree of accuracy, the drawings, plans and maps required. A legal survey (requiring the services of a registered surveyor) may be required for land or water lease title.

2. Additional Surveying

The site must be resurveyed after clearing and stripping to re-establish control points and improve the accuracy of the elevations.

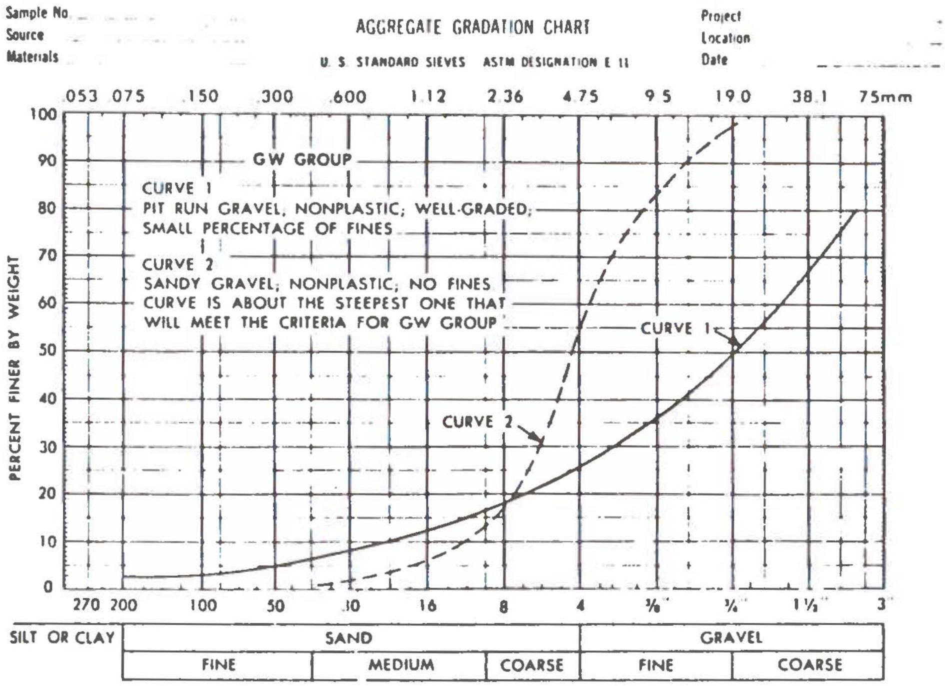
The construction program must also make provision for surveying throughout the project. Grade stakes will have to be set for each lift of fill so that desired compaction is obtained. Slope stakes will be set on the edge of the fill to achieve the desired profile. Similarly, surveys of borrow pits and spoil areas should be made throughout the project to identify problems before they occur. Materials removed and placed must be continually surveyed or measured for payments to the contractors. Usually the contractor will have his own crew measure his work. The company engineer must be able to document his claims in case of dispute.

3. Soil Sampling

During the geotechnical survey, soil types and depths will be analyzed. In some cases, simple grab samples can be taken but where the soil is deep or is of particular interest, a backhoe should be used. The dug trench can be inspected to determine the amount and layering of the various soil types.

*See Bibliography for reference material.

Soils analysis and sampling techniques are standardized. The Asphalt Institute published a handbook entitled "Soils Manual for Design of Asphalt Pavement Structures" which describes soils, soils analyses, soil sampling, standard tests, etc. that can be used by the engineer on a sortyard construction project. Figure VIII-1, taken from this handbook, shows the graph used for plotting sieve analysis results which will show the suitability of various samples for fill or aggregate. Figure VIII-2 is a soils classification and evaluation guide.



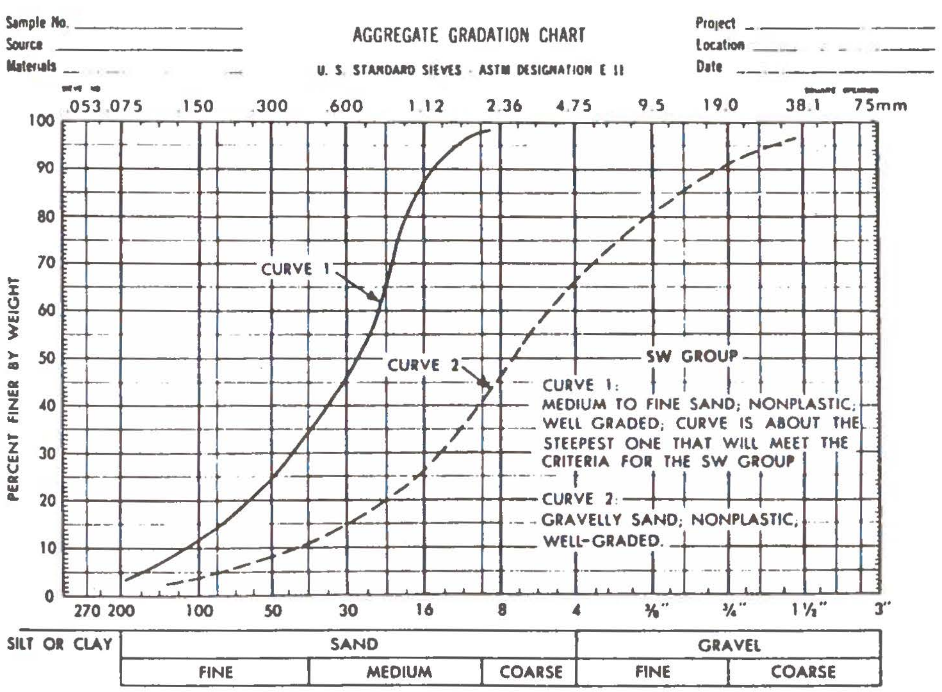


Figure VIII-1. Sieve Analysis Graph.

Table VI-2—Characteristics Pertinent to Roads and Airfields

Major Divisions (1)	(2)	Symbol: Letter (3)	Symbol: Hatching (4)	Symbol: Color (5)	Name (6)	Value as Subgrade When Not Subject to Frost Action (7)	Value as Subbase When Not Subject to Frost Action (8)	Value as Base When Not Subject to Frost Action (9)	Potential Frost Action (10)	Compressibility and Expansion (11)	Drainage Characteristics (12)	Compaction Equipment (13)	Unit Dry Weight lb. per cu. ft. (14)	Typical Design Values: CBR (15)	Typical Design Values: Subgrade Modulus k lb. per cu. in. (16)
SOIL	GRAVEL AND GRAVELLY SOILS	GW		Red	Well-graded gravels or gravel sand mixtures, little or no fines	Excellent	Excellent	Good	None to very slight	Almost none	Excellent	Crawler-type tractor, rubber-tired roller, steel-wheeled roller	125-140	40-80	300-500
		GP		Red	Poorly graded gravels or gravel sand mixtures, little or no fines	Good to excellent	Good	Fair to good	None to very slight	Almost none	Excellent	Crawler-type tractor, rubber-tired roller, steel-wheeled roller	110-140	30-60	300-500
		GM d		Yellow	Silty gravels, gravel-sand-silt mixtures	Good to excellent	Good	Fair to good	Slight to medium	Very slight	Fair to poor	Rubber-tired roller, sheepsfoot roller, close control of moisture	125-145	40-60	300-500
		GM u				Good	Fair	Poor to not suitable	Slight to medium	Slight	Poor to practically impervious	Rubber-tired roller, sheepsfoot roller	115-135	20-30	200-500
		GC			Clayey gravels, gravel-sand-clay mixtures	Good	Fair	Poor to not suitable	Slight to medium	Slight	Poor to practically impervious	Rubber-tired roller, sheepsfoot roller	130-145	20-40	200-500
	SAND AND SANDY SOILS	SW		Red	Well-graded sands or gravelly sands, little or no fines	Good	Fair to good	Poor	None to very slight	Almost none	Excellent	Crawler-type tractor, rubber-tired roller	110-130	20-40	200-400
		SP			Poorly graded sands or gravelly sands, little or no fines	Fair to good	Fair	Poor to not suitable	None to very slight	Almost none	Excellent	Crawler-type tractor, rubber-tired roller	105-135	10-40	150-400
		SM d		Yellow	Silty sands, sand-silt mixtures	Fair to good	Fair to good	Poor	Slight to high	Very slight	Fair to poor	Rubber-tired roller, sheepsfoot roller; close control of moisture	120-135	15-40	150-400
		SM u				Fair	Poor to fair	Not suitable	Slight to high	Slight to medium	Poor to practically impervious	Rubber-tired roller, sheepsfoot roller	100-130	10-20	100-300
		SC			Clayey sands, sand-clay mixtures	Poor to fair	Poor	Not suitable	Slight to high	Slight to medium	Poor to practically impervious	Rubber-tired roller, sheepsfoot roller	100-135	5-20	100-300
FINE-GRAINED SOILS	SILTS AND CLAYS LL IS LESS THAN 50	ML		Green	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	Poor to fair	Not suitable	Not suitable	Medium to very high	Slight to medium	Fair to poor	Rubber-tired roller, sheepsfoot roller; close control of moisture	90-130	15 or less	100-200
		CL			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Poor to fair	Not suitable	Not suitable	Medium to high	Medium	Practically impervious	Rubber-tired roller, sheepsfoot roller	90-130	15 or less	50-150
		OL			Organic silts and organic silt-clays of low plasticity	Poor	Not suitable	Not suitable	Medium to high	Medium to high	Poor	Rubber-tired roller, sheepsfoot roller	90-105	5 or less	50-100
	SILTS AND CLAYS LL IS GREATER THAN 50	MH		Blue	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	Poor	Not suitable	Not suitable	Medium to very high	High	Fair to poor	Sheepsfoot roller, rubber-tired roller	80-105	10 or less	50-100
		CH			Inorganic clays of high plasticity, fat clays	Poor to fair	Not suitable	Not suitable	Medium	High	Practically impervious	Sheepsfoot roller, rubber-tired roller	90-115	15 or less	50-150
		OH			Organic clays of medium to high plasticity, organic silts	Poor to very poor	Not suitable	Not suitable	Medium	High	Practically impervious	Sheepsfoot roller, rubber-tired roller	80-110	5 or less	25-100
HIGHLY ORGANIC SOILS		Pt		Orange	Peat and other highly organic soils	Not suitable	Not suitable	Not suitable	Slight	Very high	Fair to poor	Compaction not practical			

Figure VIII-2. Soils Classification and Evaluation Guide.

Grab samples or samples obtained from trenches supply enough information in most cases but some sites, because of questionable soil quality or deep soil depths, may require a subsurface drilling program. For example, if the soundings and rodding of the intertidal area have indicated a layer of muck, if the site is near the mouth of a river or if the intertidal area has to be dredged, then it probably is advisable to drill the intertidal fill area and take samples. The sampling program will show if there are areas that cannot support the load of the fill, how much intertidal material will have to be removed to provide a suitable foundation and if the dredgeate can be used as fill on the site. Also, the drilling program will show how much additional material will have to be dredged in order to retain a desired shape when tidal influence or unstable material is a problem.

If a cut and fill construction program is needed at the land site, then subsurface drilling investigation may be advisable. The drilling would determine the type and volume of overburden to be removed, the foundation characteristics of the site and if there are any areas of special concern that will affect construction or design (i.e. hardpan layers or silt deposits). An intertidal and site drilling program, soils analysis, mapping and professional advice may cost $75 000 for a 15-hole program. As a result, judgement is required in balancing the cost of the drilling work with the costs of possible differential settlement in the sortyard and sloughing in the intertidal areas. If the geotechnical survey indicates soil bearing problems, then it is advisable to use a subsurface drilling program to get more information.

Under normal circumstances, the soil sampling and analysis program can be done by the engineering crew. The tests and equipment are relatively straightforward and inexpensive. However, on a large sortyard project (greater than 6 ha) where there are many samples or when soil quality is marginal, it is advisable to use soil consultants.

The soil consultant can determine if the material on site, in the pit or to be dredged is suitable for fill. He will advise on compaction levels necessary in the base fill. If asphalt surfacing is planned, the consultant may also be able to recommend the depth and the mix design, as well as specify the standards for the crushed base layer. He can give advice on the suitability of materials for the aggregate design and concrete mixes.

4. Surface Drainage

Gradients can be used to advantage in providing drainage for the running surface of the yard. Surface maintenance, environmental damage and winter icing can be reduced and site preparation costs can be minimized by good running surface design.

On asphalt or rolled concrete surfaces, a minimum of 0.5 percent slope is needed to make water flow in a desired direction and on gravelled surfaces the gradient should be a minimum of 2.0 percent. To achieve a cross flow, the gradient on the perpendicular co-ordinate will have to be greater.

The simplest surface design is a flat plane tilted in the direction of the desired drainage flow. However, with this design a large area will require large cuts and fills and site preparation costs will escalate. Also, the yard will drain along one side and containment ditches may be expensive. Tilting the flat plane in two directions reduces ditching costs. A drainage profile that resembles a simple inverted house roof with the trough running down the centre of the yard is an alternative that may reduce cut and fill costs while tilting the peak may force the water to drain to one point and reduce drainage ditch costs. A yard of this design can be built so that it is impossible for drainage water to discharge directly into the ocean or a nearby river (Figure VIII-3).

The following are some hints to minimize costs and problems in drainage designs:

- Drain from asphalt to gravel rather than vice versa. Water running from gravel will carry gravel onto the yard and will expose the asphalt edge to mechanical damage.
- A gravel perimeter next to the asphalt surface may act as a filter for the surface discharge. However, if it is too narrow or not maintained, then channeling will occur and water will discharge without filtering.
- Keep the surface design and layout simple or asphalting costs will escalate. Paving costs will be lowest when paving machines work in long straight lines.
- Design to avoid pools of surface water.
- Try to locate stationary equipment and buildings at the high points so water drains away from them.

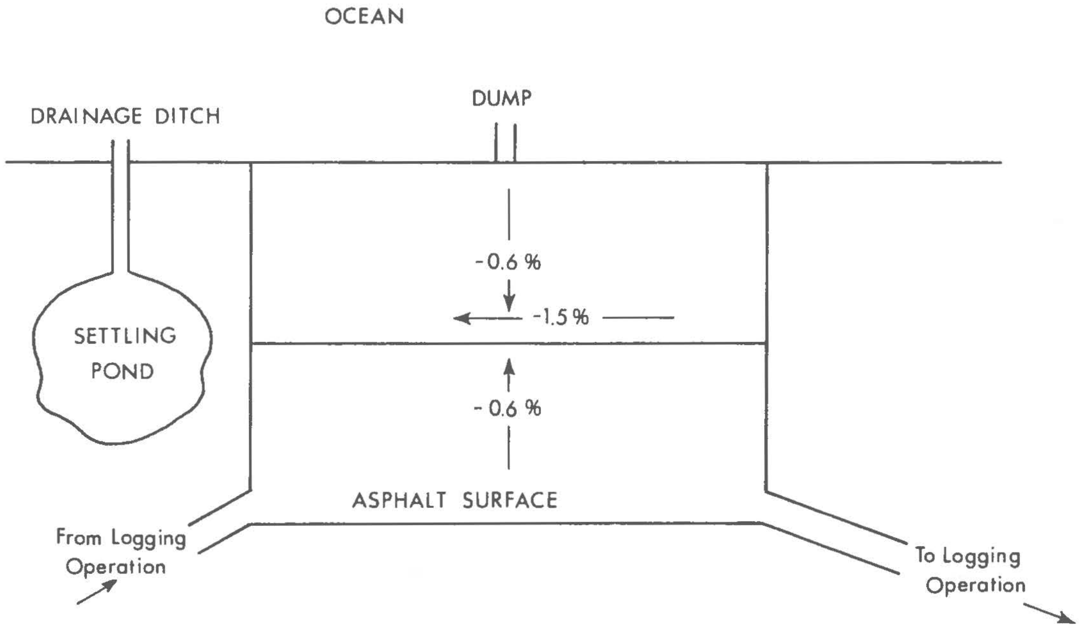


Figure VIII-3. Tilted, Inverted Roof Surface Design.

Large yards may require more complex surface profiles (Figure VIII-4) to obtain the desired drainage.

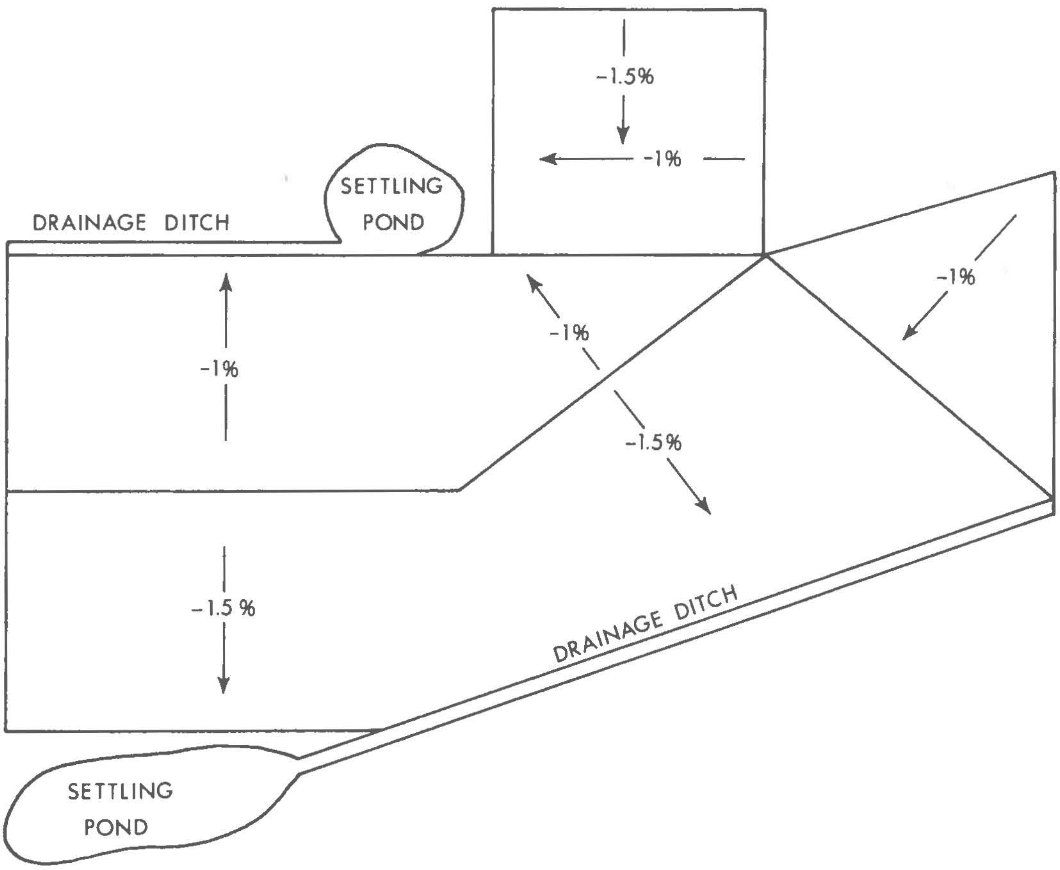


Figure VIII-4. Complex Surface Design.

5. Drainage Structures

As most B.C. coastal sortyards are built at tidewater, provisions must be made in their design to prevent damage to the marine environment. What is required will depend on the location. For example, in a sortyard located next to deep water and without an adjacent fish stream or an abundance of shellfish, it is probably acceptable for the surface runoff to drain through a gravel filter strip before entering the ocean. However, in a sortyard located next to shallow water and with an abundance of shellfish, then most likely the surface runoff should go through a settling pond before being discharged. As mentioned in the previous section, the yard surface can be designed to direct the flow of surface runoff to desired points of discharge. Surface runoff from sortyards is almost continuous because when it is not raining the dust suppression sprayers are turned on to control the dust in the yard.

To design settling ponds*, calculate the water flow from the yard area during several potential rain intensities and rain periods by examining the historical 2 year storm, 5 year storm, 10 year storm and 25 year storm data. The calculated flows can then be used to select the diameter of sewer piping. Laboratory tests of the bark, dust and dirt from the yard will determine settling rates and the required retention time in the settling pond can be calculated. This plus the expected flow rates can then be used to calculate the size of the settling pond and the frequency of cleaning of the pond. The shape of the pond should take into account the type of cleaning machinery as well as the area available. There should also be provision in the settling pond to skim off floating debris from the discharge water before it enters the ocean. This is usually accomplished with a weir but a simpler design may be a floating log tied back to the edges of the pond. Figure VIII-5 is one design for a settling pond.

The design of runoff ditches and culverts is basically the same as settling pond design. From rainfall intensities and periods for various potential storms and the area of the sortyard surface, a flow rate and volume can be determined. It then becomes a matter of calculating the cross sectional area or diameter of ditch or pipe needed to discharge that flow without backing up.

6. Engineering Plans

After the site survey and soil sampling are completed, engineering plans can be developed. The engineering plans are necessary for soliciting construction bids. They will be more accurate if they are based on detailed surveys of the existing site, the required final profiles, the borrow pits, the volumes of material to be moved and drawings of structures and foundations rather than rough estimates. Detailed plans will also facilitate approvals from agencies such as the Ministry of Forests, Department of Fisheries & Oceans, Marine Resources Branch, Lands Branch, etc.

Engineering designs and drawings will be required for all structures and buildings which are to be built or supplied on contract. Preparation may require the services of civil or mechanical engineers.

7. Balancing Elevations in Final Plans

After the completion of the clearing, stripping and resurvey, the volumes of cut and fill material must be recalculated and the elevations balanced to minimize construction costs. In some cases it may be necessary to juggle the elevation of the sortyard in its relationship to the booming ground. If major changes are necessary, the location and angle of the dump ramp may have to be reconsidered and redesigned in an effort to achieve the best trade off between construction costs and future operating costs. Care must be taken not to introduce potential environmental and operating problems with water currents or tides by saving on initial construction costs (e.g. steep dump ramp angles may cost less but may result in poor bundle survival and high dredging costs).

The final plans which will be used for construction are now prepared. Further changes made during construction will probably be expensive, may disrupt the time schedule and may result in redoing work in progress. Good luck should not be necessary but it is helpful.

*Some of the references in the Bibliography can be used for design of settling ponds.

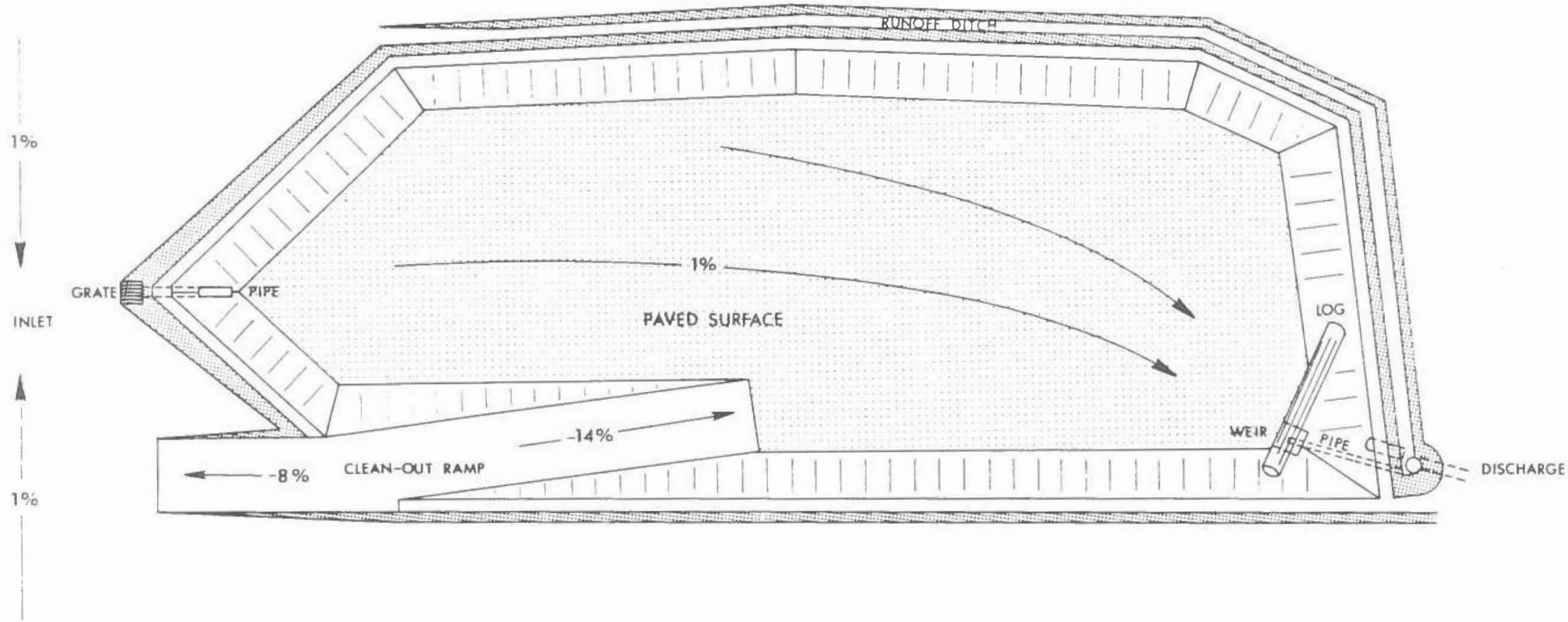


Figure VIII-5. Settling Pond Design.

B. SCHEDULING AND CONTROL

1. Initial Checklist

Early in the project, the engineer should establish an initial step-by-step construction program to serve as a checklist - a point from which to start discussions on alternative construction methods and a basis from which contractor plans can be compared. An initial checklist would include:

- Discuss selection of final site with government agencies.
- Legal survey, if required.
- Applications for approval:*
  - Ministry of Forests - cutting permit and site approval
  - Ministry of Lands, Parks and Housing - site approval, foreshore lease
  - Department of Fisheries & Oceans - site approval, intertidal fill approval, booming ground approval
  - Department of Health - potable water supply and sewage disposal
- Detailed plans:
  - Ministry of Forests - proposed scaling system and weight scale facilities
  - Tenders for construction contract
  - Department of Fisheries & Oceans - spill containment facilities, drainage structures
- Clear trees and brush from borrow pits or waste disposal sites.
- Stripping - remove overburden, stumps, debris, etc.
- Resurvey cleared sites.
- Resurvey and stake site for construction.
- Construction:
  - Roads for removal of dredgeate
  - Causeway around sortyard to protect fill
- Dredging.
- Drainage structures in fill area if fill is sand or finer material.
- Strip and level rock to at least one metre below top of planned fill.
- Haul and compact fill material.
- Haul ballasting material.
- Complete rip rap program.
- Complete drainage structures.
- Locate and build permanent structures, booming ground, ramps, water tanks, fuel stations, etc.
- Surface sortyard.
- Locate and build temporary structures.

As can be seen, even this rough program can serve to highlight errors in logical flow, detect omissions and form a basis for comparison with other programs.

2. Schedules

Preparing the construction schedule forces the construction manager to plan the best ways and most logical

*See Appendix I for a copy of the B.C. Ministry of Lands, Parks and Housing Prospectus.

order to build the yard. The schedule lays out visually the project sequence, identifies potential conflicts and bottlenecks, highlights critical completion dates, illustrates interdependence between phases and shows the project duration.

Several scheduling aids are available including simple bar charts, Gantt charts, Program Evaluation and Review Technique (PERT) and Critical Path Scheduling (CPS). Which system is best will depend on the size and complexity of the project and experience of the construction supervisors.

Scheduling a project involves not just the activities occurring at the project but all the prior and peripheral activities, such as solicitation of bids, signing of contracts and mobilization of equipment.

The scheduling function must determine how to do the work, when to do the work and how to control the flow of work. Scheduling systems are basically schemes for keeping track of workloads, charting progress of work, reporting back and reshuffling schedules and deadlines. In constructing a schedule, whether one works backward or forward, will depend on whether there is a due date or not. If there is a specific date for project completion, you work backward from that due date, otherwise work forward from the starting date. By determining the required time to complete the total project, we also determine the due dates for the various phases of the project. If the phase due dates are not met and the schedule cannot be shuffled, then the project is delayed. It is critical for the supervisors responsible for the various phases to develop their own schedules and sequence of work. If there are timing restrictions for in-water work by the Department of Fisheries and Oceans, they should be included. The phase schedules can then be discussed, modified if necessary and then assembled into the master schedule. In this way, the supervisors have a better understanding and commitment to the project schedule.

a) Gantt Charts

Gantt charts are a form of schedule developed by Henry L. Gantt who was a pioneer of management science. They provide a construction schedule and measure progress as well as giving information on the availability and load on equipment and manpower. The construction plan and progress relative to plan are plotted in relation to time. Projects can be scheduled to any degree of detail required. Figure VIII-6 is a Gantt chart for a simple project in a sortyard construction program.

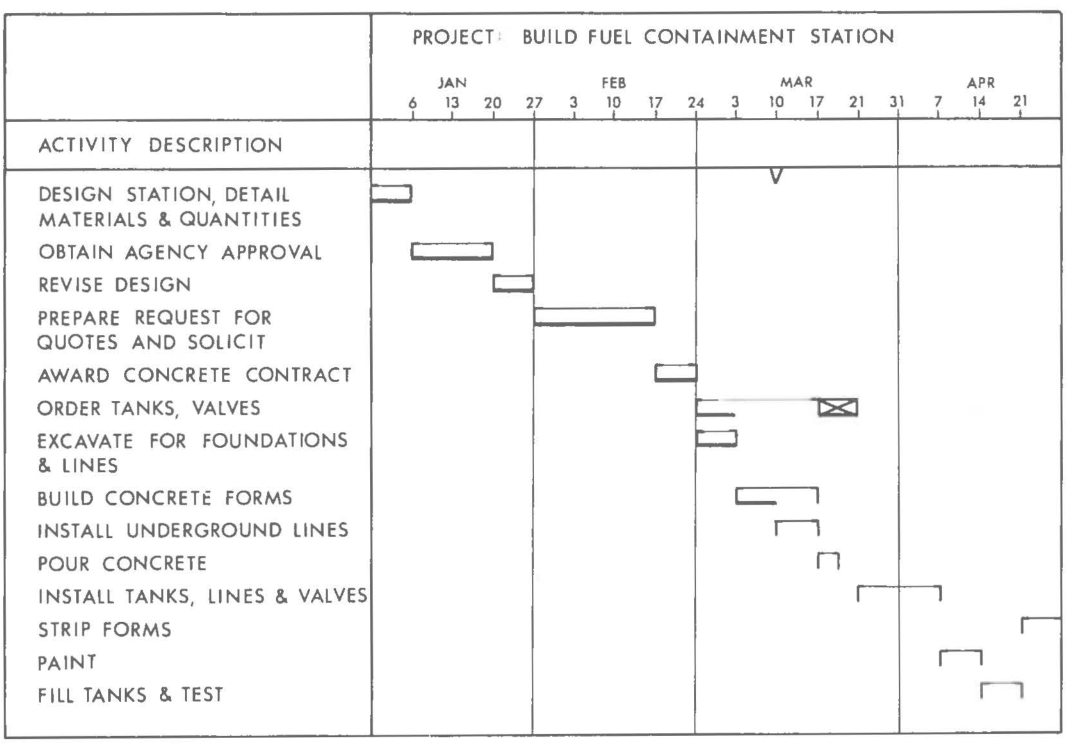


Figure VIII-6. Gantt Chart.

In Figure VIII-6 the symbols mean:

┌ - indicates date when work scheduled to begin

┐ - indicates date when work scheduled to end

—— - light lines indicate scheduled work

▬▬ - heavy lines show completed work

V - today's date

⊠ - time needed to get back on schedule

As can be seen in Figure VIII-6, the project is about one week behind schedule. However, if the valves and material are received no more than a week late, the project completion date can be met. Since scheduling in part depends on the availability of men, machines and materials, the Gantt load chart (Figure VIII-7) is also a valuable planning and scheduling tool. It shows the accumulated workload, month by month, for each machine.

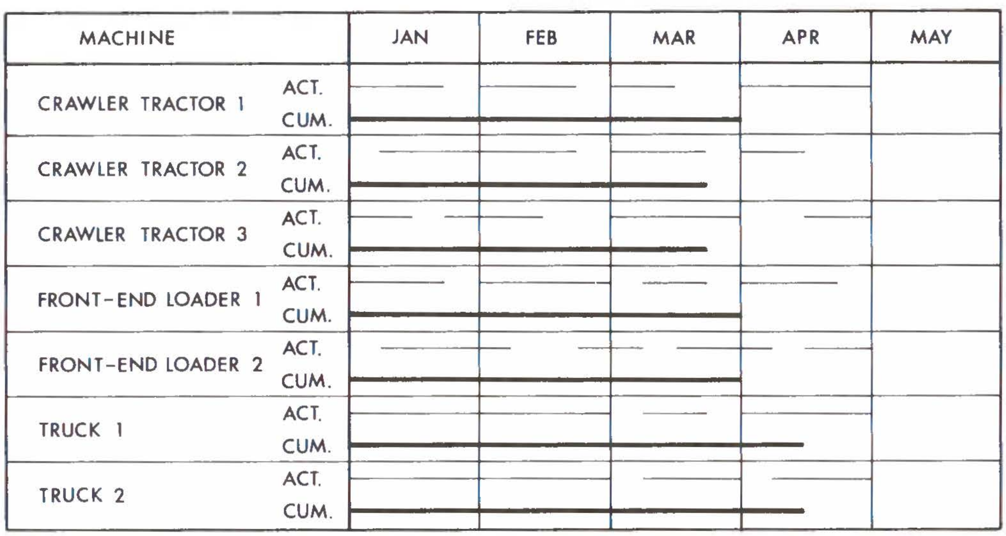


Figure VIII-7. Gantt Load Chart.

As the project develops it can also show the accumulated backlog. If further detail is required, then a Gantt chart can be prepared showing the jobs planned for each machine or man and the total time available (Figure VIII-8).

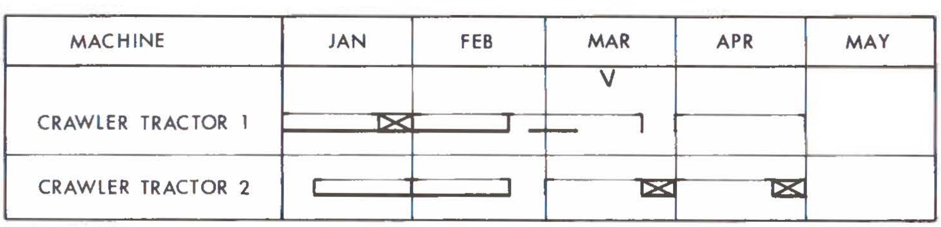


Figure VIII-8. Gantt Layout Chart.

The charts must be kept up to date to be of value in ongoing scheduling or control. Various phases are rescheduled as work progresses. Mechanical boards and magnetic boards are available to speed up the updating and rescheduling. The chart updating can be reduced considerably if records and a schedule are kept only for the key phases, costly phases or bottleneck phases of the project. The rationale here is that if the important phases are scheduled and controlled properly, then the less important phases will work out all right. For large projects the Gantt chart is limited, unless it is used at a general level, because as the complexity and detail increase, the chart becomes very large and difficult to maintain.

b) Critical Path Scheduling (CPS)

Another technique for the planning and control of construction projects is PERT (Program Evaluation and Review Technique) or CPS (Critical Path Scheduling). The two systems are similar; the main differences are in how the time estimates for activities are used and how the arrow diagram is prepared. The basis of both systems is the application of network analysis which separates the functions of planning performance from planning time schedules. The separation allows independence of performance control and scheduling control.

CPS, rather than PERT, will be described here. The first step in CPS is to define the project objectives and scope. The project is then divided into activities of the smallest unit that has to be scheduled and controlled. After the activities have been established, determine their sequence. An example of the foregoing three steps is given in Figure VIII-9.

ACTIVITY - BUILD FUELING STATION & CONTAINMENT BUNKERS

JOB	DESCRIPTION	IMMEDIATE PREDECESSORS	ESTIMATED TIME (DAYS)
a	Start		0
b	Design station & bunkers and prepare bill of materials	a	5
c	Obtain agency approval	b	10
d	Modify drawings	c	1
e	Estimate job cost	d	2
f	Obtain quotations on concrete work, installation of tanks & piping, and excavation work	d	15
g	Order tanks, valves, pipes, fittings, etc. and receive	d,e	15
h	Award concrete, excavation & installation contracts	f,e	2
i	Excavate	h	1
j	Build footing forms	i	2
k	Lay underground piping and wiring	g,i	3
l	Pour concrete footings	j	1
m	Lay steelwork anchors	i,g	1
n	Pour bunker floor	k,l,m	1
o	Install tanks and tie down	g,m,n	3
p	Electrical wiring	n	1
q	Install pumps and motors	n	3
r	Ground system	q	1
s	Erect wooden frame and roof	o	4
t	Fill tanks	o	1
u	Paint tanks and wooden frame	q,s,t	2
v	Test system	u	1

Figure VIII-9. Activity and Performance Chart.

The sequence or precedence is usually set by physical requirements of the activity. For example, you cannot pour the foundations before excavation.

The next step in setting up a CPS network is to prepare the arrow diagram. The rules are quite simple:

- Circles represent activities. Within the circle the letter indicates the job and the number indicates the time required for the job.
- Arrows represent sequences of activities and the direction of flow. If it is possible to trace a circular path of arrows, then a mistake has been made in the diagram.

Figure VIII-10 is an arrow diagram of Figure VIII-9.

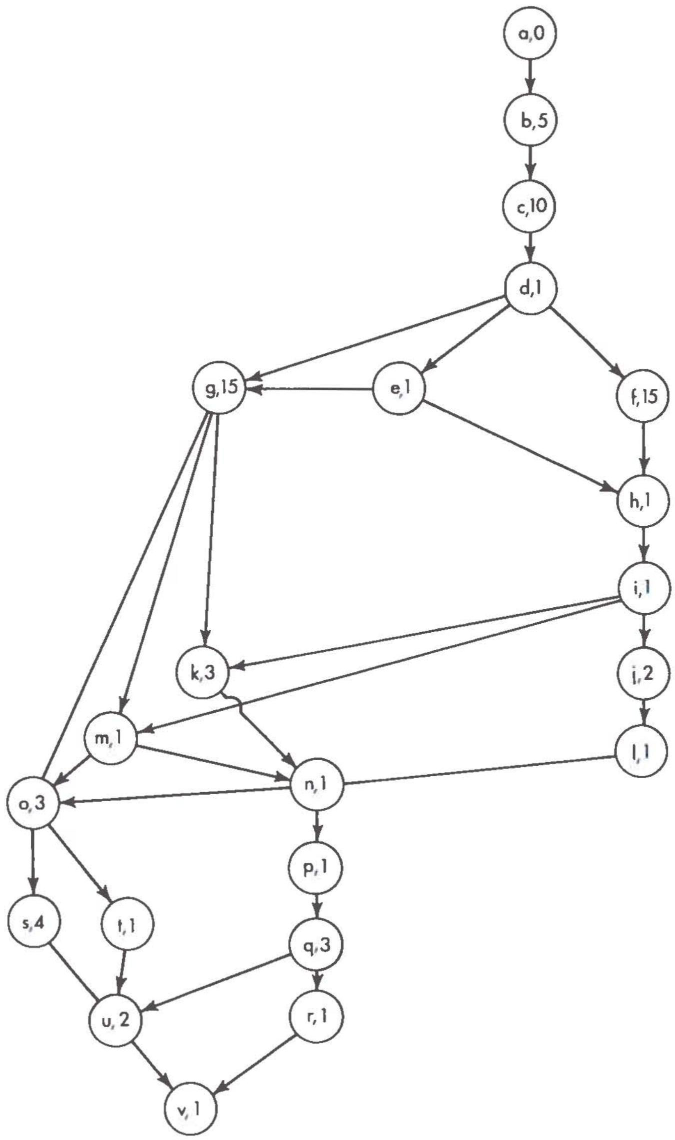


Figure VIII-10. Arrow Diagram of Figure VIII-9.

In Figure VIII-10 there are several unique paths through the arrow diagram. The shortest path takes 41 days and the longest path takes 47 days. The longest path is the critical path and it determines the duration of the project. The activities on this path are critical to the project's meeting a minimum time schedule of 47 days. By analyzing the diagram, it is possible to calculate the earliest time that each activity can start and finish, and the amount of slack time available. These earliest, latest and slack times give the project supervisor an idea of how much flexibility he has in each activity. Activities with slack time can be juggled to reduce peak demands for manpower and machinery. However, activities on the critical path cannot be started later nor take longer than the planned time without affecting the completion date of the project. Computer programs that solve CPS networks for the critical path and calculate the various slack and start times are available.

The CPS network can also be used as a control device. Also, the interdependence of activities can be seen by the construction supervisor. The planned start dates, actual start dates, percentage of work completed, work backlog, etc. can all be obtained from the diagram and reported. It will identify if delays in certain activities are going to shift the critical path. Estimates can be made of the costs of speeding up or slowing down certain activities in order to meet schedule deadlines. The effect on the overall project of rescheduling certain activities allows the construction supervisor to see the likely future effect of a present change in the schedule.

c) Modified Scheduling Method

Another project planning and control technique involves combining features of CPS and Gantt charts. It was developed by the author because the Gantt chart was not sensitive enough and the methodology of the CPS was too complex for some users. The technique loses some of the benefits of the CPS in the rescheduling area, but allows more detail than a Gantt chart. Figure VIII-11 is an example. It uses the same project as shown in Figures VIII-9 and VIII-10.

The technique shows the interdependence of activities tied to calendar dates and shows the critical sequence of activities that determine the project duration. It also shows which supervisor is responsible for each activity in the project. The technique shown in Figure VIII-12 is commonly referred to as "crashing".

When a plan is crashed, every circuit in the network becomes a critical path and if any activity takes longer than planned or is late in starting, then the completion of the project is delayed. However, on some projects this represents the method of operation and the planning method is at least realistic.

This technique supplies the same benefit as the CPS and Gantt systems. In preparation, the construction manager must go through a logical, sequencing process and examine the overall project step-by-step. Whether he applies the crashed technique or not depends on priorities. The technique has all the control reports of CPS and as the project progresses, the actual performance can be plotted to determine when and if rescheduling is necessary.

At least one of these planning and control techniques should be used when designing and building a sortyard. If not, the project will be built on a reaction basis and changes will be made without a full knowledge of the impact on other activities. Some dryland sort projects have used CPS networks for the design stage in order to make sure that all jobs are done and done in the correct sequence before the proposal was due.

3. Contracts, Purchasing and Inspection

Specialized assistance is usually needed in the preparation of contract specifications, requests for quotations and purchase orders. Clearly written contracts and purchase orders minimize the conflicts over interpretation with contractors. Company purchasing agents and lawyers should be used to prepare agreements and resolve conflicts so that the construction people can concentrate on building the yard.

An inspection process will have to be established to ensure the project is being completed as specified. On smaller jobs, commercial inspection companies can be used to conduct the tests. On bigger projects, a project engineer may be responsible for inspection and testing of construction work.

All mobile equipment should be checked to ensure it meets the specifications and that pre-delivery servicing has been completed. In the case of fabricated equipment such as sorting bunks, dump ramps and weight scales, it is advisable to send someone to the manufacturer's plant as the equipment is being assembled. This serves as an inspection and also provides the inspector with information on how the equipment is put together and can be maintained in the future.

It is wise to ask for proof of bonding from the major contractors on the project to protect the company if the contractor becomes insolvent. Also, it is important to establish which unions the contractors and suppliers intend to use so that potential problems of jurisdiction are avoided. The contractor should also be made aware that he is responsible for the safety of his workers and for ensuring safe working procedures and equipment.

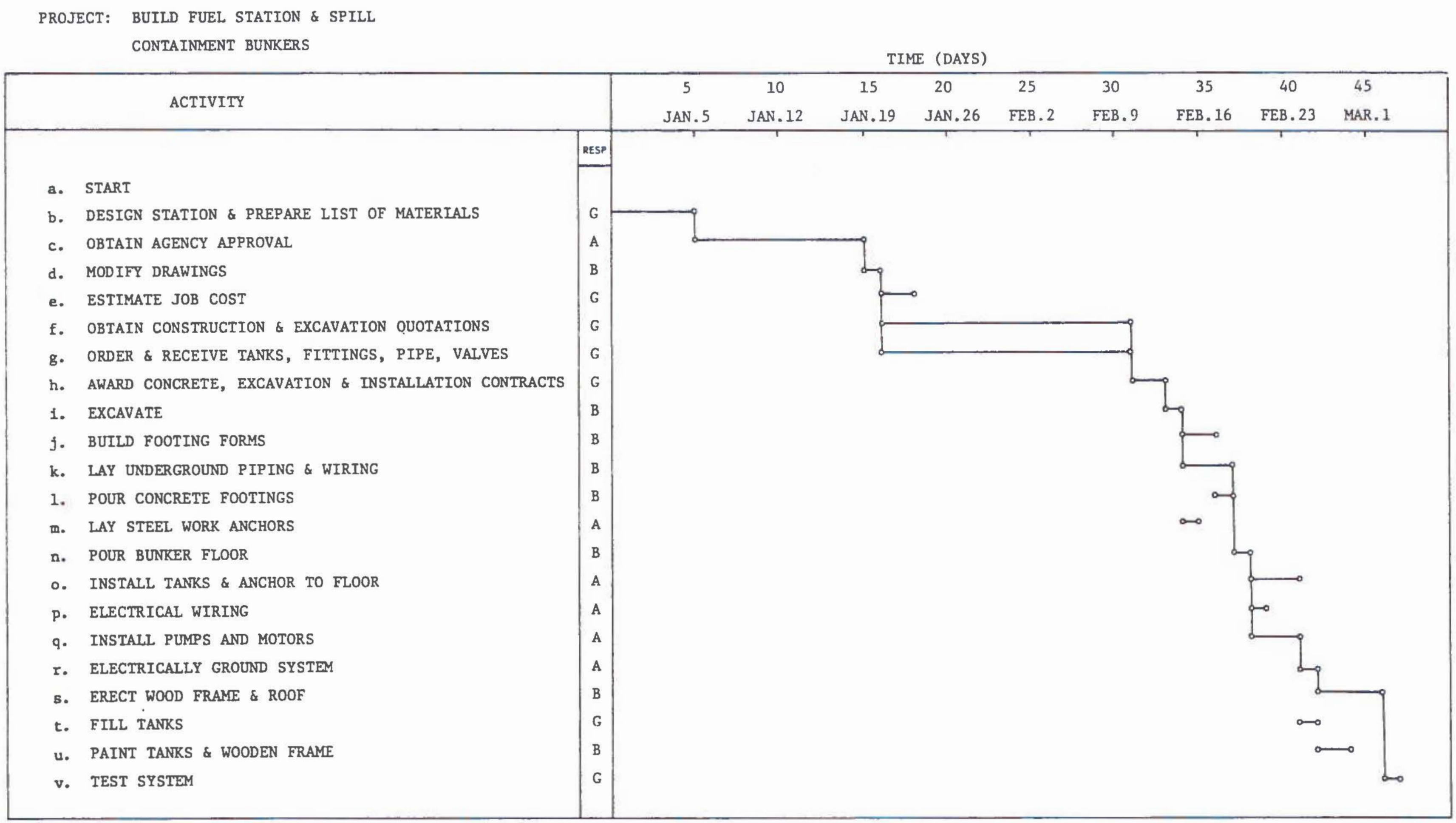


Figure VIII-11. Schematic Scheduling and Planning.

PROJECT: BUILD FUEL STATION & SPILL
CONTAINMENT BUNKERS

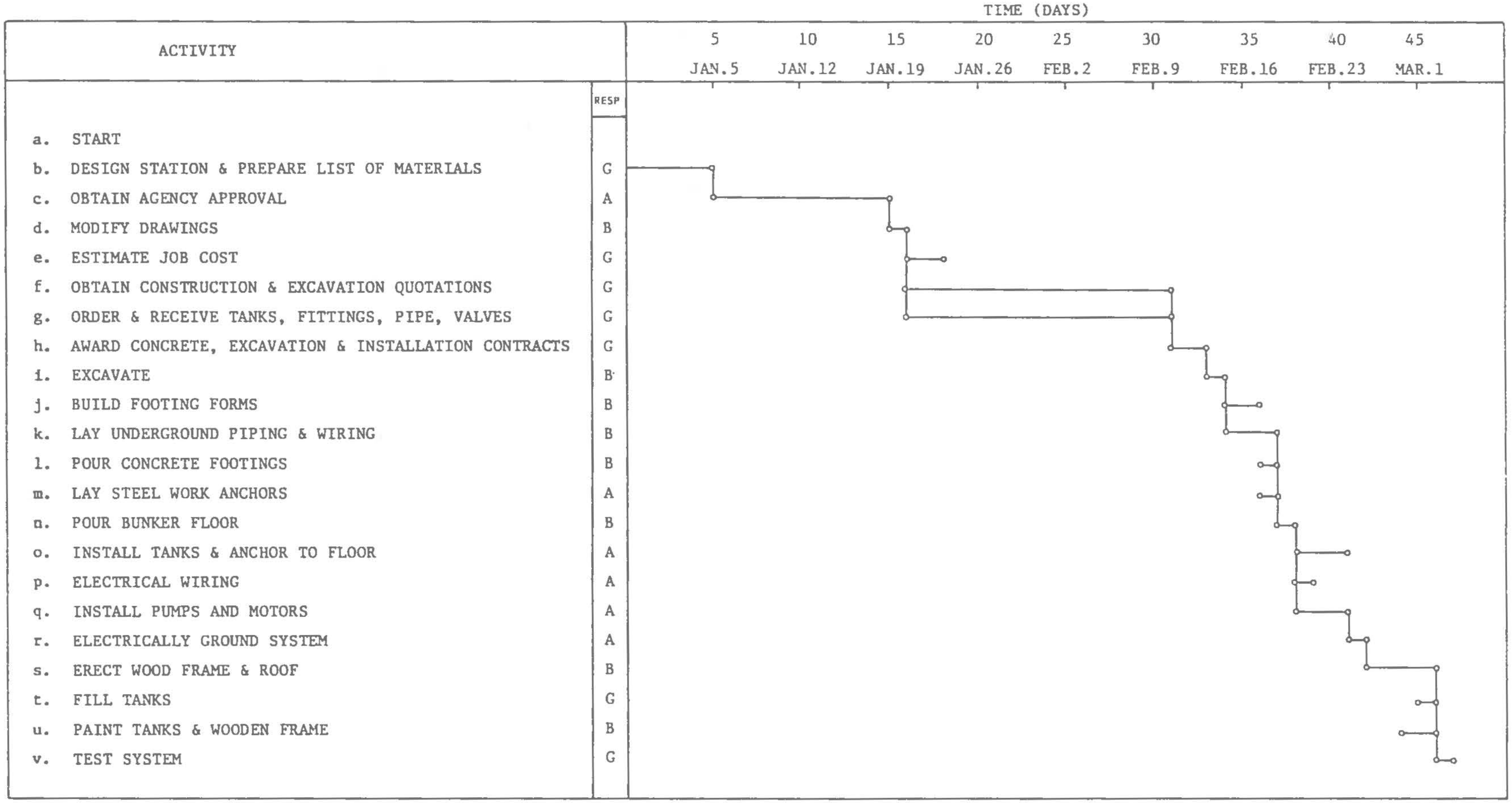


Figure VIII-12. Schematic Scheduling and Planning - Crashed.

4. Cost Control

The project must have cost control once money begins to be spent. The logging division accountant or a project accountant must determine the items received, compare them with the amount ordered and the amount invoiced, and verify the invoice for payment. He must issue cheques, endorse payment, and keep records. He must estimate the monthly cash flow of the project. The accountant may be bothersome to project personnel but he is an integral part of the project team. In order for cost control to be effective, the project budget should be broken down into major purchases or contracts and the timing of the cash flows established. From this, planned and actual performance can be compared and variances established.

In the mid 1970's, sortyards were built with tremendous cost overruns. As a consequence, senior management demanded tight cost controls and reporting as well as regular performance reports and performance project cost forecasts as the project progressed. On some projects, weekly meetings were held where performance to date was reviewed, the next week's work was planned and purchase recommendations and decisions were made. The people who designed, were building and would operate the yard were involved as well as the specialists.

C. CONSTRUCTION

1. Selecting Contractors

The construction of a sortyard is a major project for a logging division. Much of the work will be done by contractors but the final results and the operation will be the responsibility of the company. It must decide who is to be the general contractor.

There are three possibilities - the company, a consulting engineer or a contractor. The general contractor is in charge of the whole job. He maintains the schedule, hires all the subcontractors and orders the supplies.

If the company is established in the area and has purchasing, accounting and other services, it will probably act as its own general contractor under the direction of a full-time project manager. It is important to clarify the role and scope of the manager and his relationship with other company personnel.

If the company does not have the facilities or the confidence, it may hire a consulting engineer to oversee the project. In this case, it is important that the roles and responsibilities are clear.

A construction contractor should only be used as a general contractor for the overall project if it is in an isolated location and when the majority of the work is being done by the contractor. In this case, the job should be bid in total rather than on unit prices for each part of the job. If unit prices are involved, the company must set up a measurement and audit system independent of the contractor and this defeats the purpose of using a construction company as general contractor.

If the logging company decides to be the general contractor, it must decide whether to permit large construction companies to subcontract some of the work to their subsidiaries and must become aware of some of the trade-offs in the heavy construction industry. Subcontracting may permit the main contractor to co-ordinate the work but it may also allow it to block out other contractors. It may be advisable to break up the main contract into smaller parts. For example, is it more economical to contract dredging and site preparation together or to separate them? From a project co-ordination point of view, is it better to have one contractor doing all site preparation work or two or three? The advantages and disadvantages of breaking up the contract should be discussed, particularly when subcontracting to subsidiary companies.

A second factor is the problem of matching the job size to the contractor size. Some of the larger earthmoving contractors can complete the work on a medium sized yard very quickly but the overhead and setup costs are high. The smaller contractor may rent equipment or hire owner/operators and reduce overhead and set up costs. The job normally takes longer because the owner/operators will own smaller, less productive equipment. Many parts of the project may be done more efficiently by local community contractors and they should not be overlooked. Such things as retaining walls, fuel containment pits, scale pits, building foundations, wiring and ditching, and pipe laying can be handled by local contractors. Also, consideration should be given to prefabricated modular structures rather than structures built on site.

In meeting with the earthmoving contractors, a variety of construction methods will evolve. One contractor may want to move the material with trucks while another will want to use scrapers. One may want to construct the rip rap protection before the fill is in place, while another will want to construct it after the fill is in place. They will also have different ideas on how much overburden has to be moved and how much can be left. It is important at this stage to state clearly, in writing, acceptable construction methods and engineering standards. Also, the contractors should be made aware that their work is going to be inspected and tested regularly throughout the project.

Even though the company may have no intention of doing the earthmoving or other work, it is worthwhile estimating what it would cost the company to do it. The estimates can be compared with the contractor's bids to see if the bids are reasonable. Usually, construction jobs are based on cost per cubic metre or tonne for specific work and volumes. If special construction techniques are used or additional volumes of material moved, then normally it will be on a cost plus or hourly rate. In order to avoid construction cost overruns, it is advisable to foresee these problems and include them in the original contract. A cost estimate of the company's construction department doing the project can be valuable as a check.

2. Clearing and Stripping

The amount of clearing and stripping is usually greater at an inland site than at tidewater.

In most cases, company fallers and equipment are used to clear the timber from the site. Once this is completed, the engineer should examine the site closely for dry creek beds, swampy areas and soft soil types. Stumps should be removed and overburden stripped to mineral soil or bedrock. Whether company crews or contractors do this depends on the availability and suitability of company equipment. It is necessary to remove as much of the organic material and silty soil as possible. If an intended site has been used before as a sorting and booming ground, then sunken logs should be removed before the fill begins. Also, the subsurface material in the intertidal zone should be examined. If it is incapable of supporting the weight of the fill, it must be removed before filling commences. In some cases, crawler tractors can be used but in environmentally sensitive areas, a dragline and a truck haul may be necessary. This latter option can be expensive as disposal sites have to be established and approved.

Engineering and geotechnical surveys should be done before and after clearing and stripping in order to determine cuts, fills, removals or additions.

3. Rip Rap Protection

If the sortyard is located at tidewater, rip rap rock will have to be used to protect the fill from erosion due to surface runoff water, tidal action and waves. One fortunate aspect of B.C.'s rocky coastline is that quarries for rip rap rock are usually readily available near the sortyard site. The quarries are usually drilled and blasted to produce rip rap predominantly about 1 metre in size. Usually, the main question concerning rip rap rock is when to place it. Do you place it before or after the fill is complete? If it is placed before the fill is started, then a more stable protective structure is built and there will be less chance of erosion during and after the fill but more rip rap will be used. Figure VIII-13 is a typical profile of rip rap that has been placed before the fill program was started. If dredging is necessary at a sortyard, then placing the rip rap before the fill program starts can be an advantage. First, if a dragline dredge is to be used, then the rip rap structure can be used as a base for the dragline and also be used to get the dragline as close to the dredge area as possible. Second, the rip rap structure can be used to contain the dredgeate as it dries out.

If it is decided to place the rip rap after the fill is in place, there will be more chance of losing fill material during construction through erosion but less rip rap will be needed to protect the fill. Figure VIII-14 shows a common profile.

4. Dredging

If dredging is necessary, there are the options of suction or dragline dredging. Some logging companies have equipped their yarding cranes with dragline buckets to dredge. However, the production rate is usually only 125 m^3 per day so they are limited to smaller jobs. Commercial dragline companies will normally only need to

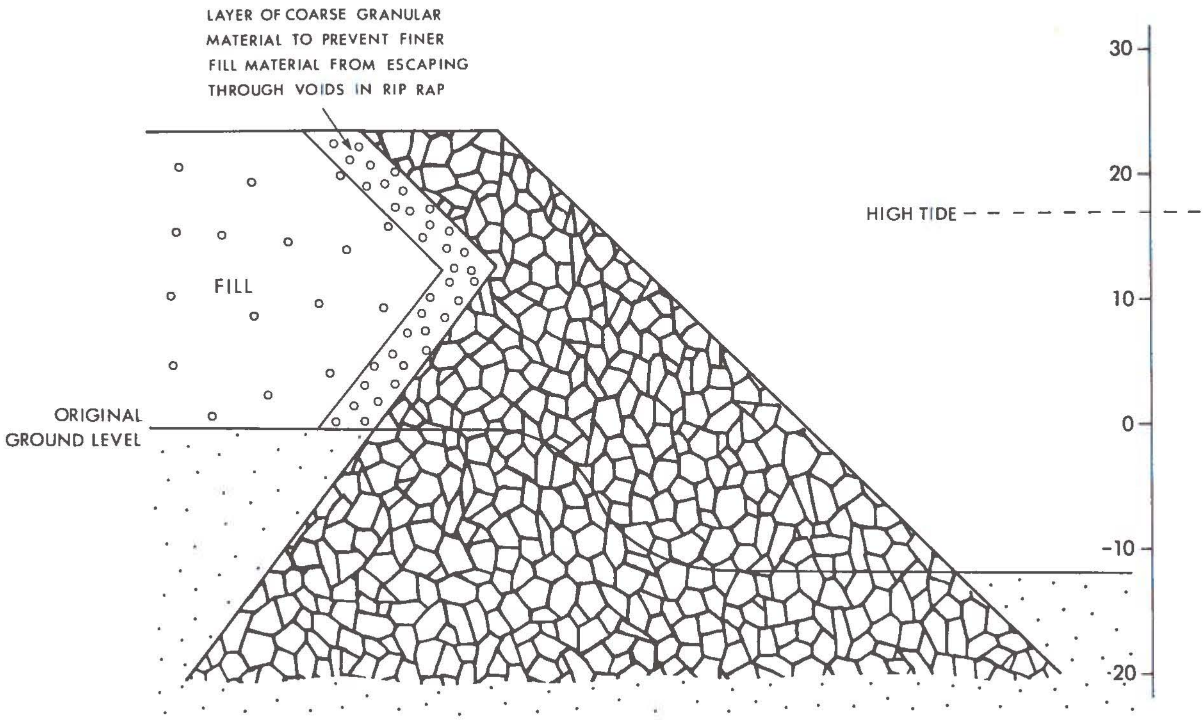


Figure VIII-13. Typical Profile of Rip Rap Placed Before Fill.

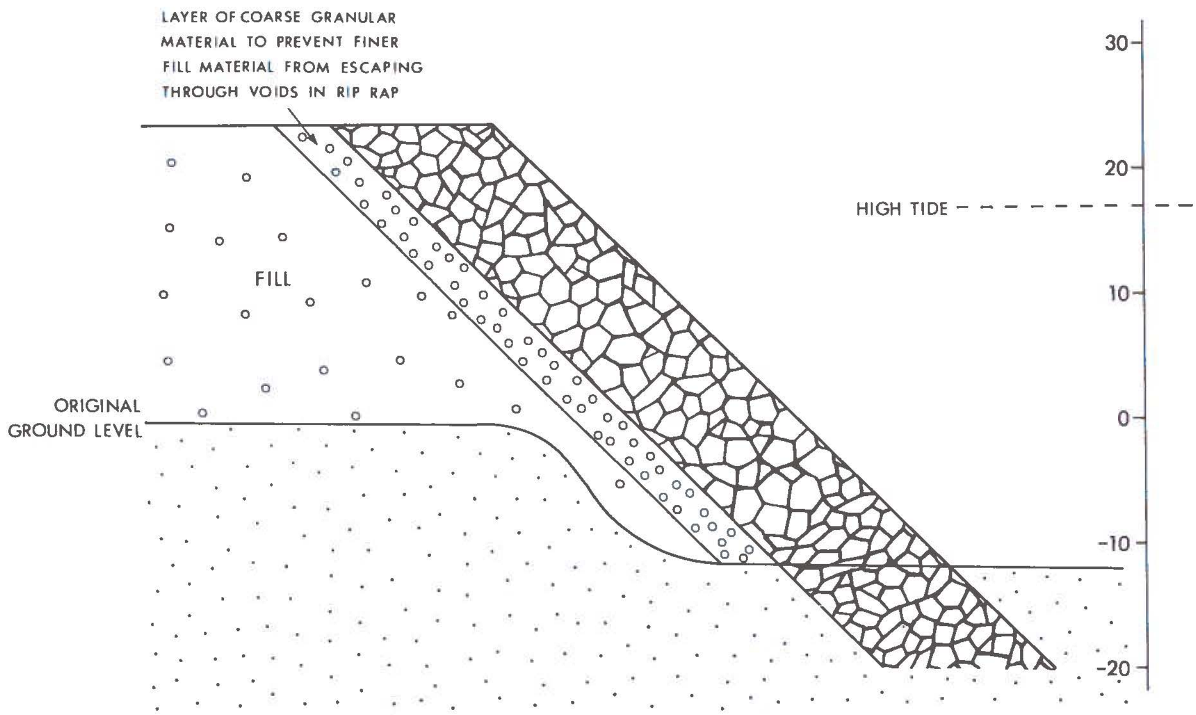


Figure VIII-14. Typical Profile of Rip Rap Placed After Fill.

tow a dragline barge and scows to the site so their mobilization and demobilization costs are low relative to a suction dredge. Dragline dredges work better in compacted or coarse soil and suction dredges in uncompacted and fine soils. The production rate of a dragline will vary depending upon the disposal of the dredgeate. The highest rates are achieved when the material can be sidecast (and hopefully used for the sortyard fill). The lowest rates are achieved when scows have to be towed a long distance and unloaded with a front-end loader. Similarly, the dredging costs will also vary significantly with the disposal method. A 2.3 m^3 capacity dragline will cost about $1 400/day and should dredge 700 m^3/shift. A 4.7 m^3 capacity dragline will cost $2 500/day and dredge 900 m^3/shift. Scows cost approximately $500/day/scow and a front-end loader will cost $700/day. With all the variables, it is difficult to estimate the cost of dredging without knowing the particulars of the job but a reasonable estimate would be $2.00 to $2.75/$m^3$ for dredging and $3.00 to $3.85/$m^3$ for disposal using two scows and a front-end loader.

Suction dredges have much higher production rates (10 000 m^3/shift). However, it may cost $50 000 to $65 000 to move a suction dredge from Vancouver to mid-Vancouver Island, set it up and then return it to Vancouver. Once in operation, the suction machine can dredge for about $2.00/$m^3$ but is not usually used on jobs under 25 000 m^3. With its disposal lines, the suction dredge can dispose of the dredgeate on land or in deeper water. The suction dredge is more susceptible to damage than the dragline, particularly when at old log dump sites where wires and logs may have accumulated. With both types of dredging, approval has to be obtained from the Department of Fisheries and Oceans, the provincial Lands Branch and Transport Canada, concerning the area to be dredged, the timing of the dredging and the method of disposal. At some sortyard locations, the allowable dredging period may be only one month and the disposal site may be a long distance from the site.

The amount of material to remove is calculated from the soundings during the site survey and the required depths in the booming ground. Subsurface investigation will indicate how much sloughing and deposition will occur. This extra material should also be dredged in order to maintain desired depths. In areas where there is a strong tidal flow in one direction, it may be wise to hire a marine consultant to assist in locating key features of the booming ground, particularly the dump ramp. Dump ramps should not be located in areas that will continually fill up with gravel. Also, dump ramps may be located so that bark deposits are swept away into deeper water and thus reduce the amount of maintenance dredging and environmental damage.

Samples of the soil and wash material taken in the booming ground area will make it possible to decide if the dredged material is suitable for sortyard fill.

5. Earth Work

The method and type of earthmoving equipment will depend on the size of the sortyard and site conditions. On a small sortyard with a nearby rock quarry, all that may be necessary is a rock drill, a front-end loader, two or three dump trucks and a crawler tractor. A large sortyard may require a suction dredge, several crawler tractors, front-end loaders, end dumps and scrapers. However, with both extremes the amount, depth and type of material should be closely monitored and controlled. Earthmoving practice is based on moving material quickly but the engineer must control the quantity and quality of material moved to ensure that the product is the one desired.

Except on the smaller sortyards, the methods and equipment used for earthmoving will be foreign to the logging division engineer. The blast-and-then-spread method of logging road construction will not be used by earthmoving contractors. Consequently, on larger jobs, the logging engineer must set up survey crews that keep ahead of the contractor to indicate the areas and amounts of fill required as well as establish a planning and control system that indicates the progress of the job. On larger jobs, the contractor will have several million dollars worth of equipment at the site and he will demand that it be used efficiently.

As with sortyard equipment, earthmoving equipment is designed to do a specific job. For example, crawler tractors are primarily used for moving and spreading material for short distances. They can also be used for rough grading and compaction. They are normally used behind end dumps to spread fill. On the other hand, a scraper can spread the fill itself with minimal assistance from a crawler tractor. The construction engineer must be aware of the advantages of the various types of construction equipment and groups of equipment that may be suggested by the contractor to produce the lowest cost job with the best results. If the logging engineer feels he needs help in deciding on the earthmoving method, then he should get advice from an earthmoving consultant. Usually, the engineers for the earthmoving contractors are willing to discuss the methods suitable for the project.

6. Surfacing

The yard surface can vary from in-place material, to pit run gravel fill, blasted rock, rolled concrete (soil cement) or asphalt. Usually, the smallest yards use the former and the larger yards use either of the latter two. Primarily, this depends on the duty cycle placed on the sortyard equipment and the resultant importance of machine travel speeds. The smallest yards are usually less than 0.2 ha in size and only process one load at a time. Consequently, machine travel distances and speeds are low and the need for a smooth surface is not great. In the larger yards where travel distances are longer, a smooth running surface is of greater significance and asphalt or rolled concrete is preferred.

Usually, in B.C. coast yards processing more than 140 000 m^3 annually, there are enough economic justifications to carry the additional capital investment necessary for hard surfacing. The designer should try to get asphalt or concrete included in the original design because it is very difficult to justify after the yard is built. First, if a yard is paved after it has been built and used, it is likely the top metre of surfacing will have to be removed before the crushed base and paving can be applied because of bark and silt contamination. This cost can add significantly to the total cost of surfacing. Also, once the yard is built, the only savings that surfacing will cause are a reduction in yard maintenance costs and machine operating and repair costs. Productivity benefits may result but unless manpower and machinery hours are reduced as a result of surfacing, they will not be actually achieved.

As was shown in Part VII-J-2-b, 20 cm of crushed base and 15 cm of asphalt can easily cost \$20.36/m^2. At this rate it will cost \$814 000 to asphalt a 4 ha site, which is a common area for a mid-sized yard. With this amount of money involved, a soils consultant should be considered to specify the compaction required on the subbase and crushed base, the thickness of the crushed base and asphalt layer, and the asphalt mix composition. The consultant can also examine the soils analysis of the material in potential gravel pits to determine if they have a suitable gradation for fill, crushed material and asphalt and, if not, what additions will be necessary to give a suitable gradation. As a result of the heavy wheel loadings found in sortyards, a high specification asphalt mix will have to be used and, again, a soils consultant should be involved in setting specifications.

The following are rules of thumb regarding asphalt for a sortyard.

Compaction

Pit run fill and crushed base should be compacted to specified levels and tests should be made during the project to ensure that the levels are being achieved. The key to success in good asphalt surfacing is good subsurface compaction because asphalt cannot bear the imposed loads by itself. Normal compaction levels are:

- crushed base - 100 percent modified Proctor compaction*
- first 0.3 metre of subbase - 100 percent modified Proctor compaction
- next 5 metre of subbase - 100 percent standard Proctor compaction
- deeper than 5.3 metre of subbase - 95 percent standard Proctor compaction.

Lift Thickness

The subbase should be applied in 30 - 40 cm lifts with each lift being compacted with a vibratory compactor. The movement of earthmoving equipment in itself may result in 100 percent compaction in localized areas but use of a vibratory compactor will ensure a consistent base level of compaction. Too much compaction is not good because the fines can be driven out of the subbase. As a result, compaction will fall off and cannot be regained without the addition of more fine material.

*Canadian soil standard manuals specify the tests required to determine these compaction levels. Some engineers prefer using only one standard to prevent possible confusion and error, while others prefer using both.

Soft and Low Bearing Areas

If soft or low bearing areas are noted when the vibratory compactors are working on the pit run fill, then these areas should be dug out and replaced with stable material. If they are not removed, further settling will occur and the surfacing will crack.

Layout

If feasible, the area in the yard that is going to be surfaced should be laid out so the paving machines have as many long, straight courses as possible. This will reduce paving costs.

Applying Asphalt

Most asphalt surfaces in sortyards range from 10 to 15 cm in thickness. The asphalt compaction levels required in sortyards cannot be obtained if the asphalt is thicker than 7 or 8 cm so the asphalt should be laid in two lifts. Normally, a tack coat between lifts is not necessary unless dirt and oils have accumulated on the surface or weathering has occurred.

Proportion of Fines

The high specification asphalt used in sortyards needs a relatively high proportion of fines (less than 200 sieve). The fines add to the asphalt's strength by plugging the voids between the larger particles. On a mix with inadequate fines, some operators will add more asphalt oil as a way to increase strength. However, this practice can cause problems in hot weather as the asphalt will soften and the oil may run. A better practice when the aggregate has inadequate fines is to add fine material such as quarry dust, cement powder or pozzolan.

Rolled concrete, rather than asphalt, has been used in some sortyards on the coast of B.C. Its main attraction, from a maintenance point of view, is that it is not attacked by oil. With the amount of hydraulic equipment in sortyards, oil spills are unavoidable and eventually asphalt will have to be patched or replaced. Also, as oil prices have increased, rolled concrete's unit price compares very favourably with asphalt. Rolled concrete has normally been used where the aggregate is unsuitable for asphalt or where the subbase cannot be compacted adequately for asphalt. Until the escalation of oil prices, it was difficult for rolled concrete to compete economically with asphalt because of the number of existing asphalt plants relatively close to sortyards. Rolled concrete projects will normally face a much larger mobilization and demobilization charge than asphalt projects.

Rolled concrete is normally laid on 15 cm of 1.9 cm minus crushed base which has been compacted to 98 percent modified Proctor density. One sortyard that used rolled concrete specified the following for the surface:

- base lift - 203 mm $\pm$ 12 mm thick, flexural strength of 2.8 mpa after 28 days, compressive strength of 28.0 mpa, and minimum of 8 percent cement (Portland type 10) content by weight.
- surface lift (wearing course) - 102mm $\pm$ 6 mm thick, flexural strength of 4.1 mpa after 28 days, compressive strength of 34.5 mpa, and minimum of 13 percent cement (Portland type 10) content by weight.

This sortyard used front-end loaders for sorting and transporting logs. In sortyards that use log stackers, the wheel loadings are much higher. A base course of 225 mm and a surface course of 150 mm is probably more suitable for these yards. The Canadian Portland Cement Association can advise on the proper specification for rolled concrete surfaces.

Some of the yards that are built without asphalt or rolled concrete surfacing will use a blasted rock surface. Eventually, the blasted rock surfacing will disappear or develop areas of instability as bark mixes in with the rock or basic problems in the subsurface material become apparent. Also, as the sorting machines clean the surface layer daily of mud, the blasted rock is mixed in with the mud and is also removed. It is unusual for a blasted rock surface to last more than one or two seasons. However, a blasted rock surface lasts longer and is easier on the sorting machines than a pit run gravel surface. A pit run gravel surface develops unstable areas almost immediately and more gravel has to be applied to compensate for the gravel being removed with the bark and mud. In most yards with pit run gravel surfacing there is an ongoing regular surface maintenance program where the trucks that are being used to transport the debris and mud to a disposal site are also used on the return trip to bring in fresh gravel. Often in pit run gravel yards, blasted rock is used to cap the fill and to provide an even running surface. Although pit run fills have a relatively low initial cost, their operating costs are high. Equipment maintenance costs and cycle times should be compared to surfaces of blasted rock, asphalt or concrete.

7. Services

The source and supply of services will need to be established. Most likely some of these services will be needed when construction starts so they will be one of the first activities in the overall construction project. Water will be needed for drinking as well as for sewer, fire protection, dust suppression and possible ambrosia beetle control. If possible, an adequate supply should be found and, if necessary, provision for storage to cover peak demands should be provided.

If electricity is to be provided by B.C. Hydro, they must be made aware of the likely demand well in advance of the need. Hydro will assist and advise on the best type of metering and the advantages of renting transformers versus purchasing them. An electrical contractor should be used for designing and installing the required electrical services. The installation will have to meet standards and be inspected after installation.

Provision for telephones should be planned for at the same time as the electrical installation. Good communications to and from a sortyard are valuable.

Provision for sewage disposal should also be made. The health officials can advise on the percolation necessary for septic tank systems and on the availability and acceptibility of chemical sewage disposal systems. They, or the labour department, can also advise on the facilities required for the crew.

8. Building and Structures

Several buildings and other structures will have to be constructed when the sortyard is built. If the sortyard requires a weight scale for logs, it may be advantageous to install the weight scale before the start of earthmoving. The earthmoving, crushed base and asphalt phases of the contract can then be weighed as a basis for payment. Most truck weight scales in sortyards are permanent installations and are mounted on concrete foundations. Scale manufacturers will supply detailed drawings of the foundations needed. In addition to the foundations for a weight scale, there will be concrete foundations needed for buildings, fueling stations, trailer reloads and retaining walls. If there is enough concrete work, it may be worthwhile to give it all to one contractor in order to get a lower unit price. Concrete handbooks can be used to assist in designing the remaining concrete work needed at a sortyard.

9. Booming Grounds and Dump Ramp

Typical booming ground layouts and costs, as well as a range of costs for dump ramps, were given in a previous section and will not be repeated here. However, some of the construction concerns will be discussed.

Obviously, a supply of boomsticks and hardware will be needed to build the booming ground. Depending on the style of the booming ground, pile drivers, concrete anchors, rigging blocks and bobbers may also be needed. In addition, piling or deadmen will have to be used on the shore to anchor the standing boom and give it the proper alignment. This will require pile drivers or backhoes. If there is an existing water sorting ground then the boomboats, tugs and swifter machines can be used to lay out and hang the boom; if not, they will have to be brought in from elsewhere. Similarly, if there is an existing sorting ground the boom crew should be able to build the new booming ground; if not, the construction will probably have to be contracted. Booming grounds have been used for years and their design and construction are relatively simple but they have to be planned in the construction program.

A new booming ground will probably change the profile of the shoreline and, as a result, approval will be needed through the Navigable Waters Protection Act (Transport Canada). Upon application, an inspector will visit the site and review the plans and drawings for the booming ground before approval to build is given. The same procedure has to be followed for storage grounds. If the booming ground is in a busy boat traffic area or near a ferry route, flashing beacons will probably be required.

As well as the booming ground, some additional floating facilities will have to be built. Usually, the logging division bridge crew will build log floats. The facilities normally include a boathouse, boomchain float, swifter line float, wharf, walkway and electricity, fuel supply and water supply. These will require carpenters, plumbers and electricians as well as materials.

The previous section showed dump ramp construction costs can vary from \$2 000 to \$200 000. The more expensive ones must be properly engineered. They involve concrete abutments, debris bins, piling and steel I-beams, and must be structurally sound. Figure VIII-15 shows the size of a dump ramp at a larger sortyard. With the larger ramps, concrete work, pile driving, rigging and crane erection are necessary. As three or four separate companies or contractors will probably be needed to design, fabricate, build and install the ramp, construction supervision and control is needed. The simpler ramps made of logs can usually be designed and built by the people at the logging division. However, no matter how simple and inexpensive the dump ramp is, it must work and have a reasonable life or it will be a serious bottleneck in the sortyard.

Figure VIII-15. Dump Ramp at a Larger Sortyard.

10. Debris Disposal

The problems caused by debris in sortyards are usually understated in the sortyard design and not fully provided for in the sortyard construction. Usually, provision for sortyard debris is made after the sortyard is built and a more costly process than necessary results. However, if a few points are followed when building the sortyard and purchasing equipment, debris disposal costs will be minimized. These points are:

Debris for Fuel Use

Keep debris free of rock and dirt if it is going to be used as fuel. An asphalt surfaced yard is an advantage but the debris should also be accumulated and stored on the asphalt. Debris contaminated with dirt and rock from yards with shot rock or pit run gravel surfaces or from the gravelled perimeter of asphalt surfaced yards has virtually no potential as a fuel. A surfaced area for accumulation and storage of debris destined for hogged fuel should be provided for when the yard is built. The debris will be generated at a volume rate equal to 5 percent of the log processing rate in the sortyard and the area needed for its storage will depend on how regularly the debris is removed.

Debris Disposal

Open burning or landfill are the only practical solutions for the disposal of debris which is not utilized. Tests have shown debris will not burn effectively in commercially available incinerators or beehive burners. Standard open burning in piles can be made quicker and less smoky by use of a FERIC* pipe burner and it is probably the cheapest way to dispose of debris where burning is required and allowed. A burning site should be provided when the yard is built. It should be as close to the yard as possible to minimize debris transportation costs, but located where it will not cause a fire hazard or vision and respiratory problems from the smoke and sparks. In order to reduce operational and maintenance problems, the burning site should be supplied with electrical service to run the fan motor and with water for fire protection. If landfill disposal is chosen, a permit has to be obtained from the provincial agencies. In the permit, the debris generation rate and the life of the landfill has to be documented. To receive a permit, several conditions have to be satisfied. The main ones are: the leachate from the landfill cannot eventually enter a fish bearing stream without treatment; the existing wildlife population is not harmed; and the landfill site has to be protected and treated so that fires do not result. The latter condition usualiy means surrounding the site with a chain link fence and alternating layers of debris with layers of gravel. After a permit is received, a road has to be built to the site and the site cleared. Provision should also be made so that access to the site can still be made as the site fills with debris.

Sortyard Cleaning

In addition to planning methods for disposal of debris, allowances should be made for sorting machine time that is regularly needed to sweep debris from the yard surface. A clean yard surface will reduce the safety hazard for scalers, graders and bundlers, reduce tire costs and machine maintenance and permit faster machine cycle times. About 5 - 8 percent of sorting machine time will be needed for sweeping debris and this should be considered when deciding on the type and number of machines to purchase when the yard is being built. Debris disposal is a cost of sorting and as such, should be provided for when building the sortyard and acquiring equipment, not after.

*FERIC Technical Report TR-34.

PART IX ORGANIZATION AND OPERATION

PART IX ORGANIZATION AND OPERATION

This section of the handbook will deal with selection and training of supervisors and crew, organizational structure, log accounting and scaling systems and planning. These topics often are overlooked in the design and construction of the sortyard but should not be because they are a very important ingredient in the success of a sortyard.

A. PERSONNEL SELECTION AND TRAINING

Normally, when a sortyard replaces a sorting ground, the foreman and crew move to the new operation. In comparison with sorting grounds and other logging operations, sortyards can be dirty, noisy, busy but still boring places to work. However, the people usually work regular shifts and are in convenient locations. Initial high turnover of ex-sorting ground personnel often results until employees are found who like the work.

1. Sortyard Foremen

The ideal time to select a foreman is before the sortyard is built. He can then be involved in the location, design, economic analysis and construction. He will have a clear understanding of the objectives of the sortyard and be familiar with its layout.

Besides supervisory skills, the sortyard foreman should have a sound knowledge of log grades. Sorting quality is critical to a yard's success and a sortyard foreman must be able to recognize missorted logs and to train the operators and graders. He must also be able to recognize the potential for upgrading logs. If the yard foreman has only a basic knowledge of log grades, then he should be encouraged to take his B.C. scaler's licence. While a licence does not guarantee log knowledge, it is a start and, over a period of time working with logs, the foreman will become competent at recognizing log grades and missorts.

Another important skill is familiarity with numbers and accounting. A characteristic of sortyards is that logs lose their identity after scaling. Consequently, elaborate accounting systems have been developed to ensure that the scale bill shows the correct information for a boom. A good understanding of the log accounting system is necessary to avoid and rectify mistakes.

It is also important for a foreman to have experience operating and maintaining equipment because of the large equipment investment in a sortyard. This is most valuable when a yard is starting up but is not the key to the success of the yard. What is more important is for the yard foreman to recognize machine abuse, inefficient moves and improper operating techniques. The foreman should know how and what the machines should do rather than how to operate them. This ability results from knowing the yard objectives, how it should operate and from watching other operations.

2. Crew Selection and Training

If the sortyard replaces an existing sorting ground, then the company is obligated by the collective union agreement to retrain the crew.

Sortyard jobs can be divided into scaling and grading, machinery operation and yard crew. The skills and training required for each job differ. Scalers and graders usually require a B.C. scaler's licence. If qualified people are not available, then private scaling companies, in conjunction with the Ministry of Forests, will put on a scaling course to train the personnel and prepare them for the scaling exams. However, the failure rate is high (usually greater than 60 percent) and it is likely the test will have to be written a second time. Even persons who have passed the exam are not competent scalers. They will have to be coached and checked by an experienced scaler for approximately two years before they can be considered competent. Company log scalers and graders are quality control inspectors. Their work is technical and requires attention to detail. In addition, there is paperwork or computer entries which must be done in a precise and consistent fashion.

Machinery operators, like scalers and graders, can be hired or transferred from other logging jobs. However, their work pace is much faster and more repetitive than normally found in logging. If the machine operators have to be trained, they must first learn to operate and service the machine. This part is straightforward and can be taught by experienced operators or equipment supplier's demonstrator/operators. During this part of the training, it will be fairly obvious which men have the necessary coordination and aptitude to be successful operators. The second part of the training is learning the job functions in the yard. The machine operator must know the objectives of the sortyard, the job priorities, safety rules and other policies applying in the yard. This part of the training is best carried out by the yard foreman. Also, it is the type of training that must be carried on continuously as people tend to forget and job priorities change. The foreman must watch that operators do not develop bad habits which will result in machine damage, log damage or lower productivity.

Training of the yard crew is also important and often overlooked. Most yard crew jobs, such as bundling, log tagging and boomstick boring are entry level jobs with high turnover. As a result, good and continuous training is necessary. With the yard crew, the foreman has an opportunity to develop good work habits from the start because it is probably their first job in a sortyard. Some yard foremen look to the yard crew for future graders, scalers and machine operators and select and train them for their future potential. Although the job duties of the yard crew are usually simple, they are important and must be carried out correctly to avoid costly mistakes. For example, bundlers must secure bundle wires properly or the bundle will break. They may also be required to keep a record of the bundles dumped which must be accurate or the log accounting system will be in error. The yard crew must be trained to use safe job procedures and be aware of hazards because they work in areas of heavy machine activity.

3. Assistance in Training

There are several sources of help for training sortyard personnel. Many equipment manufacturers have training centres for teaching mechanics to service and maintain equipment. They may have a newsletter service that informs the mechanics of changes in equipment, servicing techniques and schedules. As a sales incentive, some equipment suppliers will offer to train operators. Their trainers can teach the operation of the machine but are limited in their knowledge of sortyard priorities. Training consultants can be employed to set up a comprehensive training program. Canada Manpower has a program for training employees affected by technological change. If requested, they will take an active role and provide technical programs, as well as the wages of the employees and trainer. The local Canada Manpower office can advise on the type and amount of assistance available. The Council of Forest Industries of British Columbia and the Ministry of Forests conduct a training program to prepare for the B.C. scaler's exams. In summary, there are many organizations, suppliers, manufacturers and consultants ready to assist in developing and implementing training programs for sortyard personnel and there is no reason why the companies have to develop training programs by themselves or entirely at their own expense.

4. Changes in Traditional Jobs

In some sortyards where the sorting ground crew was retrained for the sortyard, the entire crew has turned over in less than a year, whereas in other sortyards the old crew is basically intact after 10 years. It is difficult to explain the difference but often a steady crew results when there is a community nearby with a good supply of skilled workers. Some workers are more comfortable with the simplicity of operating a boomboat in a sorting ground, than with operating a front-end loader, whereas others prefer the warmth and dryness of a front-end loader cab that more than offsets the added complexity of the work. Another phenomenon in the yard is the migration that some employees make through the various jobs. There is very little upward mobility in the sortyard and employees may wish a different job for a change. Some sortyards recognize this and train their personnel to do several jobs. This allows the crew a variety of jobs and reduces boredom and turnover. Other yards employ a relief spare to operate the machines while the regular operator has a break. This has the added benefit that operators changing types of machines throughout the day experience less fatigue and boredom.

The sortyard system has forced changes on some traditional jobs. When scalers worked on the water, they would scale a whole boom at once and could set their own pace of work. However, in sortyards they have to scale as soon as the logs are spread and the scaler's pace is now set by the machines. In sorting grounds, the boat operators graded and sorted the logs themselves. These men required several years of log experience as well as machine operating skills. In most sortyards, grading and sorting are two separate tasks. The machine operator must make sure the log gets into the sort indicated. He needs no grading skill and has lost a function that was a source of pride. The sortyard is much more like a factory or mill than the sorting ground. While this may make management simpler and more precise, the inherent repetitiveness and boredom can have an adverse effect on the employees unless steps are taken to build variety into their jobs.

B. ORGANIZATIONAL STRUCTURE

A successful sortyard must meet quality goals as well as quantity goals. Traditionally in logging, the primary goal has been quantity which in sortyards will reduce quality because good grading takes time. Also, upgrading logs to a higher value takes even more time and supervisors will reduce this activity if pressured to increase log throughput. Some companies recognize this potential conflict and have their log yard supervisor report to a log trading or fibre supply department rather than a log production department. In other companies, he reports to the divisional manager. In any case, it is essential that the sortyard foreman report to someone in the company who is in a position to optimize the company profit and reduce the quality-quantity conflicts.

The organizational structure within the sortyard will depend on its size. In the smaller sortyards (less than 140 000 m^3 annually) there may be no supervisor, whereas in the larger sortyards (greater than 900 000 m^3 annually) there may be a superintendent, a foreman, an accountant, a master mechanic, a scaling supervisor and a booming ground chargehand. In the smaller yards, a mature crew will need little or no supervision and if problems occur, they can resolve the problems themselves. In the larger yards, the span of control and the required areas of expertise are just too great for one man to be responsible and additional supervisors or specialists are needed.

Organizational conflicts may occur over the location of the repair shop and the reporting hierarchy of the mechanical crew. From a sortyard point of view, the repair shop should be located as close as possible to the yard and the mechanical crew should report to the sortyard foreman. Mechanical availability must be high in the sortyard and the equipment must be given the same priority as the rest of the logging equipment. There are several ways to ensure this:

- have the sortyard foreman report to the divisional manager so he is at the same level as the other foreman and can demand the same repair priority;
- if the yard is large enough, locate a shop at the yard and have the master mechanic or shop chargehand report to the sortyard foreman; or
- assign fulltime mechanics and a field service truck to the sortyard.

The job functions, responsibility and authority of each sortyard supervisor should be clearly defined and written down. As mentioned earlier in the handbook, if the sortyard objectives are stated and priorities amongst objectives established, then the foreman's job is much easier. Besides these aspects, management should require that the supervisor and crew have a positive, aggressive attitude.

C. SAFETY

Safe working procedures must be established for each job in the sortyard. Hazardous areas should be indicated and control maintained over personnel entering these areas. Safety training of the employees must be a significant part of their job training. All companies recognize the importance of having a safe work place and safety conscious employees. However, maintenance of a safe work place and safe attitude of employees is difficult because people tend to forget about safety. Attempts to emphasize safety and overcome this problem have been many and varied. Some companies have gone to the extent of having the employees write their own safe job procedures (Figure IX-1). Regular safety meetings are a good way to ensure that a safety emphasis is maintained. The safety committee should check that a safe work place continues and that unsafe operating habits are not developing. The Workers' Compensation Board of B.C. publishes safety regulations* that must be adhered to. They also inspect operations to ensure that the regulations are being followed.

Some of the conditions unique to a sortyard that can cause safety problems and possible solutions are:

1. Close proximity of people and machines - minimize hazard by having machines and people in area at

*See Appendix III for regulations regarding sortyards.

different times, by reducing the congestion of machines and people or by making the people highly visible.

2. Wood debris on yard surface - potential tripping hazard or flying object hazard - minimize by cleaning yard surface or reducing people in the area.
3. Caulk boots - caulked boots are needed when walking on logs but are a potential slipping hazard on metal surfaces which are found in sortyards at bundling areas and dewatering areas - define jobs requiring caulk boots.
4. Machines losing logs - create areas or corridors around machines where people are not allowed.
5. Poor machine visibility - select machines with better visibility or lay out yard so that chance of collision with equipment on personnel is minimized.
6. Loose logs when unloading logging trucks - minimize hazard to truck driver by restraining load while binder wires are released and by removing driver from unloading area or protecting him within unloading area.

Figure IX-1. Safe Job Procedures - Scalers & Graders (Written by a Sortyard Employee).

PERSONAL PROTECTIVE EQUIPMENT

- Hard hat
- Caulk boots
- Hi-vis vest
- Gloves when required
- Eye and ear protection when required

GENERAL HOUSEKEEPING

- Keep tripping hazards to a minimum.
- Empty paint cans must be put in the garbage can.

OPERATION

Working at the table:

- Stand clear of moving logs while at the table.
- Ensure that everyone is in the clear before starting table.
- Know horn signals of machines: three toots, going ahead; two toots, backing up.
- When stacker is spreading, keep alert and in the clear.
- Do not stand at the switches for the table when stacker is spreading. Go inside the Two-High.
- Look for dangers before walking on or between the logs to grade them. Stay clear of logs that could roll.
- Do not grade or stamp logs while table is moving.
- Ensure grapple operator knows if you are going to be working close to that machine.
- Know the lock-out procedures and have your key with you at work. (Check with foreman.)

Working in the spread sort:

- When working in pairs, work together on the same row. Once you finish that row, don't go back to it.
- Always use the same route going to and from the spread sort and walk together.
- Announce over the radio when going to the spread sort.

- Stay well in the clear when stacker is spreading a load.
- Ensure that grapple operator and front-end loader operators know where you are if working near them.
- Be aware that there must be two feet of clearance between loader counterweight and any other objects.
- Stay clear of swing area on the grapple.
- Look for dangers before walking on or between the logs to grade them. Stay clear of logs that could roll.

Working in scaling areas:

- Scale sticks to be carried point down.
- Use caution when walking past the strapping bunks for stackers and front-end loaders loading these bunks.
- Do not stand too close when stackers are spreading loads or front-end loaders are working in this area.
- Look for dangers before walking on or between the logs to grade them. Stay clear of logs that could roll.

Working on the boom:

- Life jackets must be worn when on the water.
- Arrange for your own safety check if you will be working alone on the booms.
- Ensure that someone is aware that you will be going onto the water and when you should be returning.

REGULATIONS

- Be familiar with WCB and Company regulations and policies.

D. LOG ACCOUNTING AND SCALING SYSTEMS

In most water sorting grounds, the Ministry of Forests scales the booms of logs after sorting and produces scale bills which are used for stumpage and royalty charges and for log sales or transfers. In most sortyards, the Ministry of Forests also scales logs but before they are sorted. This is satisfactory for determining stumpage and royalty charges but does not supply the information necessary for booms to be sold or transferred. Consequently, the logging companies and independent scaling services have developed systems that use the presort scale information to generate a scale bill for the boom of sorted logs. Some companies rescale sorted logs. There are about seven basic scaling systems in use on the coast of B.C. Some of them are available commercially.

Most of the scaling systems use the boom cutoff method to determine the grade, volume and pieces in a log boom. This system is only accurate if the log yard supervisors and scalers take great care to determine which log is the last going into the boom, ensuring that the scaler indicates this last log on his scale sheet and ensuring that it gets into the boom. Boom cutoff systems have had a tendency to become less accurate with time. However, mill or customer complaints and constant checking and counting will restore accuracy. Companies that sell or trade a large proportion of their logs may use the log tag system which has a greater potential for accuracy. Some of the sortyards scale by load or bundle rather than sort and let the computer classify the information in the boom. This method also provides logging division production statistics. For material handling and manpower efficiency and productivity, scaling by weight is preferred. Weight scaling reduces the number of scalers required. However, as each log is not individually scaled it is resisted by log traders because it does not describe exactly what is in the boom. The accuracy associated with stick scaling may be important on the high value, old growth species where size and shape vary but is not necessary for low grade or sorts of uniform logs.

Following are detailed descriptions of seven different scaling and grading systems.

1. Canadian Forest Products Ltd.: Harrison Mills Sortyard

The sortyard processes an average of 1 285 m^3 or 890 pieces per eight hour shift. Two Ministry of Forests scalers and a company clerk using a Monroe 2860 calculator are employed to operate a simple, inexpensive boom cutoff scaling system.

The scalers maintain a scale sheet for each of the 21 possible sorts (8 main sorts). At the beginning of each shift, the clerk photocopies the previous day's scale sheets for each sort. The clerk calculates the net volume of each log scaled and enters this information plus the grade information on a Boom Report Worksheet. The calculator maintains a cumulative total in its memory of the volume and pieces in each sort, which the clerk uses to prepare the daily production report. When a boom is about to be completed, the booming ground chargehand tells the log grader how many more bundles will be required. The grader counts the logs in that sort to determine the last log in the last bundle in the boom. He marks this log so that when the scaler reaches the log he can cut off the scale sheet for that sort. The clerk sees a cutoff mark on the scale sheets and completes the Boom Report Worksheet. The booming ground chargehand counts the boom gear and the scalers scale the boomsticks on the completed boom for the clerk to include in the Boom Report. Completed Boom Reports are forwarded to the Log Trading department for pricing and conversion into boom invoice.

In addition to the Boom Report Worksheets, the clerk also prepares a Daily Production Report, Boom Reports on completed booms and a monthly summary of swifter and boomstick production and inventory. She also provides information for Cut Control and prepares a Boom Gear and Boomstick Report. The cost of the log accounting work is estimated at $0.09 per piece. The cost of the Ministry of Forests scalers is estimated at $0.28 per piece. The yard operators report that underruns and overruns on boom volumes are minimal.

2. MacMillan Bloedel Ltd.: Northwest Bay Sortyard

The sortyard processes an average of 1 160 m^3 or 1 550 pieces per eight hour shift. Scaling is done by two private scalers and log accounting is done by a clerk using a Datapoint 1100 computer. The system is similar to the Harrison Mills system with the exceptions of the use of electronic hand-held recorders rather than scale sheets and the use of a computer rather than a calculator with memory.

The scalers enter net log dimensions, Forest Service log grades, timber mark, sort and species information into the MSI-77 hand-held recorders as they scale. On the peewee hembal and fir sort, the scalers only scale 30 percent of the pieces and apply a piece average to the rest. At the end of a shift, the information in the recorders is put into the computer.

The bundlers maintain a peg board to record the number of bundles dumped per day. As well, they count and keep a record of the logs in each bundle and spray paint the number of pieces and the bundle number on each bundle. The bundle record is given to the foreman at the end of the shift. He maintains a daily bundle count and running total of bundles by sort. Each morning, the head boomman is provided with a list of bundles in the water. He notifies the foreman what booms will be cut off that day. The foreman then estimates the last log in the boom and marks the last log with paint. When the scalers reach the marked log in the scaling deck, they indicate a cutoff has been made into the recorder. After a boom has been completed, the foreman adjusts his record of the number of bundles in the water.

A boatman inspects the completed boom and counts the chains, swifter wires, bundle wires and number of bundles. A scaler scales the boomsticks and also counts the boom gear and bundles. Loose logs in the boom are counted but not rescaled. The computer prints a boom report for a completed boom that lists the volume and pieces by grade. The gear count and boomstick volume is added to this report. The scaling company uses this information to prepare a Summary of Scale on the boom (Figure IX-2) which can be used for invoicing purposes. Figures IX-3 to IX-5 give samples of the forms used in the sortyard for control purposes. Figure IX-3 is the count of bundles in the water which is given to the booming ground chargehand at the start of each shift. Figure IX-4 is the running total of bundles and is used by the foreman and yard chargehand for cutoff on booms. Figure IX-5 is the Boom Tally Sheet prepared by the boatman and double checked by the scaler on completed booms.

The computer is programmed to check the information from the hand-held recorders for coding errors. The scalers are consulted to make corrections. Daily, the computer summarizes the pieces, volume, species and

LOG-1001

SUMMARY OF SCALE

A E LOG SCALING

Boom No. NWB 1071 Scaler's No. XAE Date Scaled Sept 2/82

Sections 5 Pieces 1863 Log Ave. .61 Chains 1882 S/W

Sort Fir Sulp Bdls: 21 Bdl. Ave. 36.47 Tbr. Mark 58 B/W.

Scaled For HP LTD

Location NORTHWEST BAY

Timber Mark	Scale	Pieces	Species	Grade	Volume
W	M3	20	FI	I	289
		149	"	J	52.5
		1231	"	X	756.7
		239	"	Y	134.5
		6	LA	J	2.5
		9	"	X	6.7
		9	"	Y	7.4
		22	WH	J	13.5
		27	"	X	16.5
		5	"	Y	5.8
		1	"	Z	2.1
		113	FI	J	43.7
		33	"	X	9.8
TOTAL	M3	1863			1130.7
BLS	M3	3	FI	H	9.6
		2	"	I	9.2
		1	"	X	2.8
		1	"	Y	3.2
		1	HE	I	4.7
		4 1	" "	J X	9.6 2.5
TOTAL	M3	13			41.6

REMARKS:

2 CONTRACT BUNDLES INCL.

SEP 24 1982

Scaled By M. Emmerson

Figure IX-2. Summary of Scale.

DATE	______________
Peeler	______________
Fir Standard	______________
Fir Pee Wee	______________
Fir Pulp	______________
Hemlock Standard	______________
Hemlock Pee Wee	______________
Hemlock Pulp	______________
Cedar Merch	______________
Cedar Pulp	______________
Cedar Pee Wee	______________
Cypress Sawlog	______________
Poles	______________
Hem Pulp	______________
Fir Pulp	______________
Domans Mix	______________
Domans Sm Hembal	______________
Domans Lg Hembal	______________

Figure IX-3. Bundles in the Water.

log average. It produces boom reports that list volume, pieces and grades for booms completed. Daily sortyard costs are based on the daily scaled production and logging costs, and production is based on the weight (converted to volume) of logs into the sortyard.

The computer also produces several weekly and monthly production reports. A clerk spends 4 hours per day entering information and at month end spends two days producing monthly reports.

The Datapoint 1100 computer has been in use 4 years. In addition to log accounting, it is used to prepare daily logging production statistics and costs, financial statements and logging plans.

The log accounting is estimated to cost $0.10 per log and scaling $0.30 per log.

BUNDLE-LOG COUNT

LOG-[illegible]

DATE: ______________

PEEL	FI. STD	FI.P/WEE	FI PULP	HE. STD.	HE. P/WEE	HE. PULP	CE. MERCH.	CE.PULP	CY S/L	O.S. FIR PULP	CY PULP
		27	3	27							
		28	4	28							
		29	5								
		30									
		1									
		2									
TOTAL											

Figure IX-4. Running Tally of Bundles.

MacMILLAN BLOEDEL LIMITED
NORTHWEST BAY DIVISION

BUNDLE BOOM TALLY SHEET

Boom No. ______________

Date: ______________

				SECTIONS
				SPECIES & TYPE
				BOOM CHAINS
				SWIFTER WIRES
				BUNDLE WIRES
				BUNDLES
				LOOSE LOGS
				PCS. IN BUNDLES
				BOOMSTICKS
				TOTAL PIECES

Figure IX-5. Bundle Boom Tally Sheet.

3. British Columbia Forest Products Ltd.: Shoal Island Sortyard

The sortyard processes an average of 3 600 m^3 or 2 700 pieces per eight hour shift. Scaling is done by five Ministry of Forests scalers and log accounting is done by Wescom Computer Services of Victoria. The log accounting is based on a double boom cutoff system which is unique because it has to account for logs received by boom rather than truck and from several logging divisions rather than one and, as well, it must record the outgoing boom volumes, pieces and grades.

When a tow of logs arrives, the sortyard foreman inspects and counts the bundles, boomsticks and boom gear in each boom. The information is recorded in a Boom Inventory Control Book. The scalers then scale the boomsticks in the tow.

Run numbers are assigned to the booms from each camp in the tow. The bundles are dewatered, one at a time, and spread separately for grading, scaling and sorting. The grader paint marks the first and last logs of each bundle with the incoming boom and bundle number. The scaler grades and scales the logs in order and records the information on a Tally Sheet for each bundle. The scaler recounts the logs in the bundle to ensure none have been missed or double-scaled and then writes the piece count on a card which is attached to the first log in the bundle. Three bundles of logs must remain between the unscaled logs and the sorting machines so that check scales can be made by Ministry of Forests scaling supervisors. A senior scaler records the information on the bundle card before releasing it for sorting, bundling and dumping. Figure IX-6 shows a sample of the report of the boom and bundles dewatered daily.

SHOAL ISLANDS LOG SORT

DAILY RECORD OF BUNDLES SCALED

DATE: Dec. 17 COMPLETED BY: [illegible]

BOOM NO. KI 41		BOOM NO. KI 45		BOOM NO. [illegible]	
BDL. NO.	RAFT TAG NO.	BDL. NO.	RAFT TAG NO.	BDL. NO.	RAFT TAG NO.
1		1	[illegible]	1	[illegible]
2		2	[illegible]	2	[illegible]
3		3	[illegible]	3	[illegible]
4		4	[illegible]	4	[illegible]
5		5	[illegible]	5	[illegible]
6		6	[illegible]	6	[illegible]
7		7	[illegible]	7	[illegible]
8		8	[illegible]	8	[illegible]
9		9	[illegible]	9	[illegible]
10		10	[illegible]	10	[illegible]
11		11	[illegible]	11	[illegible]
12		12	[illegible]	12	[illegible]
13		13	[illegible]	13	[illegible]
14		14	[illegible]	14	[illegible]
15		15	[illegible]	15	
16		16	[illegible]	16	
17		17	[illegible]	17	
18		18	[illegible]	18	
19		19	[illegible]	19	
20		20	[illegible]	20	
21		21	[illegible]	21	
22		22	[illegible]	22	
23		23	[illegible]	23	
24		24	[illegible]	24	
25		25	[illegible]	25	
26		26	[illegible]	26	
27		27	[illegible]	27	
28		28	[illegible]	28	
29		29	[illegible]	29	
30		30		30	
31		31		31	
32		32		32	
33		33		33	
34		34		34	
35		35		35	
36		36		36	
37		37		37	
38	[illegible]	38		38	
39	[illegible]	39		39	
40	[illegible]	40		40	
41	[illegible]	41		41	
42	[illegible]	42		42	
43	[illegible]	43		43	
44	[illegible]	44		44	
45	[illegible]	45		45	
46	[illegible]	46		46	
47	[illegible]	47		47	
48	[illegible]	48		48	
49	[illegible]	49		49	
50	[illegible]	50		50	

Figure IX-6. Daily Record of Bundles Scaled.

The scalers and senior scalers check the Bundle Tally Sheets and compare them to the Daily Record of Bundles Scaled. The foreman also checks this information and enters a sequential number on each Tally Sheet. The Tally Sheets must be keypunched in the correct sequence so that outgoing booms are cut off in order and the Boom Summaries agree with the physical boom. The yard foreman prepares a Batch Transmittal Report (Figure IX-7) showing the last log in any completed boom. This, along with Tally Sheets and the Daily Record of Bundles Scaled, is delivered to Wescom Data Centre for keypunching. Wescom produces the necessary reports within two days of receiving a Batch Transmittal Sheet.

B A T C H   T R A N S M I T T A L

CAMP RUN #: 009   LT1   Bundles 61-99

NUMBER OF BUNDLES: 39

OUTGOING BOOM STARTED	SORT	OUTGOING BOOM #	STARTING SHEET #	STARTING LOG #
	GN	Shoal 193	009-011	12
	=	Shoal 194	009-015	6
	V	Shoal 195	009-099	49
	•	Shoal 191	009-099	49

R E P O R T   P R O C E S S I N G   R E Q U E S T

1. END OF RUN REPORTS FOR RUN #: 009

2. END OF MONTH REPORT TO: RUN #: ______ SEQUESTIAL # ______

REQUESTED BY: [illegible]   DATE: FEB 19/82

Figure IX-7. Batch Transmittal Sheet.

When a boom has been completed, it is inspected by the foreman. The bundles and boom gear are counted and the boomsticks scaled. This information is added to the Boom Volume Report.

Any loose logs in an incoming boom are treated as a bundle. For stumpage and royalty purposes, they are treated as no-mark-visible logs.

The yard supervisors were asked for any criticisms about the system. The main complaint of this system is checking the Tally Sheets for errors and then getting the Ministry of Forests' permission to correct them.

When a run is completed, Wescom produces the following reports:

a) Run Summary by Timber Mark - This report gives the run number and summarizes the pieces and volume by timber mark, species and grade (Figure IX-8).

-------INCOMING------- RUN	MARK	PIECES	SPECIE GRADE	CUBIC METRES
047	F63031	1	CE M	.8
		1 *		.8 *
047	NMV	1	BA I	2.4
		2	BA X	.3
		1	BA Y	.1
		3	CE I	4.0
		8	CE J	4.9
		2	CE L	3.3
		1	CE M	.7
		2	CE X	.9
		1	CE Y	.1
		2	FI H	7.0
		1	FI J	.6
		1	FI Y	.1
		1	HE I	1.6
		19	HE J	9.6
		6	HE X	1.1
		1	HE Y	.1
		52 *		35.5 *
047	17/10	5	BA C	9.6
		3	BA D	16.7
		6	BA H	27.8
		29	BA I	51.7
		41	BA J	29.0
		24	BA X	14.3
		1	BA Y	.3
		15	CE H	45.9
		16	CE I	26.5
		403	CE J	259.3
		1	CE K	2.1
		6	CE L	10.7
		24	CE M	28.0
		63	CE X	33.7
		9	CE Y	3.2
		1	FI B	4.2
		27	FI C	76.0
		1	FI D	12.8
		68	FI H	154.1
		34	FI I	53.7
		73	FI J	46.1
		46	FI X	37.2
		11	FI Y	14.5
		1	HE D	4.9
		31	HE H	95.9
		171	HE I	301.6
		849	HE J	585.0
		349	HE X	184.6
		28	HE Y	30.5
		2	HE Z	.3
		4	SP C	11.6
		1	SP D	5.4

Figure IX-8. Run Summary by Timber Mark.

b) Incoming Boom Summary by Timber Mark - This report gives the same information as (a) but by boom rather than run.

c) Incoming Boom Summary by Ministry of Forests Grade and BCFP Sort - This report gives the number of bundles in the incoming boom and lists the pieces and volumes by species and BCFS grade. It also shows the sort and outgoing booms of the logs.

d) Incoming Boom Bundle Summary - This report details the incoming boom number , the run number, the bundle sequential number in the run, the bundle number in the boom and the timber mark and shows the pieces and volumes by species, Ministry of Forests grade, company sort and the outgoing boom that the logs went into (Figure IX-9).

SHOAL ISLAND DLS   INCOMING BOOM: KI-0005 KNIGHT INLET

-------INCOMING-------				SPECIE	CUBIC	--OUTGOING--	
RUN-SEQ	BUNDLE	MARK	PIECES	GRADE	METRES	SORT	BOOM
047-0205	0001	17/7	7	BAI	13.3	I	SH-0351
			22	BAJ	17.2	.	SH-0335
			1	BAJ	.7	X	SH-0345
			4	BAX	1.2	.	SH-0335
			2	BAX	1.3	X	SH-0345
			2	BAY	.7	X	SH-0345
			1	CEH	2.6	A	SH-0344
			2	CEJ	1.9	M	SH-0342
			1	FIB	5.1	+	SH-0352
			1	FIH	2.3	+	SH-0352
			1	HEH	3.1	I	SH-0351
			1	HEI	.9	//	SH-0347
			6	HEI	14.3	I	SH-0351
			30	HEJ	19.0	.	SH-0335
			1	HEJ	1.7	I	SH-0351
			2	HEJ	.4	X	SH-0345
			2	HEX	3.2	//	SH-0347
			1	SPJ	.7	SP	SH-0340
			87 *		89.6 *		
047-0206	0002	17/7	1	BAX	.2	.	SH-0335
			2	CEI	4.9	A	SH-0344
			2	CEI	10.4	L	SH-0336
			9	CEJ	5.7	M	SH-0342
			2	CEK	3.8	S	SH-0343
			1	CEM	.5	V	SH-0293
			1	CEX	.2	M	SH-0342
			1	FIJ	.9	O	SH-0314
			2	FIX	1.3	LR	SH-0312
			28	HEJ	13.0	.	SH-0335
			4	HEJ	1.8	X	SH-0345
			2	HEX	.4	.	SH-0335
			1	HEX	.8	//	SH-0347
			4	HEX	1.2	X	SH-0345
			2	SPJ	1.3	.	SH-0335
			1	SPJ	.6	SP	SH-0340
			1	SPJ	.5	X	SH-0345
			64 *		47.5 *		

Figure IX-9. Incoming Boom Bundle Summary.

e) Outgoing Shoal Boom Summary - This report details the volume and pieces by species and grade in a completed outgoing boom. It also shows the source of the logs in the boom (Figure IX-10).

DATE: 82/09/15   B.C. FOREST SERVICE SCALE
-SUMMARY BY SPECIE GRADE-

SHOAL ISLAND DLS

SHOAL BOOM: SH-0313   FIR PEELER

	PIECES	SPECIE GRADE	CUBIC METRES
	12	FI A	84.7
	43	FI B	222.2
	215	FI C	570.5
	7	FI D	58.1
	375	FI H	955.4
	26	FI I	80.4
	29	FI J	35.0
	11	FI X	17.4
	2	FI Y	3.1
BOOM TOTAL	720 **		2026.8 **

PRODUCED FROM 7 SOURCES
SEK-042
SPS-040
TPL-041
OR-044
NI-046
OR-039
KI-047

Figure IX-10. Outgoing Boom Summary.

f) Summary of Scale - This report (Figure IX-11) summarizes the production by company sort from a run in an outgoing Shoal Island boom in the same format as a Ministry of Forests Stumpage and Royalty (S & R) Report. The format of this report was designed by the Ministry of Forests to follow the same format as their S & R's and is used in calculation of the S & R account.

54880

B.C. FOREST SERVICE — B.C. FOREST PRODUCTS LTD

S U M M A R Y OF S C A L E

SEQ#	SCALER#	RAFT#	PROD.MARK	# OF CHAINS	CAMP BOOM NUMBER	SECTIONS
0000					SH0335-82 KI047-01	
(1)----	(5)----	(9)---	(12)-------	(19)--------------	(33)------------------	(51)---

YYMMDD	PAY BY	COPY TO	EXPENSES	TIME CHG
820915	01074	03798		
(54)------	(60)-----	(65)-----	(70)-----	(75)-----

SEQ#	FNF	LOGS	STN#	PLACE OF SCALING
0011	INI	4648	16G	SHOAL ISLAND DLS
(1)----	(12)---	(15)----	(19)---	(22)--------------------------

SEQ#	MARK	PAINT	NMV	PIECES	SPGR	OTHER	QUANTITY	RATE
(1)----	(12)-------	(19)--	(21)-	(22)-----	(27)---	(30)---	(33)-------.-	(40)-----
0024	NMV			1	BAX		0.1	
0034				17	HEJ		9.2	
0044				2	HEX		0.7	
0054	17/10			35	BAJ		23.5	
0064				14	BAX		6.7	
0074				2	CEJ		0.9	
0084				1	FII		0.8	
0094				7	FIJ		3.9	
0104				2	FIX		0.6	
0114				8	HEI		10.6	
0124				701	HEJ		473.5	
0134				136	HEX		64.0	
0144				9	SPJ		5.0	
0154	17/55			3	HEJ		3.6	
0164				1	HEX		1.3	
0174	17/7			1	BAC		2.3	
0184				14	BAI		12.4	
0194				585	BAJ		437.2	
0204				108	BAX		55.9	
0214				1	BAY		0.3	
0224				2	CEJ		1.1	
0234				14	FIJ		7.4	
0244				7	FIX		2.3	
0254				29	HEI		40.3	
0264				2528	HEJ		1648.0	
0274				368	HEX		180.1	
0284				6	HEY		3.1	
0294				2	SPH		2.4	
0304				1	SPI		0.6	
0314				39	SPJ		19.9	
0324				4	SPX		3.9	
TOTAL				4648 *			3021.6 *	

Figure IX-11. Summary of Scale.

g) Bag Control Summary - This report gives the run number, the incoming boom numbers in the run, the outgoing boom numbers in the run and the pieces and volume in each boom or bag (Figure IX-12). The total pieces and volume for the run are shown and can be verified against the Run Summary as a control that incoming pieces and volume match outgoing pieces and volume.

SHOAL ISLAND DLS — INCOMING BOOM -BAG CONTROL SUMMARY-

-----OUTGOING BAG----					
SH-BOOM	RUN	SORT	PIECES	CUBIC METRES	
SH-0335	KI-047-01	.	4648	3021.6	HEMBAL SMALLWOOD
SH-0313	KI-047-02	+	274	891.5	FIR PEELER
SH-0352	KI-047-03	+	72	235.6	FIR PEELER
SH-0341	KI-047-04	//	443	301.5	HEMBAL PULP LARGE
SH-0347	KI-047-05	//	543	1025.0	HEMBAL PULP LARGE
SH-0344	KI-047-06	A	245	539.0	CEDAR MERCH
SI-0123	KI-047-07	BS	2	6.8	BOOMSTICKS
SI-0122	KI-047-08	BT	3	3.5	BURNT
SH-0324	KI-047-09	F	246	734.7	FIR SAWLOG
SH-0350	KI-047-10	F	163	490.9	FIR SAWLOG
SH-0231	KI-047-11	H	1	3.9	HEMBAL PEELER
SH-0337	KI-047-12	I	90	154.0	HEMBAL SAWLOG
SH-0346	KI-047-13	I	934	2164.5	HEMBAL SAWLOG
SH-0348	KI-047-14	I	823	2019.3	HEMBAL SAWLOG
SH-0351	KI-047-15	I	825	2006.3	HEMBAL SAWLOG
SH-0354	KI-047-16	I	163	363.0	HEMBAL SAWLOG
SH-0336	KI-047-17	L	51	236.9	CEDAR LUMBER
SH-0312	KI-047-18	LR	272	360.6	FIR PINE PULP
SH-0358	KI-047-19	LR	9	14.7	FIR PINE PULP
SH-0342	KI-047-20	M	1023	693.0	CEDAR SMALLWOOD
SH-0334	KI-047-21	U	1	1.0	CYPRESS SAWLOG
SH-0186	KI-047-22	P	3	8.4	PINE SAWLOG
SH-0343	KI-047-23	S	258	554.4	CEDAR SHINGLE
SH-0340	KI-047-24	SP	509	1721.8	SPRUCE SAWLOG
SH-0353	KI-047-25	SP	117	429.0	SPRUCE SAWLOG
SH-0293	KI-047-26	V	153	72.1	CEDAR CYPRESS PULP
SH-0331	KI-047-27	X	58	20.6	HEMBAL PULP SMALL
SH-0345	KI-047-28	X	1626	637.8	HEMBAL PULP SMALL
SH-0314	KI-047-29	O	226	143.5	FIR SMALLWOOD
RUN TOTAL			13781 **	19409.5 **	
			104	506.8	
			13,885	19,916.3	

FROM BOOM 5 BDLE 1
TO BOOM 10 BDLE 45

Figure IX-12. Bag Control Summary.

When a run is completed, the Ministry of Forests Regional Office receives the original Tally Sheets and reports (c), (f) and (d). The company receives reports (a), (b), (e), (f) and (g).

When the company needs information on monthly production for its own management accounting system, it indicates to Wescom between what calendar dates it wants the information and Wescom produces the reports.

The log accounting and computer costs of the system are estimated at $0.105 per log. The scaler's and the yard foreman's supervision costs (75 percent of his time) are estimated at $0.43 per log.

4. Pacific Forest Products Ltd.: Sooke Sortyard

This sortyard processes 1 700 m^3 or 1 250 pieces per eight hour shift. Scaling is done by Bruce Woodrow Scaling. The system requires two or three scalers and additional personnel to put tags on the logs, pull them off and keypunch the log tag and scaling information (3 people). Woodrow also produces the log accounting information through Wescom Computer Services.

The system starts when a prenumbered tag is attached in sequence to every log in the scaling deck. The scalers scale the logs and record the information and the log number. When the logs have been sorted and bundled, the log tags are removed and a numbered tag put on the bundle.

The log tags from a bundle and the bundle number are accumulated together. The scaler's information and log tags by bundle numbers are keypunched in the yard office. Completed bundles are put in sorted log storage which is laid out so that a storage bay holds a boom of logs. During the afternoon shift, bundles are recovered from storage and transported to the booming ground. Only one sort is boomed at a time. When the boom has been completed, the boomsticks are scaled, the boom gear is counted and the bundle tags are recorded. This information is put into the computer. From the log tag and bundle tag information, the computer prints out a Boom Advice Report which lists the pieces and volume by species and grade in the boom and bundles, as well as the boom gear and boomsticks. A Production Summary by timber mark listing pieces, volume, species and grade is produced monthly. This report is used for the S & R account, for payment to contractors and for company accounting purposes.

The advantages of the log tag system are that the boom cutoff is very accurate (within 3 percent), unsorted logs are indicated in the Boom Advice, sawmills can estimate the volume left in booms that they have only partially cut and can sequence the bundles into the sawmill to optimize productivity. The main disadvantage is the cost because it requires extra people to control the log tags. Also, if bundles break, control is lost. The system creates greater buyer confidence in the log scale and grade in the boom.

The cost of the log accounting system is $0.22 per log. This includes the keypunch operator, equipment and computer time. The cost for the scalers and log tag personnel is estimated at $0.65 per piece. Log tags cost $0.02 per piece.

5. MacMillan Bloedel Ltd.: Shawnigan Sortyard

This sortyard processes 1 170 m^3 or 1 285 pieces per eight hour shift. The scaling and log accounting is done by Shadforth Log Scaling. In this system, the higher quality logs are stick scaled and the lower quality logs are weight scaled. Log production is determined by weighing all incoming trucks of unsorted logs.

In this system, the pulp logs and small logs are weighed on the trucks as they leave the yard for transport to the booming ground. The weighmaster records the number of bundles going to the booming ground and tells the foreman how many bundles need to be scaled to maintain the one in ten sampling intensity. The weight-volume conversion ratio and grade information is based on samples from the previous boom as well as the present boom.

Sawlogs and high grade logs are stick scaled in the scaling decks. The scalers maintain a scale sheet for each sort which is computed weekly. The logs are scaled in metric and graded in Ministry of Forests grades. Loads of logs transported to the booming ground are weighed and a record is kept on the number of bundles.

The booming ground works on five different booms at one time but never two of the same sort. Usually, two booms are made up from logs being recovered from log storage and three booms are made from logs coming directly from the sorting decks. The accounting for booms being made up from logs from storage is relatively straightforward as each bay, when full, is equivalent to a boom. When the boom is complete, the information from the weighmaster on weights and bundle counts is sent to Shadforth Scaling for computation. The completed boom is inspected, boom gear and bundles counted, and boomsticks scaled. For booms made of a stick scaled sort coming directly from the sorting decks, the weighmaster records the number of bundles. When a boom is nearly complete, he will call for a cutoff. At this point, the graders change paint colours to indicate to the scalers to cut off their scale sheets on that sort and for the sorting machine operators not to load the sort onto the trucks. If there are not enough logs to complete the boom, then the grader will mark additional logs with the old colour and the scalers will add these to the old scale sheets. Once the last bundle has been sent to the booming ground, the system resumes its normal operation and a new boom is started.

For every completed boom, Shadforth prepares a Boom Advice Report which lists the volume and pieces by species and grade. A weekly Summmary Report is produced which lists the same information on completed booms and also lists logs scaled but not in completed booms. This information is used to determine opening and closing inventories and for cut control.

The cost of scaling and log accounting is estimated at $0.61 per piece. This includes the weighmaster and a charge for the truck weight scale.

6. Canadian Forest Products Ltd.: Beaver Cove Sortyard

This sortyard processes 3 160 m^3 or 2 000 pieces per eight hour shift. The Ministry of Forests weight scales all incoming loads for the payment of stumpage. The company stick scales logs destined for market. Pulp grades and logs used by company mills are weight scaled. All log accounting is performed at the yard office using a Hewlett Packard 83A computer.

After grading and sorting into bunks, the logs to be weight scaled are then taken to another set of bunks for bundling. A number and four tags are put on each bundle which is then weighed and dumped into the water for booming. If a sample scale is required, the stacker is weighed empty and again with the sample bundle. The bundle is then spread for stick scaling. After scaling, the logs are bundled, reweighed and dumped. The bundle weight slips and the sample scale information are sent to the office for processing. As new sample scale information is added to the computer memory, an equal amount is removed so that the weight-volume conversion and grade information is based on a bundle-by-bundle, moving average.

After grading and sorting into bunks, the logs destined for sale are moved to a scaling area where they are stick scaled to fbm grading and scaling rules. After scaling, the logs are bundled, a number is marked on the bundle and tags are stapled to it.

As the boomboat operators stow bundles into the boom, they radio the bundle number and pocket number to the company weighmaster. When a boom is filled, the boomboat operator reports the number of bundles in the boom. The boom is then inspected, boom gear and bundles are counted, and the boomsticks are scaled by company scalers. This information is entered on the Boom Report and the report is sent to the yard office for compilation.

Figure IX-13 is a sample of the Boom Report maintained by the weighmaster. Figure IX-14 is a sample of a Weight Scale Load Slip. This is filled out by the weighmaster as each bundle is weighed. Figure IX-15 is a sample of the Scale Sheets used by the company scalers for recording information on sample scale bundles and stick scaled sorts.
Figure IX-16 is a sample of the Boom Map made up when the boom is inspected. As can be seen, any loose logs in the boom are rescaled and it is noted whether or not the bundle-wire wedge connectors are up or down. The location of the bundles in the boom is also identified. The Boom Map is checked by the yard superintendent, who re-inspects the boom.

The Weight Scale Load Slips and Log Scale Sheets are sent to the office each day and are filed by sort. Sample weight scales are entered into the computer daily. As a sample is entered, the oldest sample is deleted to upgrade the information (Figure IX-17). When a Boom Map is received in the office, a Boom Advice is prepared (Figure IX-18). For bundles that have been stick scaled or loose logs in the boom, the computer calculates the volume and prints out the volume (cubic metre or fbm) and pieces by grade and species. For bundles that have been weighed, the bundle numbers and weights are entered into the computer which prints out the pieces and volume (m^3) by species and grade. The Boom Maps and Boom Advice are sent to Head Office Log Trading department for pricing.

The Ministry of Forests supervised weight scale, located at the entrance to the yard, is used to weigh all incoming loads. Ten strata are used to separate company and contractor logs and different timber ownership. Two MOF weighmasters and two scalers are used.

The cost of scaling (Ministry of Forests and company) at this sortyard is estimated at $0.54 per piece. The cost of log accounting is estimated at $0.06 per piece.

8

CANFOR

Weight Scale Boom Report

SORT ____________ POCKET No. ____________

DATE ____________ BOOM No. ____________

TIME ____________ WEIGHMASTER ____________

1			
2			
3			
4			
5			
6			
7			
8			
32			
33			
34			
35			
36			
37			
38			
39			
40			

BUNDLE COUNT BY BOOM CREW ____________

Figure IX-13. Boom Report.

CANFOR **Weight Scale Load Slip**

W

DAILY LOAD No. ____________

BUNDLE No. ____________

SORT SYMBOL ____________ ____________ GROSS

SORT NUMBER ____________ ____________ TARE

STACKER No. ____________ ____________ NET

Mark "X" if this load is a sample load. ____________ DATE ____________

REMARKS ____________ TIME ____________

____________ ____________

(Scalers Signature)

Form 4264

Figure IX-14. Weight Scale Load Slip.

Log Scale Sheet

Canadian Forest Products Ltd. CANFOR

Englewood Logging Division

L

BUNDLE No.	SCALER	DATE

	SCALE					SPEC	SORT	GRADE
	CUBIC			F.B.M.				
	Length	D_1	D_2	Length	TOP			
1								
2								
3								
4								
5								
6								
7								
8								

Figure IX-15. Log Scale Sheet.

BEAVERCOVE
BUNDLE SUMMARY REPORT
METRIC SAMPLE
SORT = HEMLOCK PEEWEE

OF SAMPLES TODATE = 17

DATE OF SAMPLING = 04/05/82

# of PIECES	SPEC	GRD	M3	% VOL
22	HEML	I	23.05	2.9392
652	''	J	585.07	74.6034
13	''	X	6.93	.8837
2	''	Y	.87	.1109
5	BALS	I	4.79	.6108
183	''	J	156.59	19.9671
2	''	X	.70	.0893
1	''	Y	.34	.0434
2	FIR	J	1.41	.1798
2	''	X	1.10	.1403
1	SPRU	J	1.14	.1454
4	PINE	J	2.25	.2869
889	TOTALS		784.24	100.0002

CONVERSION FACTOR = .001077

TOTAL WEIGHT = 728260

Figure IX-17. Sample Composition.

WEIGHT-CALCULATIONS REPORT
METRIC BOOM

BOOM #: ENG 2-054
SORT = HEMLOCK STANDARD
DATE: 03/15/82

No.	BUNDLE DATA	WGT
36	OF BUNDLES WEIGHED	1755224
0	OF BUNDLES AVERAGED 48585	0
36	TOTAL BUNDLES & WGT	1755224

OF SAMPLES: 17

DATE OF SAMPLING: 03/15/82

# of PIEC	SPEC	GRD	M3	% VOL	M3
7	HEML	D	43.00	4.62	91.4
88	''	H	331.89	35.67	705.6
141	''	I	313.56	33.70	666.6
45	''	J	65.03	6.99	138.2
2	''	X	3.09	.33	6.6
1	''	Y	1.33	.14	2.8
1	BALS	C	5.89	.63	12.5
23	''	H	84.99	9.13	180.7
29	''	I	61.57	6.62	130.9
12	''	J	16.98	1.82	36.1
1	PINE	I	3.17	.34	6.7
350	TOTALS		930.50	99.99	1978.1

WGT of
SAMPLED BUNDLES = 825940
CONVERSION FACTOR = .001127

LOOSE LOGS

SPECIE	GR	PIECES	
HEMLOCK	D	1	6.8
HEMLOCK	H	2	7.7
HEMLOCK	I	3	6.7
Vol of LOOSE LOGS		6	21.2
NET VOLUME OF BOOM			1999.3

STATISTICS

Avg. WGT per SAMPLE	48585
Avg. WGT per BOOM	48756
Difference	171
% Difference	.35
Avg. # of PIECES - SAMPLE	20.59
PIECE average - SAMPLE	2.66
CONV. FACT. LAST BOOM	.001123
CONV. FACT. THIS BOOM	.001127
Difference	.000004
% Difference	.36

Figure IX-18. Boom Advice.

Boom Report

Canadian Forest Products Ltd.

Englewood Logging Division

3 ~ BUNDLES

CANFOR

BOOM No.	SORT	LOC.	SCALER
ENG - 2-054	HEM-BAL SAWLOG	EAST BAY	S. WOODSIDE

DATE	SEC.	CH.	B/W	DOWN	S/W
MARCH 15, 1982	6	14+2	71	1	6

BUNDLE DATA and COMMENTS

No. 25-857	No. 25-787	No. 25-810	No. 25-833
B/W 2 DN. ∅	B/W 2 DN. ∅	B/W 2 DN. ∅	B/W 2 DN. ∅
X	✓	✓	X
No. 25-872	No. 25-870	No. 25-848	No. 25-861
B/W 2 DN. 1	B/W 2 DN. ∅	B/W 2 DN. ∅	B/W 2 DN. ∅
✓	✓	X	✓
No. 25-875	No. 25-867	No. 25-826	No. 25-883
B/W 2 DN. ∅	B/W 2 DN. ∅	B/W 2 DN. ∅	B/W 2 DN. ∅
✓	✓	✓	✓
No. 25-884	No. 25-880	No. 25-869	No. 25-828
B/W 2 DN. ∅	B/W 2 DN. ∅	B/W 2 DN. ∅	B/W 2 DN. ∅
✓	✓	✓	✓
No. 25915	No. 25 817	No. 25-897	No. 25-878
B/W 2 DN. ∅	B/W 2 DN. ∅	B/W 1 DN. ∅	B/W 2 DN. ∅
✓	✓	✓	✓
No. 25-916	No. 25-939	No. 25-935	No. 25-898
B/W 2 DN. 0	B/W 2 DN. ∅	B/W 2 DN. ∅	B/W 2 DN. ∅
✓	✓	✓	✓
No. 25-936	No. 25-909	No. 25-894	No. 25-910
B/W 2 DN. ∅	B/W 2 DN. ∅	B/W 2 DN. ∅	B/W 2 DN. ∅
✓	✓	✓	✓
No. 25-908	No. 25-946	No. 25-956	No. 25-911
B/W 2 DN. ∅	B/W 2 DN. ∅	B/W 2 DN. ∅	B/W 2 DN. ∅
✓	✓	X	✓
No. 25-984	No. 25-985	No. 25-945	No. 25-943
B/W 2 DN. ∅	B/W 2 DN. ∅	B/W 2 DN. ∅	B/W 2 DN. ∅
✓	✓	✓	✓
No.	No.	No.	No.
B/W DN.	B/W DN.	B/W DN.	B/W DN.
No.	No.	No.	No.
B/W DN.	B/W DN.	B/W DN.	B/W DN.

BOOM STICK SCALE

	METRIC			F.B.M.		SPECIES	SORT	GRADE
	Length	D1	D2	Length	Top			
1	204	16	22			He	•	J
2	204	19	25			↓	—	/
3	206	20	30				—	/
4	202	16	25				•	J
5	204	15	24				•	J
6	204	22	28				—	/
7	204	25	30				—	/
8	204	23	28				—	/
9	204	17	28				•	J
10	202	24	31				—	/
11	206	20	28				—	/
12	204	20	26				—	/
13	204	26	35			↑	—	H
14	204	19	28			He	—	/
15								
16								

LOOSE LOG SCALE

	Length	D1	D2	Length	Top	SPECIES	SORT	GRADE
1	120	27	35			He	—	H
2	132	20	30			|	—	/
3	120	19	24			|	—	/
4	122	19	28			|		/
5	142	28	32			He	—	H
6	106	40	50			He	—	D
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								

Figure IX-16. Boom Map.

7. Crown Zellerbach Canada Ltd.: Nanaimo Lakes Sortyard

This yard processes 1 300 pieces or 1 400 m^3 per eight hour shift. The scaling system, although similar to others, is described because it is part of a complete log inventory control system.

Incoming log loads are weighed on a truck scale. The origin of the load, number of logs, weight and trailer number are recorded on a Weight Slip. On a random basis, the loads will be sample stick scaled to maintain weight-volume conversion ratios and grade information.

The weighed logs are unloaded and spread. Two to three company scalers grade, scale and mark the logs. The dimensions, deductions, grade and species information of each log are entered into hand-held electronic recorders. The grade recorded is similar to Ministry of Forests grades but is modified to reflect the type of logs that Crown Zellerbach's mills can process. Higher grade logs and logs to be sold are 100 percent scaled, gang mill and peewee grades of logs are 25 percent scaled and pulp grades are 20 percent scaled. After sorting and bundling, a scaler counts the pieces and attaches four tags to the bundle. The bundle number and number of pieces are entered into the hand-held recorder and this information is transmitted daily to a central computer.

The bundles are put in storage or loaded on railcars for transport to the booming ground where they are made into bundle booms or loaded onto barges. As a barge is being loaded or a boom made, the bundle numbers are entered into hand-held recorders. At the end of each shift, the information from the recorders is transmitted to the computer. All this information is used in the inventory control system.

When a barge load or bundle boom reaches a mill, the bundle numbers are again recorded, transmitted to the central computer and the log supply inventory adjusted.

The camps that only weigh and bundle unsorted logs also send in the weight and bundle numbers daily. With this system, the daily production of each camp is known and the company knows the volume of logs entering and leaving their inventory. Figure IX-19 is a sample of a Production Report. As can be seen, the basic unit is the bundle. The report also lists the species, grade, pieces and volume in the bundles. Once the bundles have been put on a barge or assembled into a boom, the basic unit becomes a transportation unit and a Scale Bill can be produced. Figure IX-20 is a sample of a Scale Bill for a bundle boom that was assembled from a barge dump at the Fraser Mills log receiving station and transferred to storage for the Richmond Mill. It lists the species, grade, sort, pieces and metric and cubic volume of the logs in the bundles as well (Figure IX-21) as the pieces and metric volume in each bundle and a distribution by log length and top diameter.

A weekly Production Report is produced which lists production by day, by camp and the number of bundles, sorts, grades, pieces and volume. This is used by mill and logging management to schedule log movements.

A daily Inventory Record, by location, is produced (Figure IX-22). Crown Zellerbach controls and minimizes its log inventory with this system.

Some of the other reports produced by the system are:

Audit Report - lists the logs as they were scaled and entered into the hand-held recorders by the scalers.

Error Record - lists the logs or bundles that have errors in information. For example, a bundle is loaded on a barge and the computer says the bundle is not at that location. These errors often result from keying errors on the recorder. Transmission errors and scaling errors are minimal.

Monthly Analysis Reports - lists log defect by camp, diameter distribution by camp and grade by camp. Inventory amounts by sort, by storage location and by transportation method. The Crown Zellerbach scaling system is part of a total package. The log transportation system, the log handling system, the accounting system, the scaling systems and the inventory system were designed to rapidly move and show the location of all company logs on the coast of B.C.

Scaling and accounting accuracy is maintained or improved by continual check scales at all locations in the log transportation system. Probable errors or inaccuracies can be pinpointed by checking the various computer printouts, ratios and check scales.

The cost of scaling (company and MOF), log accounting and the inventory control system for all of the coast is estimated at $0.53 per piece or $0.63 per cubic metre.

450044 10/23/82 CROWN ZELLERBACH CANADA LTD PAGE 4
PRODUCTION REPORT BY SUPPLIER
EUS:- BUNDLE PERIOD OCT 14, 1982 TO OCT 22, 1982 AGGIE
SUPPLIER 060 JOHNSTONE STRAITS

DATE	PIECES	VOLUME	RESCALE VOLUME	WEIGHT	BUNDLES
10/14/82	1,439	1,328.6		11,254,400.0	38
10/15/82	1,461	1,510.4		12,840,800.0	47
10/16/82	770	1,058.7		8,292,400.0	26
10/17/82	448	704.9		5,499,800.0	18
10/18/82	1,013	1,225.8		9,213,600.0	33
10/19/82	858	950.2	12.7-	7,460,000.0	25
10/20/82	738	964.1	3.5	7,201,600.0	25
10/21/82	550	655.1		4,397,000.0	22
10/22/82	549	631.9		4,626,000.0	19
TOTAL	7,826	9,029.7	9.2-	71,285,600.0	253
115	81	146.9		1,266,800.0	4
131	44	108.0		923,800.0	4
155	106	57.8		521,800.0	3
FIR F	231	312.7		2,712,400.0	11
233	1,042	2,686.4	9.2-	15,451,400.0	58
240	191	459.8		2,963,400.0	13
255	214	68.1		511,600.0	4
CEDAR C	1,447	3,214.3	9.2-	18,926,400.0	75
316	1,108	1,389.2		13,074,800.0	39
332	334	854.4		8,016,800.0	25
350	1,712	1,181.0		10,885,200.0	34
355	977	608.6		5,491,600.0	17
370	1,368	589.2		5,645,600.0	24
390	23	71.4		554,800.0	8
HEM. H	5,522	4,693.8		43,668,800.0	147
418	66	83.5		645,800.0	2
BAL. B	66	83.5		645,800.0	2
615	132	159.4		1,171,200.0	4
633	84	275.7		2,107,600.0	7
SPRUCE S	216	435.1		3,278,800.0	11
733	344	290.3		2,053,400.0	7
CYP. Y	344	290.3		2,053,400.0	7
TOTAL	7,826	9,029.7	9.2-	71,285,600.0	253

Figure IX-19. Production Report.

450027 11/16/82 CROWN ZELLERBACH CANADA LTD 11/15/82 PAGE 14

SCALE BILL

SUPPLIER 068 C.W.S. FRASER MILLS UNIT NO. 068-2-800251

LOCATION 075 RICHMOND LBR. STGE. SORT 233 MERCH CEDAR

SPECIE	GRD	SRT		PIECES	METRIC	CUBIC
CEDAR	C	SL-D	223	1	4.3	152
CEDAR	C	SL-F	223	10	80.0	2,825
CEDAR	C	SL-H	233	129	458.3	16,183
CEDAR	C	SL-I	233	228	680.0	24,011
CEDAR	C	SL-J	233	223	241.8	8,538
CEDAR	C	SL-X	233	55	67.6	2,387
CEDAR	C	PW-J	255	57	38.2	1,349
CEDAR	C	SH-M	240	4	15.8	558
CEDAR	C	PW-X	255	1	.2	7
CEDAR	C	PU-X	271	2	3.4	120
CEDAR	C	DG-U	272		129.8	4,583
LOG TOTAL				710	1,719.4	60,711
FIR	F	SL-H	190	1	3.8	134
HEM.	H	SL-H	390	6	22.9	809
BAL.	B	SL-H	490	1	3.8	134
SPRUCE	S	SL-H	690	6	22.9	809
B/S TOTAL				14	53.4	1,885
** TOTAL **				724	1,772.8	62,597

SUP	EUS	BUNDLE NO.	PIECES	METRIC
080	233	0802078233	36	51.2
080	233	0802078308	27	44.7
080	233	0802078425	23	31.9
080	233	0802078541	9	40.4
080	233	0802078714	8	7.9
080	233	0802078715	15	29.6
080	233	0802078716	10	39.3
080	233	0802078717*	11	26.0
080	233	0802078718	17	25.5
080	233	0802078719	12	23.4
080	233	0802078720	13	32.7
080	233	0802078721	12	33.2
080	233	0802078722	14	35.2
080	233	0802078723	15	27.1
080	233	0802078739	14	29.4
080	233	0802078758*	14	34.0
080	233	0802078765	9	36.0
080	233	0802078779	17	33.8
080	233	0802078781	16	25.7
080	233	0802078782	11	31.8
080	233	0802078786	10	16.1
080	233	0802078787	8	21.9
080	233	0802078983	10	28.2
080	233	0802078984	8	21.6
080	233	0802078985	15	17.2
080	233	0802078986	9	11.6

RAFT DATA

SECTION	6.0
UNIT TYPE RAFT	
LOGS	709
BUNDLES	57
TIMBER-MARK	
SCALE TYPE	AM / MM
DEDUCT OPTION	0

SCALING DATA

SCALER	12
B. RODGERS	
SCALING FEE	709.15
EXPENSES	
TOTAL	709.15

RAFT GEAR

BOOMCHAINS	15
COUPLINGS	2
SWIFT LINES	6
BUNDLE LINES	
TOTAL	23

DEGRADE DEFECT

SHAKE	.4	.1
SHATTER	26.6	2.5
SWEEP	1.7	.1
ROUGH TOP		
TWIST	.1	
CHECKS	22.4	3.5
ROT	6.7	1.4
TOTAL	57.9	7.6

F.W.DEDUCTED DEFECT

HOLLOW

CONK

ROT

BURN

TOTAL

POLES

PILES

DUAL GRADE

Figure IX-20. Scale Bill.

450027 11/16/82 CROWN ZELLERBACH CANADA LTD 11/15/82 PAGE 16

SCALE BILL

SUPPLIER 068 C.W.S. FRASER MILLS — UNIT NO. 068-2-800251

LOCATION 075 RICHMOND LBR. STGE. — SORT 233 MERCH CEDAR

LENGTH	PCT OF PIECES	PCT OF VOLUME	TOP DIAMETER	PCT OF PIECES	PCT OF VOLUME
2.8	0.1	0.0	18	0.1	0.0
3.2	0.3	0.0	20	2.1	0.5
3.6	0.3	0.1	22	1.0	0.2
4.0	0.4	0.1	24	4.9	1.5
4.2	0.6	0.1	26	4.8	1.7
4.4	0.7	0.2	28	5.8	2.1
4.6	0.7	0.3	30	6.2	3.0
4.8	1.3	0.4	32	4.5	2.1
5.0	0.1	0.1	34	5.0	2.7
5.2	1.4	0.6	36	8.6	4.5
5.4	0.4	0.3	38	4.9	3.8
5.6	2.7	1.6	40	5.5	4.0
6.0	2.0	0.8	42	6.5	5.8
6.2	1.3	0.5	44	3.4	3.0
6.4	4.0	2.5	46	3.4	3.5
6.6	0.3	0.2	48	4.9	4.9
6.8	0.8	0.5	50	2.8	3.2
7.0	0.7	0.4	52	3.2	4.1
7.2	4.0	1.5	54	1.8	2.3
7.6	2.0	1.4	56	4.1	5.2
8.0	2.9	2.4	58	1.5	2.2
8.2	3.4	2.4	60	1.4	2.4
8.4	0.8	0.4	62	1.5	2.7
8.6	0.1	0.1	64	1.3	2.2
8.8	0.7	0.3	66	1.9	3.2
9.0	0.7	0.6	68	1.0	2.4
9.2	0.7	0.6	70	0.6	1.0
9.4	0.5	0.3	72	1.5	3.6
9.6	3.4	3.3	76	0.7	1.6
10.0	8.1	7.0	78	0.3	0.7
10.2	5.3	6.0	80	0.6	2.1
10.4	2.4	2.0	82	0.7	2.4
10.6	1.0	1.1	84	0.4	1.3
10.8	4.5	4.7	88	0.1	0.6
11.0	2.4	2.3	90	0.3	1.0
11.2	6.2	7.0	92	0.3	0.9
11.4	0.8	0.6	94	0.3	1.5
11.6	2.8	3.2	96	0.4	1.5
11.8	0.1	0.1	98	0.3	1.3
12.0	4.2	5.3	100	0.3	1.0
12.2	3.8	4.3	102	0.1	0.7
12.4	4.9	8.3	108	0.1	0.7
12.6	8.1	13.0	110	0.1	1.0
12.8	2.0	4.3	114	0.1	0.8
13.0	1.8	3.2	116	0.1	0.7
13.2	0.7	0.6	120	0.1	0.3
13.4	0.3	0.3	130	0.3	1.0
13.6	3.0	4.1	150	0.1	0.9
14.8	0.1	0.1			
			TOTAL	99.9	100.3

Figure IX-21. Diameter and Length Distribution.

SECTION INVENTORY TYPE	BUNDLES	SECTIONS
290	0	6.2
390	0	140.0
490	0	33.7
690	0	60.2
TOTAL	0	240.1

080	GOLIATH BAY						
115	SMALL PLR FIR	SCAL LOOSE	40	32.9	605	1,315.4	2.
131	STANDARD FIR	SCAL LOOSE	225	29.6	2,122	6,654.3	3.
150	GANGMILL FIR	SCAL LOOSE	66	26.4	1,762	1,740.4	1.
174	FIR PULP	SCAL LOOSE	107	18.9	1,778	2,025.1	1.
233	MERCH CEDAR	SCAL LOOSE	104	37.5	1,739	3,902.9	2.
240	SHINGLE CEDAR	SCAL LOOSE	44	32.2	382	1,417.8	3.
274	CEDAR PULP	SCAL LOOSE	213	19.4	7,410	4,126.6	.
299	CULLS CEDAR	SCAL LOOSE	1	8.8	1	8.8	8.
316	PLR. HEMLOCK SMALL	SCAL LOOSE	77	26.2	1,251	2,016.9	1.
332	LUMBER HEMLOCK	SCAL LOOSE	404	33.9	4,130	13,691.8	3.
350	GANGMILL HEMLOCK	SCAL LOOSE	374	35.7	11,781	13,367.4	1.
355	PEE WEE HEMLOCK	SCAL LOOSE	2	24.0	109	47.9	.
370	PULP HEMBAL	SCAL LOOSE	737	31.6	44,880	23,286.3	
371	CHIPPERWD HEMLOCK	SCAL LOOSE	1,438	24.6	16,412	35,389.0	2.
373	REJECT BOOMSTICKS	SCAL LOOSE	3	36.6	51	109.7	2.
379	REJECT BOOMSTICKS	SCAL LOOSE	56	28.9	869	1,618.5	1.
416	PLR. BALSAM SMALL	SCAL LOOSE	77	28.5	1,237	2,193.1	1.
432	LUMBER BALSAM	SCAL LOOSE	3	14.4	3	43.2	14.
471	CHPWOOD BALSAM	SCAL LOOSE	4	10.8	4	43.0	10.
613	PEELER SPRUCE	SCAL LOOSE	43	30.2	617	1,298.4	2.
621	HIGRADE SPRUCE	SCAL LOOSE	25	153.4	537	3,834.6	7.
633	MERCH SPRUCE	SCAL LOOSE	257	26.7	1,987	6,856.3	3.
671	CHPWOOD PULP SPRUC	SCAL LOOSE	185	8.1	185	1,506.5	8.
733	MERCH CYPRESS	SCAL LOOSE	22	22.5	264	495.4	1.
774	CYPRESS PULP	SCAL LOOSE	29	17.8	544	516.8	1.
874	COTTONWOOD PULP	SCAL LOOSE	7	19.7	76	137.6	1.
LOCATION TOTAL			4,543	28.1	100,736	127,643.7	1.
084	DUNCAN BAY-BARGES						
115	SMALL PLR FIR	SCAL LOOSE	42	30.8	670	1,293.7	1.
131	STANDARD FIR	SCAL LOOSE	29	29.2	289	847.8	2.
233	MERCH CEDAR	SCAL LOOSE	42	35.1	692	1,474.6	2.
240	SHINGLE CEDAR	SCAL LOOSE	13	31.1	166	404.5	2.
314	PLR. HEMLOCK LARGE	SCAL LOOSE	5	27.1	56	135.4	2.
332	LUMBER HEMLOCK	SCAL LOOSE	71	30.3	765	2,151.1	2.
370	PULP HEMBAL	SCAL LOOSE	4	35.3	148	141.1	1.
414	PLR. BALSAM LARGE	SCAL LOOSE	5	31.4	60	156.8	2.
LOCATION TOTAL			211	31.3	2,846	6,605.0	2.
086	B.COVE SORTING GRDS						
113	CAMP RUN PLR FIR	SCAL LOOSE	1	24.6	9	24.6	2.
170	GRDWOOD PULP FIR	SCAL LOOSE	2	8.7	2	17.3	8.
233	MERCH CEDAR	SCAL LOOSE	3	16.2	30	48.5	1.
255	PEEWEE CEDAR	SCAL LOOSE	[illegible]	7.9	43	15.7	
314	PLR. HEMLOCK LARGE	SCAL LOOSE	22	32.1	309	705.8	2.
332	LUMBER HEMLOCK	SCAL LOOSE	86	27.1	579	2,329.2	4.
350	GANGMILL HEMLOCK	SCAL LOOSE	64	35.3	2,360	2,260.6	.
370	PULP HEMBAL	SCAL LOOSE	1,041	28.7	24,376	29,877.0	1.
390	BOOMSTICKS HEMLOCK	SCAL LOOSE	9	59.6	108	536.6	5.

Figure IX-22. Inventory Record by Location.

E. ASSESSMENT OF SORTYARD PERFORMANCE

Once the sortyard has been operating for six months to a year, the start up problems will be resolved. Errors in sortyard design and construction will have been identified and modified. Generally, the operation will become routine. At this stage, sortyard operators shift their attention away from the day to day operation, assess the results and plan for the future. They examine possible improvements to the yard. They may begin by examining employee turnover and investigating changes in job content. They visit other sortyards to get ideas to increase their productivity. They examine their operation phase by phase, to see if it can be improved. In short, the focus of the yard shifts from reacting to forward planning.

Part of this shift to planning is the desire to meet the objective of achieving the forecasted savings. Obtaining most of the savings promised for the sortyard will need a concerted effort by management if they are going to be realized. The outward evidence of this type of work is the foreman working on projects. Some common projects started to improve yard efficiency are:

- Training course for scalers and graders to prepare them for the B.C. scaler's licence examination and to improve their performance.
- Studies to reduce equipment downtime.
- Examination of the log accounting system to reduce overruns and underruns in log boom volumes.
- Analysis of the reasons for and methods of reducing missorts.
- Examination of repair parts inventory to determine if it is in balance between the mechanical requirements and financial goals.
- Examination of different types and makes of tires to reduce the cost and extend the life.
- Modifications to sorting bunk design to reduce damage and repair costs.
- Changes to the lighting system to improve the visibility in the grading, scaling and sorting area.
- Examination of scalers work schedule to see if overtime can be reduced.
- Examination of the debris disposal problem. Consider permanent solutions and utilization of debris.
- Methods to reduce total truck unloading time.
- Feasibility study on the merits of increasing the paved area of the sortyard.
- Ambrosia beetle control systems to reduce the downgrading of logs.
- Examination of specific problems in the yard or system.

These new projects may not reflect a poor original design. The designers selected a system and built the yard based on the best information available. Conditions may have changed, or new sorting techniques and equipment been developed, that make the original plan, or parts of it, eligible for improvement. A sortyard where supervision is involved in planning, examining improvements or questioning the status quo is characteristic of a mature yard and a healthy operation.

PART X NEW DEVELOPMENTS

PART X NEW DEVELOPMENTS

Developments in other industries, sorting practices in other countries and trends in log supply all indicate continued changes in sorting systems, methods and machinery. This section gives examples of some of these new developments and modifications.

A. POTENTIAL AREAS FOR IMPROVEMENT IN EXISTING YARDS

In 1979 - 1980 FERIC visited 26 sorting operations to examine the system, areas, manpower, machinery and costs. The conclusions of this study are:

1. Large Yards Versus Medium and Small Yards

Higher volume operations are more efficient, economic and make more sorts than lower volume operations (Table X-1).

Table X-1. Comparison of Dryland Sortyards.

Volume Class (m^3/year)	0- 170 000	171 000- 453 000	454 000- 736 000	737 000- 1 416 000
Number of yards in class	6	6	3	3
Number of yards using weight scaling	3	1	1	0.7
Average number of sorts	6.8	13.0	12.3	18.0
Percentage of annual volume bundled (%)	94	83	99	99
Total cost/piece* ($)	5.12	5.64	7.89	4.97
Pieces/manday	79.02	65.72	41.04	71.17
Pieces/sorting machine operating hour	31.32	33.46	26.40	39.18

*1980 costs

Sortyard operators should examine the feasibility of grouping small to medium operations into one large operation.

2. Area Users Versus Area Savers

Certain log sorting functions are area users and others are area savers.

Area Users	**Area Savers**
Stick scaling	Weight scaling
Extra sort classes	Pre-sorted truckloads
Increased pieces/shift	Uniform load arrivals
Batch processing	Balanced continuous workload
Log storage	

As the sorting area increases, the travel distances and travel time increase. This may require more machinery which will lead to increased congestion and safety hazard, and reduced productivity. The area savers that a sortyard operator can influence are weight scaling and balancing manpower and workload needs. Operators must study ways to keep the area used to a minimum to offset the negative effects of a continuously decreasing piece size.

Sortyard operators have less influence on presorted truckloads and more uniform load arrival rates as means of reducing area requirements and increasing productivity. More uniform load arrival rates could be achieved by parking trucks where they are at the end of the shift. Sortyard operators have less control over diminishing piece averages and more sort classes but will have to study ways to offset the negative effects on productivity and area requirements of more sorts and pieces.

3. Bundle Rafts Versus Flat Rafts

Bundle booms require 72 percent less area than flat rafts to store the same volume of logs and also reduce sinking losses and towing costs. Although the size and cost of water storage areas are not usually significant at sortyard locations, they are significant at mill locations. Flat rafting, except for large, high floating logs, will become rare.

4. Water Storage Versus Land Storage

The development cost of log storage areas on land is twice that of water storage areas and logs stored on land are more difficult to protect from ambrosia beetle attack. Therefore, when possible, logs should be stored in the water rather than on land.

5. Weight Scaling Versus Stick Scaling

Weight scaling results in greater productivity, lower costs and less interference with the sorting process than stick scaling.

In every yard studied, the scalers set the pace of production when stick scaling. In addition, scalers usually work different hours than yard personnel, report to a different supervisor and belong to a different union. In the future, ways must be found to get the scaling process out of the mainstream of the log sorting system.

6. Sort Before Scaling

The only difference in material handling between conventional water sorting grounds and dryland sortyards is the point in the process where scaling and sorting are done. In water sorting grounds, the logs are scaled after sorting and the scaler's sheets will indicate missorted logs. In dryland sortyards, the logs are scaled before sorting and this control is not available. This places more emphasis on supervisors who must pay close attention to the log graders and machine operators. The log tag system of scaling control will indicate missorting but it is more expensive than the boom cutoff system. One smaller sortyard scales logs after sorting and this may be a way that yard operators will modify their yards as logs become even more valuable and accurate log sorting even more important.

7. Productivity With Small Logs

The number of pieces to be sorted is more important than volume sorted for sortyard design and operation.

In the future, if the pieces are smaller and more uniform in size, then smaller machines with limited capability can be used rather than general purpose machines. Hopefully, smaller, limited capability machines will lead to higher productivity and lower costs in the future.

8. Log Bucking

Log upgrading is not practical in water sorting grounds but can be introduced into land sortyards. This will be a significant advantage as higher quality logs increase in value.

B. OVERHEAD CRANES

For many years, overhead cranes have been used in other industries for transporting heavy loads. They are common in warehouses where efficient use of space is important. Recently, overhead portal and pedestal cranes have been introduced to the North American forest industry to unload trucks and store logs in millyards.

1. Advantages

- Land storage - the crane can store three times as many logs in an area as a stacker.
- Less energy is required. The crane can recover, store and water logs with about 200 kw of electric motors whereas two 45.4 tonne capacity stackers and a marine railway would require a total of 800 kw

of diesel motors to do the same work.

- Less site preparation work is required and asphalt specifications can be lower. Front-end loaders will be needed to spread and reclaim logs from the grading and scaling bays but their wheel loadings are much less than log stackers. The log storage area can be gravel surfaced.
- Less manpower is required. One crane operator can replace two stacker operators and a marine railway operator per shift.
- The crane manufacturers claim the repair costs on the portal crane are less than a log stacker but not enough experience has been gained to substantiate this.

2. Disadvantages

- The crane requires a higher initial investment. A 40.8 tonne capacity portal crane running on 335 metres of rail will cost \$3 000 000. Two 45.4 tonne stackers, a marine railway and a dump ramp should cost about \$1 940 000.
- The yard is dependent on one machine and one operator and the portal crane must have high mechanical availability.
- The crane rails fix the layout. It is difficult to modify the sortyard to compensate for changes in log supply.
- The crane is not efficient at spreading and reclaiming logs for grading and scaling.
- The crane grapple has difficulty recovering loose logs from the water.

3. L & K Lumber (North Shore) Ltd.

In 1979, L & K Lumber (North Shore) Ltd. purchased a 40.8/90.7 tonne capacity portal crane for its new sortyard at Langdale, B.C. (Figure X-1). An adjacent mill will receive all its logs from the sortyard. In the fall of 1980, the crane began operation, although the sawmill did not. At the time, it was the first portal crane in a Western Canadian log sortyard and was the largest capacity portal crane built by Heede International. FERIC assisted in the layout of the sortyard and calculation of cycle times after the crane was purchased. Basic cycle times were measured after the crane was installed and shift level productivity studies were conducted during the first year of operation. In addition, FERIC studied the feasibility of including a portal crane in another new coastal sortyard.

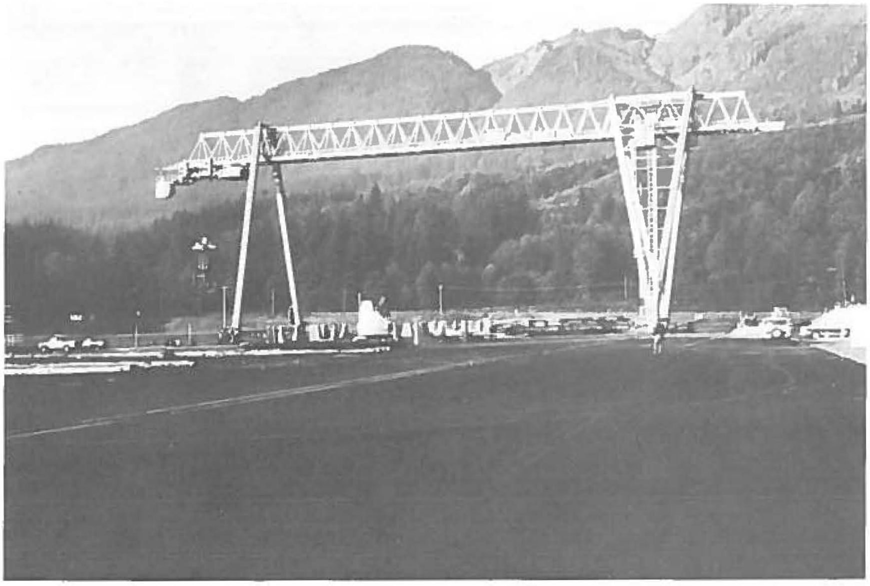


Figure X-1. Portal Crane (40.8/90.7 tonne capacity).

Because the majority of the logs sorted at the L & K sortyard will eventually go to a sawmill, the crane rails run perpendicular to the waterfront rather than parallel to it (Figure X-2). The logs will be sorted and approximately eighty percent of the volume will move into mill storage. The remaining twenty percent of the logs will be returned to the water for sale.

At present, the system operates eight hours a day using the Heede crane, a Clark 275 B front-end loader, a debris-cleanup front-end loader, two log loaders, a debris truck (part time) and a boomboat. The separate booming ground supplies incoming booms and assembles outgoing booms. The sortyard crew includes a boat operator, crane operator, three bundlers, one grader, one bucker/debris truck driver, four machine operators, four scalers and one foreman. The system is presently processing 800 to 1 200 pieces per shift (approximately 1 100 to 1 700 m^3).

In the future, the system is budgeted to process 900 000 to 1 300 000 m^3 per year (1.4 m piece average) in 245 double-shifted days. This converts to 1 430 to 1 630 pieces per shift.

Theoretically, logs can be decked 16.8 metres high in the storage area (Figure X-3). This is three to four times higher than the storage decks in conventional, coastal sortyards.

Figure X-3. Log Deck Heights.

The step-by-step flow in the sortyard is:

1 Incoming, camp run bundle booms are stripped of boom gear adjacent to the two incoming raceways.

2 Once the boom is in the raceway, a boomboat pushes the bundles next to the shore and aligns them for the portal crane.

3 The portal crane lifts the bundles out of the water and puts them into bunks (3) where the bands or wires are removed.

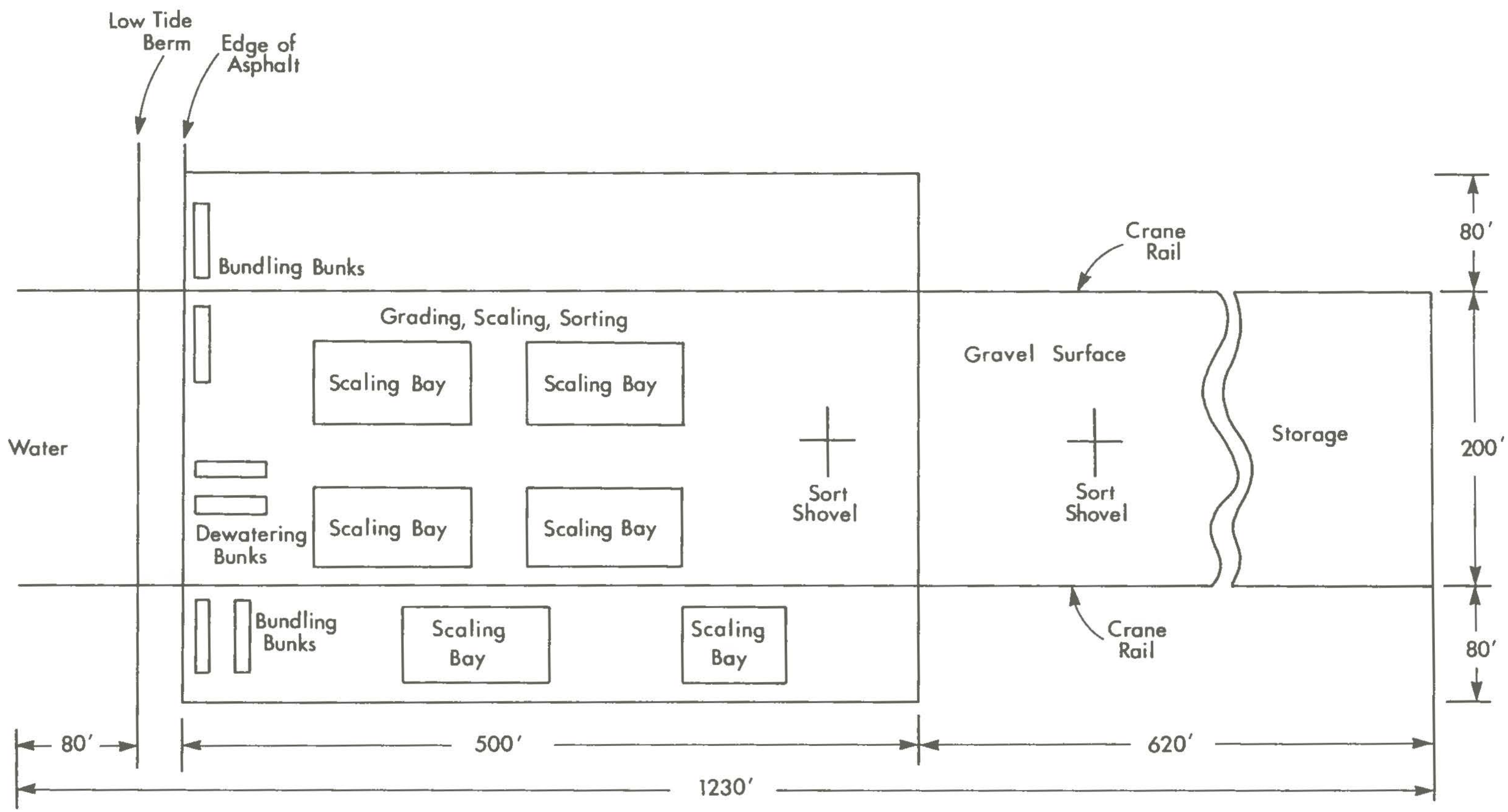


Figure X-2. Plan of L & K Sortyard.

4 The portal crane lifts the log bunch out of the bunk and places it in one of six grading and scaling bays. Each bay is approximately 30.5 metres long by 15.2 metres wide and has enough room for spreading two, 28 m^3 bundles.

5 The front-end loader spreads the bunches of logs for grading and scaling.

6 The logs are bucked, if necessary, graded and paint marked and then scaled by Ministry of Forests' scalers.

7 After a bay has been completely scaled, the front-end loader reclaims the logs and forwards them to a stationary log loader.

8 The log loader sorts the logs into ten sorting bunks and one pile (mixed species, chip-n-saw sort).

9 The crane reclaims the logs from the pile and forwards them to a second stationary loader for resorting into bunks by species.

10 When a sorting bunk is full, the crane reclaims the sorted bunch of logs and transports them to sorted log storage or to the bundling bunks at the waterfront.

11 After bundle wires and bundle tags are placed on the logs, the crane lifts the bundle and puts it into the water (Figure X-4).

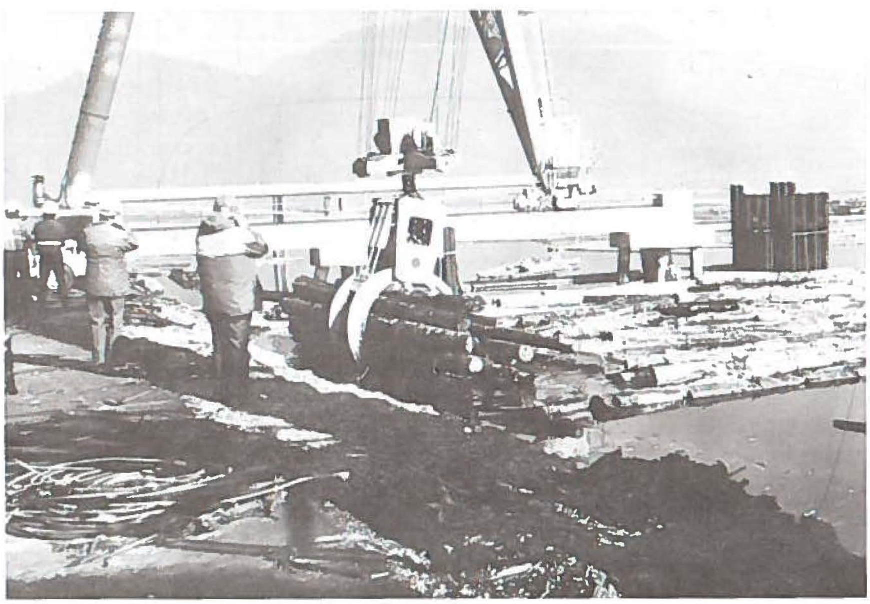


Figure X-4. Bundle Being Placed in the Water.

(12) A bundle is stowed into one of eight pockets located either on the south (2) or north (6) side of the yard.

The design specifications on the crane were:

Capacity - 40.8 tonne over entire span
- 90.7 tonne in span 15.2 metres in from north rail
Span of crane - 85.3 metres
Length of rails - 375 metres
Stacking height of crane - 16.8 metres
Gantry speed - 152.4 mpm
Gantry motors - 4 @ 18.7 kW
Trolley speed - 91.4 mpm
Trolley motors - 4 @ 9.3 kW
Hoist speed - 25.5 mpm (40.8 tonne mode)
- 12.8 mpm (90.7 tonne mode)
Hoist motors - 1 @ 74.6 kW
Grapple - 7.3 metre tip to tip wide open
- 9.66 square metre enclosure
- full open - 15 seconds
- full close - 21 seconds

The area utilization in the yard is:

Function	**Dimensions (m) and Area (ha)**	
	Gravel	**Asphalt**
Dewatering & Bundling		21.3 x 85.3 = .18 ha
Grading & Scaling		131.1 x 24.4 + 97.5 x 61.0 = .93 ha
Sorting Area	57.9 x 61.0 = .35 ha	33.5 x 61.0 = .20 ha
Storage Area	131 x 61.0 + 189 x 24.4 + 189 x 24.4 = 1.72 ha	131.0 x 24.4 = .32 ha
Total	2.07 ha	1.63 ha

Total Area = 3.70 ha

In 1981, FERIC received production information from the sortyard as part of a study on the portal crane. A summary of the information is:

Scheduled operating days - 81 days
Scheduled operating hours - 694 hours
Actual operating hours - 627.25 hours
Crane mechanically down - 31 hours
Crane mechanically available - 95.5%
Crane utilization - 90.4%
Pieces scaled - 83 095 pieces
Pieces per crane operating hour - 132.5 pieces/hour
Pieces per crane scheduled operating hour - 119.7 pieces/hour

During the period that the production information was collected, L & K was modifying the sorting system, adding equipment and striving to improve the mechanical availability. The sortyard operated on a single shift basis.

When FERIC was assisting in the design and layout of the sorting system, we were constrained to use the acceleration time curves of the electric motors to calculate basic cycle times because there were no other similar operating portal cranes. Also, basic cycle times were assembled to form duty cycle times based on how we thought they should be sequenced rather than on field observations. Once the crane was operational, a seven day field test was conducted to validate the theoretical cycle times and the method of assembly of these theoretical cycle times into basic duty cycle times.

The field test results both agreed and disagreed with the calculated results. The differences occurred for two reasons. The first reason was because the grapple opening and closing observed times were longer than calculated or suggested, and when this basic cycle was part of the duty cycle then the duty cycle was longer. The second reason was that the assumptions on whether a basic time element could be combined or had to be performed in sequence did not agree with the practice followed by the operator. Obviously, when we assumed that basic cycle times could be combined and they were not in practice, then a longer duty cycle resulted.

Another coastal forest products company has been examining the use of a portal crane for a proposed sortyard. In their application, the crane rails would be parallel to the waterfront and all the logs would return to the water after sorting. The system would use a 40.8 tonne capacity crane, a mobile log loader for sorting and two front-end loaders for spreading logs and forwarding bunches of sorted logs. Incoming logs would be from bundle booms or from log barges carrying log bundles. The company is interested in the crane because of the reduced land requirements resulting from higher log storage decks and the reduced energy requirements of the crane relative to log stackers and a marine railway.

C. MECHANIZED SORTING SYSTEMS

1. Sorting Tables and Linear Systems

Several sortyards in Oregon and Washington have linear sorting and bucking lines and low profile, grading and sorting tables that move the logs with conveyor chain. One B.C. sortyard operation has a low profile table. These systems have a high production potential if the logs are uniform. They require much less land than mobile equipment. However, they are permanent and not flexible to changes in log supply or sorting requirements. They cannot easily accommodate stick scaling.

The yards that use these systems in Oregon and Washington are receiving logs from predominantly uniform second growth stands. Some southern and mid Vancouver Island sortyards are already processing predominantly second growth logs and are having difficulty maintaining production volume (cubic metre) goals with their mobile equipment-based sorting systems. As more B.C. companies move into second growth stands, the attractiveness of mechanical systems will increase. Some of the Swedish mechanical systems are bucking and sorting up to 6 pieces per minute. Although the coastal sortyards do not need this productive capacity at present, they may very well within five years.

2. Delimbing and Bucking Machines

Several coastal sortyards are using delimbing and bucking machines in conjunction with mobile sorting equipment. They log tree length, limb and buck in the yard with the machine, and then sort and bundle the logs. These machines could probably be improved by adding a short sorting deck behind the cut-off saw. This deck could make a three-way sort by kicking the logs to right or left of the conveyor deck or allowing the logs to run off the end.

D. PRESORTING

Presorting in the logging division or at the entry to the yard improves sortyard productivity. With a predominant species or grade in the load, grading and scaling is easier and less sorts are needed and so the logs are processed quicker.

Although the logyard foreman cannot dictate that logs be presorted in the landings, he can change his own system to take advantage of presorting in the yard. In many yards, the hemlock, balsam and cedar species form over seventy percent of the log supply and often sixty to seventy percent of the logs are of low quality and value. One existing type of sorting system can be easily modified to take advantage of quality-value relationships. In this sorting system, the logs are push-unloaded onto ramps, graded at the ramps, sorted and then transported to scaling decks for stick scaling. After scaling, they are transported to the waterfront for bundling and dumping. If the lower value logs are sorted at the unloading ramps and taken directly to the waterfront, put in bunks for weighing and bundling and then dumped, the productivity of the yard would increase and cost of material handling would be more in proportion with the value of the logs. The higher valued logs would still be taken to the scaling bays for grading, remanufacture and stick scaling. This simple change of presorting and lower value logs would increase productivity and reduce costs.

Logyard foremen will have to examine if presorting in their yards can increase productivity. It may be the least expensive option they have in order to overcome the loss in productivity that will result with the smaller sized log of the future. Presorting the lower quality, lower value logs out before they enter the high quality sorting system and sending those logs through a simpler, less costly scaling system will increase productivity.

E. MOBILE SORTING MACHINES

The trend away from stationary log sorting machines to mobile log loaders to save a material handling step will continue. The recent innovation of pulling a log trailer behind a mobile log loader will be introduced in more yards. It can increase the capacity by up to 400 pieces per shift as well as resulting in an improved bundle. The potential is limited because in certain sorting systems the addition of a trailer will reduce rather than increase production. The trend to mobile log sorters will mean the front-end loaders will become primarily transporters rather than sorters. The addition of larger capacity front-end loaders as transporters may increase production. On the other hand, sorting systems that use front-end loaders for sorting may use smaller machines. The 988-size machines are too large and slow for sorting small logs and the 966-size machine is better. In the smaller yards where one front-end loader is used for all sortyard jobs, the 980-size machine will continue as a general purpose machine.

F. TRUCK UNLOADING

Stackers will continue to be used because of their flexibility in the yard, but they are not likely to get larger. To build and operate a stacker large enough to unload off-highway truckloads in a single pass would be very expensive. The largest stacker (63.5 tonne capacity) presently built cannot enclose or lift off-highway loads and its cost is over $1 000 000. Changes that will come are a possible shift to smaller size trucks when the total economics of transporting logs with large trucks (90.7 tonne capacity) versus heavy duty conventional trucks (50 tonne capacity) are examined. If smaller trucks are proven more economical, then many of the problems associated with unloading will be removed. Other changes will come through different unloading techniques. Two innovative unloading techniques have recently been developed to reduce unloading time of large log loads. One system still requires two passes but reduces unloading time by pulling the load through rather than lifting it over the trailer stakes. The trailer stakes must be modified to return to the upright position after the load has been pulled through. The other system pulls the load in a single pass onto an unloading ramp. This is achieved by making the grapple large enough to enclose the load. Further, a FERIC study indicates that more potential exists in areas other than unloading for reducing the truck in-yard time. Such simple things as using a stationary trailer reload rather than a log stacker may reduce the in-yard time by two minutes and also release the stacker for unloading the next truck.

G. SCALING

The scaling methods, hardware and institutions should undergo significant changes in the future. With the present stick scaling systems, the scalers are spending an estimated 80 percent of their time measuring and recording data and 20 percent of their time grading logs when the opposite should be true, particularly for high quality logs. The use of hand-held electronic recorders has helped reduce the time needed for recording and also has allowed a direct interface with computers. The next logical step to reduce recording time is the use of voice recorders for the log measurements and grades. The voice record will be fed directly into the computer. Another alternative is to use scanners, television or movie cameras to measure log volumes. Studies have shown this system to be more accurate than weigh scaling. The Department of Electrical Engineering at UBC is presently investigating this method. In the future, the scaler may concentrate only on species, grade, and defects while electronic components may measure the gross volume and calculate the net volume of the log.

In the scaling systems that use prenumbered tags, wanding systems are already in use. The wands read numbers electronically to reduce the problem of misreading. Wanding will see further implementation, as more companies use hand-held electronic recorders and transmit data directly to the computers rather than keypunching.

The net effect of rising costs and high interest rates make it expensive to carry inventories of logs. Intensive management of inventories will require daily, or at least weekly, inventory reports rather than the common monthly one. At present, several coastal companies use computers to process scale bills and production reports. It would be a simple extention to modify the programs to produce inventory reports. However, for better inventory reporting, all company producers and users will have to be included. All divisions of a multi-division logging company, the mills and log trading must be linked and coordinated. To completely implement a log inventory control system throughout a company will take at least three or four years. However, if the company can reduce its log inventory and improve its log handling and transportation system, then the effort will be worthwhile.

On the B.C. coast, we will see more of these integrated, computer-based inventory control systems in the future. A company-wide approach will be needed, the inventory information will be needed on an almost daily basis and the company should be prepared to make changes in its log handling and transportation systems. The need for these changes has existed for some time but the implementation of an inventory control system will highlight and emphasize the necessity. Fortunately, the computer-based log accounting systems already in place at some of the dryland sortyards will assist the implementation of the inventory control system.

H. DEBRIS MANAGEMENT

As energy prices increase because of world prices or taxes, the option of generating steam and electricity from hogged fuel rather than natural gas or oil will become more attractive. At present, although hogged fuel is worth $50 to $60 per green unit in terms of oil replacement value, it is only selling for $4 to $5 per green unit FOB supplier. Once the mills have used up their own residuals, they will look to the sortyard for supplies. This has already started in the Crofton area where a sortyard has been supplying sortyard debris for processing into hogged fuel at a pulp mill for over three years. Recently, other sortyards have begun to supply sortyard debris to the same pulp mill. One large sorting ground hogs its wood waste and barges it to a pulp mill. This trend will continue and increase.

Sortyard operators will be faced with utilizing their sortyard debris rather than disposing of it. The method they choose should be based on careful analysis because, debris (like logs) has physical characteristics, a cost, a value, supply locations, demand locations, user quality specifications and an existing transportation network. The best utilization system will fit all the above constraints. The decision to chip, shear or hog at the yard or at the mill cannot be decided until this analysis is made.

The first step in the analysis must be to determine the type and amount of sortyard debris that is generated. Second, establish the amount and type of debris required by the user. Third, establish the costs and methods of the various transportation options between the supply and the user. The final step is to analyze the costs of the various systems that can process the debris into a product that can be moved in the transportation system and is acceptable to the user. Once this has been done, then the system should be built. Some sortyards and sorting grounds have already gone through this exercise and established debris utilization systems while others have decided the economics are not attractive and have continued to dispose of their debris. However, forecasted energy price increases and fiber supply shortfalls will likely happen. Some fiber supply managers feel that the price of hogged fuel will eventually equal or exceed the price of pulp chips. If this happens, then not only will sortyard debris be utilized, but competition will exist for low quality logs.

I. BUNDLING SYSTEMS

Wire, steel banding, wire rope and other materials attached with a variety of clamps and hooks are used for bundling. These all require time to attach which disrupts the flow of the sortyard. No system is entirely satisfactory and sortyard operators will continue to search for materials which will improve their convenience, cost and bundle security.

Two B.C. yards are now using automatic bundling machines; one attaches steel banding and the other a continuous wire. These machines secure a bundle in two minutes as compared with six minutes using the fully manual system. In addition, the machine has a more uniform standard of application. We can expect further developments in bundling machines.

J. NIGHT LIGHTING

Because of the high costs of capital, companies will give consideration to operating sortyards on two shifts. Traditionally, sortyards have operated a single shift because logging operates one shift. In addition, the lighting used has been poor. However, two of the larger sortyards on the B.C. coast work a double shift and others may follow. There have been problems with inadequate lighting levels, shadows, glare and colour changes but if the system is properly designed and installed, then these problems are minimized. One double shifted sortyard compared the amount of missorts and inaccurate grading between day shift and night shift and found it to be lower on night shift. It would appear from this study that supervision, rather than adequate light was the limiting factor.

Night lighting systems are expensive to build and operate. Many fixtures on tall poles (18 metre or higher) are needed to minimize glare and shadow and maximize illumination (160 to 215 lx are needed in grading and scaling areas). Also, the poles should not obstruct equipment and this can lead to more fixtures and poles than needed to obtain the required lighting levels. Research and development work has been done on a high intensity, all weather "VORTEK" light which will be tested by FERIC in 1984 in a coastal sortyard. Although all the parameters that apply to the conventional halide and mercury vapour lighting systems apply to this light, it has the potential to significantly reduce the number of lights and energy consumption. It has been estimated that two VORTEK lights could adequately illuminate a 4 ha sortyard. If the field tests are successful, this light will reduce lighting costs and remove one more of the reasons for not double shifting sortyards.

K. MARINE SORTING SYSTEMS

In the first sections of the handbook, the possibilities of improving the productivity of existing sorting grounds or installing new, mechanized sorting grounds were proposed as viable alternatives to building dryland sortyards. Some people strongly believe that as long as the time logs are loose in the water is minimized, then water sorting grounds make more economic sense than dryland sorts. They argue that bundling, and not dryland sortyards, reduces sinker loss and that the sinker loss estimates apply only to some hemlock and are often overstated. Some companies may look at the alternatives available in the water rather than continuing to build dryland sortyards.

Mechanized Water Sorters

One such alternative was designed and constructed from 1976 to 1979 by Crown Zellerbach Canada Ltd. The company now operates two sorting grounds using this type of equipment (Figure X-5) with annual production levels of 950 000 m^3 and 240 000 m^3. The people who introduced this system (M. R. Lehman and P. Oakley) claim the capital cost and operating costs are significantly below the costs for equivalent sized sortyards.

This system has merit where there are few sinkers, where the logs are delivered by barge to a central point, where there is no available land for a sortyard or where the facility will need to be frequently moved.

A system based on this design was proposed by J. T. Trebett for Ocean Falls. It is sized to process 340 000 m^3 or 240 000 pieces in 200 operating days. It has a construction advantage in that the system can be prefabricated and towed to the site for final assembly. Thus, construction costs at remote sites would be minimized. Figure X-6 is a drawing of the system.

Referring to Figure X-6, the system would operate as follows:

- Bundle boom stripped of boom gear.
- Bundle wires removed over submersible grid.
- Scalers grade, mark and scale logs in raceway.
- Floating log loader sorts logs into floating bundling bunks.

Figure X-5. Water Sorters Processing Logs.

- When a bunk is full, the bundling straps are applied and then the bundle is dumped in the water.
- Sorted log bundles are pushed into appropriate pockets for booming.
- The submersible grid is raised when an incoming boom is completed and the low floaters and sinkers are loaded onto a float for grading and scaling. The sinkers and low floaters are metered into the normal bundles.

The capital cost of building and installing the system is estimated as $3 168 000.

The crew on the system would consist of seventeen people and the annual sorting costs are estimated as:

Labour Cost	$ 523 750
Supplies and Services	294 800
Equipment Operating and Repair	268 100
	$1 086 650

$$\frac{\$1\ 086\ 650}{340\ 000} = \$3.20/m^3$$

$$\frac{\$1\ 086\ 650}{249\ 999} = \$4.53/\text{piece}$$

This operating cost is less than those found in conventional sorting grounds and in dryland sortyards of the same size. The investment required per cubic metre of wood sorted annually is less than that required in dryland sortyards of the same size. At present, about $11.50/m^3 of capital is needed to build and equip a dryland sortyard and booming ground that can process 340 000 m^3 per year. As calculated previously, the capital cost of the mechanized water sorting ground and shore facilities is estimated at $3 168 000 or $9.30/m^3. These amounts of cost differences, combined with the fact that companies are developing logging operations in more remote areas of the B.C. coast will mean that mechanical sorting grounds will attract interest in the future.

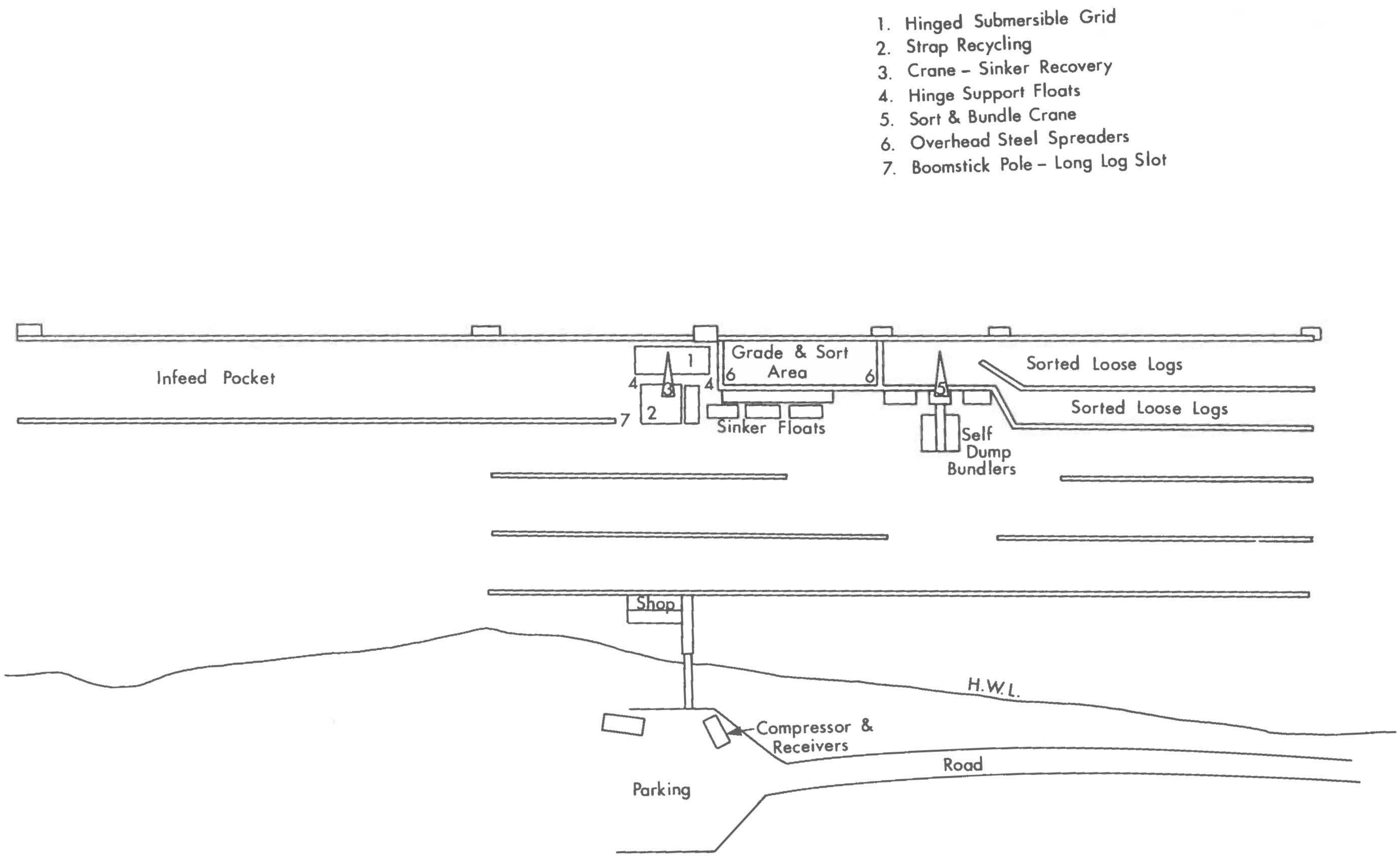


Figure X-6. Plan of Mechanized Water Sorting Ground.

L. MULTIPLE-USER SORTING OPERATIONS

Water sorting and booming grounds which process logs for a variety of customers have been in operation for many years. However, until recently, dryland sortyards have only processed logs for one logging division. This changed when two larger sortyards were designed and built to receive and process logs from several logging divisions. In the last year, one large sortyard has begun to process logs on a contract basis for other companies as well as processing logs for several company logging divisions. Also, another large size dryland sortyard is in the initial planning stages that will operate on a purely contract basis for a variety of customers.

Whether the trend will continue in the future is difficult to predict because of a series of offsetting factors. Factors such as the sort efficiencies inherent in larger sortyards and the scarcity of available sites for dryland sortyards on the South Coast support the trend. However, log security, differences in log grades, and statutory log scaling requirements will hinder the trend. Because owners of logs must retain possession of their own logs, the multi-user sorting yard must operate in batches. This increases the complexity of the process and requires more storage area than continuous sorting.

Hopefully, the decision to build a new multiple-user sorting facility will be based on the process outlined in Part V of the handbook. That is, identify the amount and location of the log supply and demand as well as future trends in order to develop volume-distance relationships. To this, add the characteristics of species distribution, log size distribution, seasonal production variations, system flexibility, bottleneck location, etc. to decide what the sorting operation has to achieve to be successful. Next, the list of available sortyard sites should be evaluated and compared with what is needed by the sortyard and the two most promising alternatives ranked on an economic and qualitative basis. Only when this has been done can a reasonable decision be made to build a multiple-user sorting operation. What may be feasible in one situation will be unacceptable, both on a quantitative and qualitative basis, in another situation.

APPENDIX I

Sections A, B, and C, Appendix 3.0 and Prospectus from Coastal Log Handling Application Guidelines, Province of British Columbia, Ministry of Lands, Parks and Housing, December 1982.

A. INTRODUCTION

Guidelines for the review and processing of coastal log handling applications are outlined in the following sections of this document. Interim guidelines were originally prepared at the direction of the Ministry of Lands, Parks and Housing Executive Committee as means of clarifying the manner in which the Ministry will process coastal log handling applications. The Ministry was requested to undertake this project by the Steering Committee of the Council of Forest Industries (COFI) and Government study (July, 1981) on coastal foreshore and estuary log handling. The conclusions and recommendations from this study are in Appendix I.0. This document represents a revision and finalization of the Interim Guidelines utilizing the 1981 study and an evaluation of the Interim Guidelines during their initial period of use.

The guidelines detail the activities and responsibilities for four general areas of the application process: Prospectus Development and Review, Approved Project, Minor Review and Major Review.

For the purpose of these guidelines, "coastal log handling" refers to all forest industrial applications for log dumping, sorting, storage, booming, barging, conversion plants and all activities associated with those practices which require Crown foreshore and/or lands covered by estuarine or marine influences. It also includes Crown upland and shoreland applications when they are directly related to the above applications for land covered by water.

The guidelines have been developed to serve a necessary purpose at this point in time in making land use decisions for coastal log handling applications. However, a longer term objective of the Ministry of Lands, Parks and Housing is for Crown land allocation through planning. This will involve the consultation and co-operation of other government agencies, industry, and the public. Through a planning forum the Ministry will be able to progress from single application *ad hoc* decision making to the full evaluation of land use options based on the entire land and water log handling and transportation system. In this way, the capital and operational costs, and social and environmental concerns related to individual projects can be viewed relative to the entire system, resulting in a meaningful land use decision.

B. GOAL AND PRINCIPLES

GOAL:

To provide guidelines for assessing coastal log handling applications in an efficient manner that ensures that Crown land is allocated and managed in a manner that optimizes the environmental, social and economic benefits to the residents of B.C. and recognizes the statutory responsibilities of other government agencies.

PRINCIPLES:

The guidelines are designed to provide a logical sequence of events which leads to rational decision-making. An open consultative process which recognized procedural fairness is considered to be the best approach to satisfying the goal.

Development of these guidelines gives recognition to the forest industry's use of the coastal shorezone while also recognizing the necessity to avoid environmental impacts on coastal resources whenever possible. When environmental impacts cannot be avoided, the resource losses should be minimized through reasonable mitigation and/or compensation for significant losses.

The guidelines are to provide a screening mechanism so that projects with no serious impacts can be processed quickly and efficiently while those with potential serious impacts receive an appropriate level of review.

The application and review process is a regional responsibility with support and policy direction from headquarters as required. The Ministry of Lands, Parks and Housing Executive Committee will provide policy direction for projects requiring in-depth review.

The intent of the guidelines is to ensure that approved projects will result in a net benefit to the residents of British Columbia. The process is based on an evaluation to the degree appropriate, of:

- the environmental, social and economic benefits and costs; and
- alternatives to the project or its proposed site,

in order to identify what trade-offs are involved. The guidelines are designed to ensure that the best available information is provided to the decision makers in the process of allocating Crown coastal shorezone land to the project.

Public involvement is utilized in accordance with Ministry policy (Appendix 3.0). The involvement should be timely and in a meaningful manner.

C. FLOW OF ACTIVITIES AND GUIDELINES

The generalized flow chart (Section 1.0) depicts the basic sequence of events leading up to and including processing an application.

The Prospectus Development and Review Process (Section 2.0) is separated into two phases. The Ministry of Lands, Parks and Housing has minimal involvement in the Prospectus development phase; the bulk of the work is undertaken by the proponent. The Ministry is directly involved in the Prospectus review phase which leads to a decision whether to proceed with application processing and, if so, under which one of the three processes the application will proceed. This is intended to match the appropriate level of review to each project.

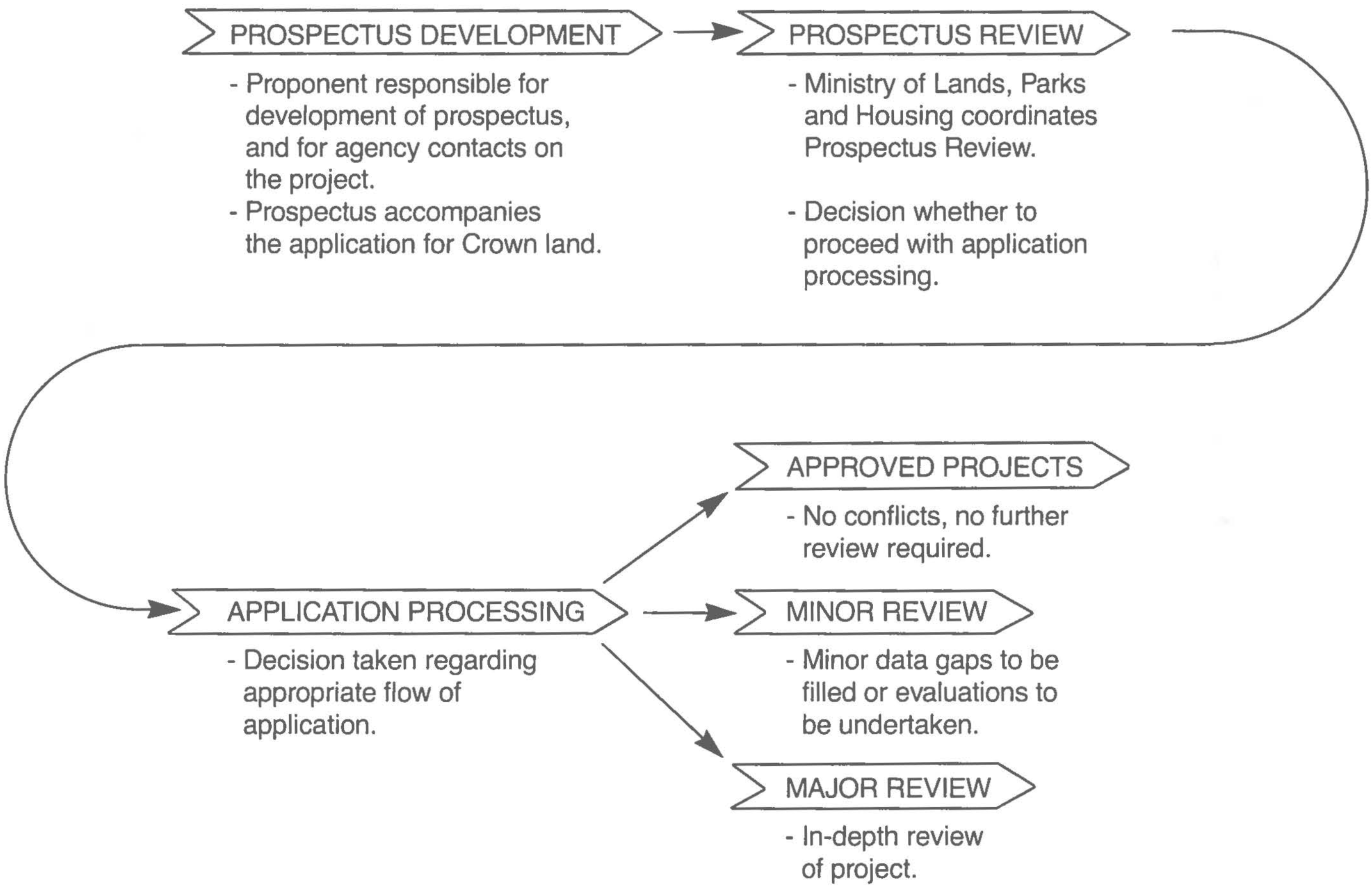
The Approved Project Process (Section 3.0) leads directly to final adjudication of a lease or licence of occupation with no further assessment for projects approved after the Prospectus Review.

The Minor Review Process (Section 4.0) is designed to provide an intermediate level of review and to fill the minor data gaps identified through the Prospectus Review which are required to make a final decision on the project.

The Major Review Process (Section 5.0) provides a sophisticated staged review for projects identified through the Prospectus Review as possessing considerable complexity and potentially significant impacts.

Section 1.0

GENERALIZED FLOW
LOG HANDLING APPLICATION
REVIEW PROCESS



Appendix 3.0

MINISTRY OF LANDS, PARKS & HOUSING — POLICY #: 3.13

MANUAL: Central Ministry Services — APPROVED BY EXECUTIVE COMMITTEE

SECTION: 3. Public Relations

SUBSECTION: 13. Public Involvement — DATE: 81-08-04

EFFECTIVE DATE OF POLICY: Immediate — SIGNED:

PERSON ISSUING POLICY: Director, Public Relations

RELATIONSHIP TO PREVIOUS POLICY:

New Policy

STATEMENT OF POLICY:

The democratic system of government allows the general public to make its views known through the political system. While the system does provide an opportunity for views to be expressed both on a broad scale and on smaller day-to-day concerns, the administrative system needs to provide more opportunity for public input, particularly in relation to matters of local interest and concern.

While it is clearly not the function of the public servant to usurp the role of the politician in his relations with the public, nonetheless it has become evident that the public servant must recognise the views of an informed and educated public if he is to successfully implement his management responsibilities to government.

Successful management in the eighties will require explicit recognition of the usefulness of informed views and opinions of public groups and individuals to ensure our programs and activities are sensitive to public need.

To achieve meaningful public involvement, contact will be required between managers in the field and the general public they immediately serve, both individuals and special interest groups.

With this in mind, this paper is produced to provide guidelines for the Ministry's managers in their relationship with the public.

OBJECTIVES:

The Executive Committee supports the general view that recognition of an informed public interest and opinion at the regional level will be of value in improving the quality of management decisions.

Much of this public involvement will be expressed by special interest groups but should also include any British Columbian who chooses to become involved.

Although management must remain accountable for its decisions, these decisions cannot exist in a vacuum of public misunderstanding. Therefore it is important that the public be kept informed, both before and after the decision to ensure that they have a proper understanding of why decisions have been made.

Not all decisions will be popular, which makes it even more important that the views of the public are elicited and understood in advance or as part of the decision making process.

Therefore, the primary objectives of the ministry's public involvement policy will be:

- to keep the public informed of our activities
- to elicit and understand the public's views
- to weigh the views of the public in the decision making process
- to inform the public of the reasons for decisions.

GUIDELINES:

Good communication is essential if a public involvement policy is to be effective.

The ministry must take the initiative in informing the public in advance when it has reason to believe that the public will want to express its views.

Staff should therefore maintain good contact on an informal and ongoing basis with special interest groups in order to gauge the extent of their views on particular matters. Although the views of special interest groups do not necessarily reflect the views of the general public, contact will provide some measure of determining how much public exposure is warranted.

A more direct means of determining public interest is, of course, the magnitude of mail received, the strength of lobby groups, and media coverage in the area.

Staff will undoubtedly be in the best position to determine the extent of public involvement required, and should take the initiative in recommending to the Executive Committee the extent and method of public involvement.

Some of the methods of keeping the public informed are:

Means	Classification	Authorization
News Release	Public Information	Regional or Program Director
Fact Pamphlets	"	"
Displays	"	"
Advertising	"	"
Technical Papers	"	"
Store Front or Open House	"	"
Discussion Papers	Public Consultation	Executive Committee
Written Briefs	"	"
Public Meetings	"	"
Workshops	"	"
Advisory Committees	Decision participation	Minister
Task Groups	"	"
Joint Planning Teams	"	"

Whichever method is selected or recommended by staff, the message should be easy to understand. Jargon should be avoided and technical information carefully explained. Where necessary the services of the ministry's advertising agency should be used to add clarity to the message. If the information is not understood by the general public, the attempt to communicate will be wasted.

One of the most difficult things to do is to choose a method adequate to deal with the issues from the public viewpoint and that also satisfies management preference for economy in time and funds. Experience is probably the only way ultimately to determine the level of involvement that is correct and adequate.

Usually one would begin with information and only move up the scale of greater commitment because this seems warranted by the extent of public opinion. Because of the cost and time involved, authority to move into a more active role will be carefully weighed by the Minister or the Executive Committee and should never be presumed, nor should the public be encouraged to seek such authority directly.

Public involvement programs take time, cost money and raise expectations. In general, the more serious and detailed the involvement, the more commitment we make to using the results. Indicated below is the degree of expectations committed:

METHOD	PURPOSE
News Release	You want the public to know about it.
Fact pamphlets, displays, advertising, technical papers	You want the public to understand and support the program.
Discussion papers, Written briefs, Public meetings	You are willing to consider altering plans and operations to accommodate the views expressed.
Workshops, Advisory Committees	You expect to implement most of the advise given.
Task Groups, Joint Planning Teams	You are fully commited to using the results.

Whilst the criteria for selecting or recommending the correct method will continue to remain a judgement call on the part of the director, some of the considerations in moving towards greater public involvement are outlined below:

Public Information

- the public has a need to know the facts
- level of public interest will indicate appropriate technique
- having the information available assists administration

Public Consultation

- Issues have minor impact, mainly a matter of public preference which can be accommodated by minor changes.
- Narrow range of options are involved.
- Small number of people are interested, generally focussed on special area of interest.
- Issues are urgent and must be dealt with expeditiously.
- Public is concerned but not demanding extensive involvement.
- Ministry has capacity to support a modest public involvement program.

Participation in decision making process:

- Issues have serious implications and trade-offs will be involved.
- Wide range of complex issues are involved.
- Many public and other government agency groups concerned with issues.
- Issues are important but there is time for planning.
- Public has expressed strong interest they want input.
- Ministry has capacity to support a complex public involvement program.

The Regional or Program Director will need to review the issues, the depth of public concern, the time constraints, the resources available, the input from organized groups and other government agencies to determine which method is appropriate, and should not hesitate to seek senior advice in arriving at a decision.

Province of British Columbia

Ministry of Lands, Parks and Housing

PROSPECTUS

Coastal Log Handling and Storage

APPLICANT NAME AND ADDRESS ▶		Ministry File No.
		NTS Map No.
APPLICANT CONTACT NAME AND TITLE ▶		Phone
Development Location	Name of proposed development (if applicable)	Is project ☐ new application ☐ renewal application

PROJECT JUSTIFICATION ▶ (Attach separate sheets if necessary.)

1. Summarize the economic and operational reasons why this project is important to the company.
2. Describe briefly alternative sites and or methods of operation which were considered for this project. Summarize the reasons for selecting the proposed project over the alternatives considered.

PROJECT LOCATION ▶ Provide information relevant to the project. Check ☒ the categories included.

REQUIRED INFORMATION

A. Project area map (scale 1:20,000 or 1:50,000)
- ☐ Proposed site
- ☐ Alternate sites considered
- ☐ Other facilities related to the project: Describe briefly
- ☐ Existing and proposed roads
- ☐ Construction borrow sources
- ☐ Waste and dredgate disposal areas

B. Proposed site map (state the scale)
- ☐ Boundaries of proposed site
- ☐ Other relevant information: Describe briefly
- ☐ Total project site area in hectares

C. Proposed development plan or detailed sketch (state the scale)
- ☐ Indicate boundaries
- ☐ Construction works or improvements
- ☐ Other information related to the project: Describe briefly
- ☐ Area to be dredged
- ☐ Area to be filled
- ☐ New and existing upland facilities neighbouring the proposed site
- ☐ Existing works, improvements or fill on the proposed site. Claimed by applicant ☐ Yes ☐ No

OPTIONAL INFORMATION
- ☐ Marine chart
- ☐ Air photo (include scale, date, number)
- ☐ Oblique photo (include date)

PROJECT DESCRIPTION ▶

A. TYPE OF DEVELOPMENT (Check ☒ all applicable categories)

1. Log sorting ☐ Dry land sort (fill) ☐ Dry land sort (upland) ☐ Water sort
2. Log dumping ☐ Logs bundled (dry land) ☐ Logs bundled (in water) ☐ Loose logs
   State method of dumping
3. Barging ☐ Log barge loading ☐ Log barge unloading ☐ Other barge loading
   ☐ Other barge unloading. State type of other barge
4. Log booming (indicate percentages) ☐ Flat rafts % ☐ Bundle booms %
5. Log boom storage ☐ Continuous basis ☐ Intermittent basis ☐ Emergency only ☐ Flat rafts % ☐ Bundle booms %
6. Conversion plants ☐ Sawmill ☐ Pulpmill ☐ Shakemill ☐ Other (specify)

L49(7/80)

PROJECT DESCRIPTION ▶
(Continued)

B. LOG FLOW

1. State the origin of the logs to be handled at the proposed site. Give type of tenure (i.e., TFL) location and name or number

2. List type and percentage of log species to be handled

3. Anticipated log volume to be handled (give ranges expected)
Daily .... m^3
Annually .... m^3

4. Average turn-over period for the logs

C. DEVELOPMENT

1. Duration of construction period

2. Anticipated date to begin construction

3. Area required in hectares
Upland .... ha
Foreshore land .... ha
Subtidal land .... ha

4. Method and timing of dredging and/or filling

5. Life span of proposed project in years ....

6. Volume to be dredged .... m^3

7. Volume to be filled .... m^3

PROJECT IMPLICATIONS ▶

A. SOCIAL AND ECONOMIC

1. Estimated capital cost of project $

2. Estimated annual operating cost $

3. Indicate if proposed project will result in any of the following:

- ☐ New or increased energy supplies or other services (i.e., water)
- ☐ Increase in regional population
- ☐ Decrease in regional population
- ☐ New townsite
- ☐ Rural residential development
- ☐ Government expenditure or cost sharing
- ☐ Company residents campsite
- ☐ Construction campsite

4. Indicate the following as applicable

Upland ownership ☐ Crown ☐ Company ☐ Other private ownership

Project relationship to official government plans or local zoning for the proposed site

☐ Compatible

☐ Not compatible: Explain

B. ENVIRONMENTAL

1. Indicate if project will result in any discharges or accumulations of

☐ Effluents ☐ Pollutants ☐ Debris

to

☐ Land ☐ Air ☐ Freshwater ☐ Saltwater

N.B.—Attach any information available describing nature of discharges or accumulations

2. Indicate if the project will likely result in any hazard or danger to public safety ☐ No ☐ Yes (explain)

PROJECT IMPLICATIONS (Continued)

B. ENVIRONMENTAL (Continued)

3. Environmental Information: Check the categories known for the proposed area. Mark "S" for those suspected.

Type of coastal area ☐ Open marine shoreline ☐ Marine bay or inlet

☐ Estuary ☐ Fresh water portion of river up to limits of tidal influence

Type of substrate (if more than one type present estimate percentage of each type):

BEDROCK	☐ Intertidal	☐ Subtidal	SAND	☐ Intertidal	☐ Subtidal
BOULDER	☐ Intertidal	☐ Subtidal	SANDY		
COBBLES	☐ Intertidal	☐ Subtidal	MUD	☐ Intertidal	☐ Subtidal
GRAVEL	☐ Intertidal	☐ Subtidal	MUD	☐ Intertidal	☐ Subtidal

Type of vegetation ☐ Marsh ☐ Eelgrass ☐ Kelp bed ☐ Other algae

4. Resource Agencies: Indicate if the company or resource agencies contacted feel that the proposal could influence the following resources or their habitat.

	Type of Influence			
	Positive	Negative	Neutral	Unknown
Wildlife:				
Ungulates (i.e., deer)	☐	☐	☐	☐
Migratory birds	☐	☐	☐	☐
Resident birds	☐	☐	☐	☐
Marine mammals	☐	☐	☐	☐
Fish:				
Salmon	☐	☐	☐	☐
Steelhead or trout	☐	☐	☐	☐
Char	☐	☐	☐	☐
Other species	☐	☐	☐	☐
Marine Animals				
Shellfish	☐	☐	☐	☐
Crustaceans	☐	☐	☐	☐
Benthic invertebrates	☐	☐	☐	☐
Heritage Sites	☐	☐	☐	☐

Indicate the approximate slope of the area being applied for (per cent and direction)

ADDITIONAL INFORMATION

(Use reverse or attach separate sheets if necessary.)

1. Briefly describe any further project planning and assessment studies which the company feels are required

2. Provide any information which the company feels is necessary to clarify or expand upon the questions answered

AUTHORIZATION

L49(7/80)

DATE SIGNATURE TITLE

APPENDIX II

Sections 2.2 and 4.6 from "A Handbook for Fish Habitat Protection on Forest Lands in British Columbia" - D.A.A. TOEWS & M.J. BROWNLEE, Government of Canada, Department of Fisheries and Oceans - May, 1981.

Sections C, D & E from "Estuary, Foreshore Water Log Handling & Transportation", Summary Report of the Steering Committee - July, 1981.

2.2 THE ESTUARINE AND NEARSHORE MARINE ECOSYSTEMS

Estuaries, formed where rivers meet the sea, and the nearshore marine area, the shallow waters along the shoreline, are particularly productive zones of the coast. Estuaries in particular are important staging and feeding areas for seaward migrating salmonids. These shallow water areas are efficient nutrient and food traps, taking organics from deeper waters and the land, and effectively mixing and recycling them by tidal current and wave action. The mixing and recycling of nutrients and food particles is then the key to the rich, if not diverse estuarine and nearshore marine communities.

Estuarine And Nearshore Marine Description

An ***estuary*** is defined as "A semi-enclosed body of water which has a free connection with the open ocean and within which sea water is measurably diluted with freshwater derived from land drainage" (Cameron and Pritchard, 1963). Estuaries can be divided into identifiable upland, intertidal and subtidal zones, and further sub-divided into areas of substrate, salinity, and vegetative communities, reflecting different physical and chemical conditions [Fig. 11, Photograph 4].

Upland. Forest, woodland, true grassland (above tidal reach)

Freshwater. Rivers and streams

Intertidal. Marshland (upper intertidal) and mud flats (lower intertidal)

Subtidal. Below low tide

Saltwater. Ocean, inlet, bay

Estuaries are unique and important systems characterized by:

(1) High productivity of lower organisms resulting from shifting of fresh and salt waters across the shallow intertidal zone, mixing their nutrient loads and providing food for fish and larger invertebrates.
(2) High sensitivity associated with an unstable environment and a limited diversity of plant and animal life.
(3) High commercial and recreational value: e.g. rearing

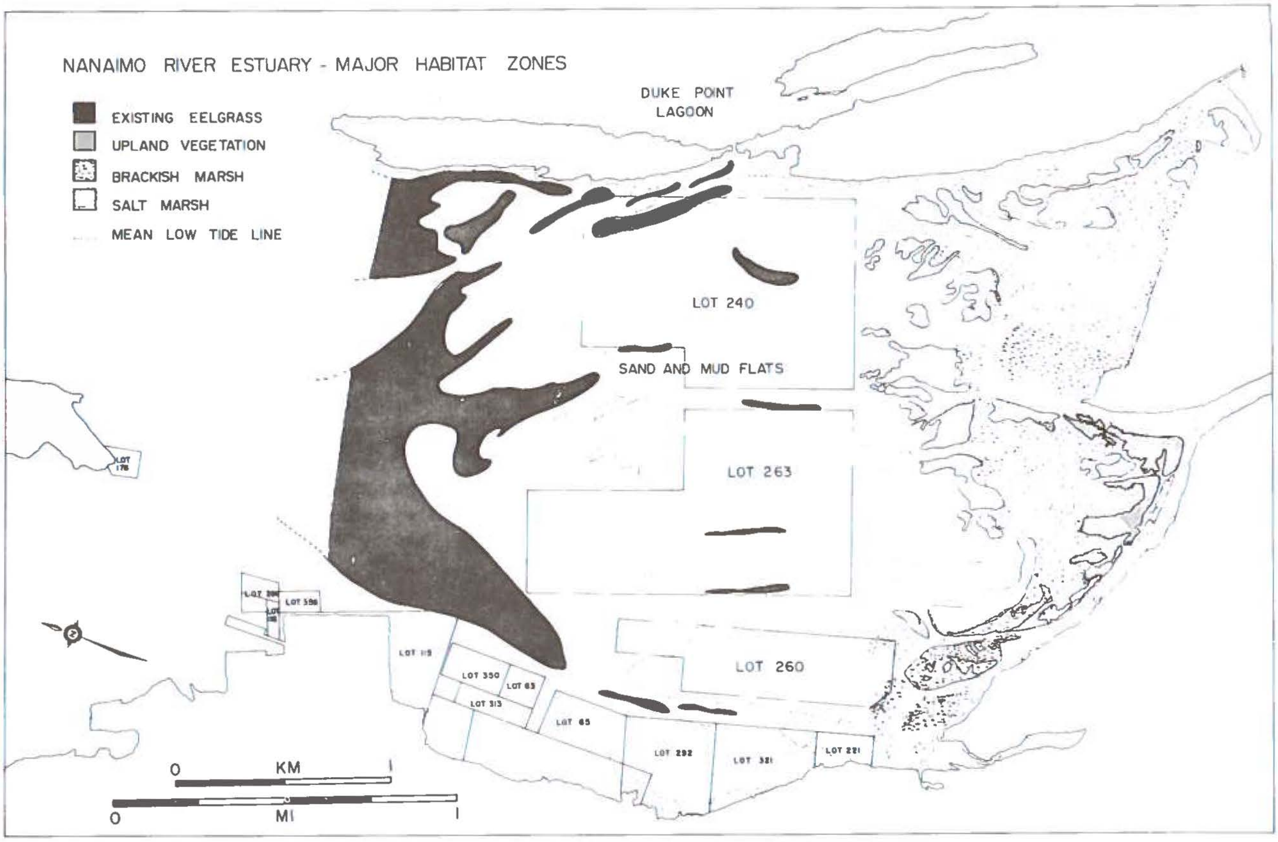


Fig. 11 A map of the Nanaimo River estuary with major habitat zones identified. The adjacent photograph illustrates log storage in this area (from Anonymous, 1980).

grounds for fish, especially herring and salmonids, shellfish, and crustaceans of commercial and recreational value; general recreational appeal of estuaries.
(4) Close proximity to user-population.
(5) Relative scarcity; only a limited number of estuaries exist on the Pacific Coast.

The high biological productivity of estuaries is tied to an interdependent and rather inflexible set of physical and chemical conditions to which a limited number of plants and animals have adapted in specific and often intricate ways. The resulting food chains tend to be simple; consequently, an alteration of only one component can often have a significant effect on the productivity of the whole system.

The ***nearshore marine*** zone is described as the shallow strip of coastal water, generally less than 30m in depth, and characterized by:

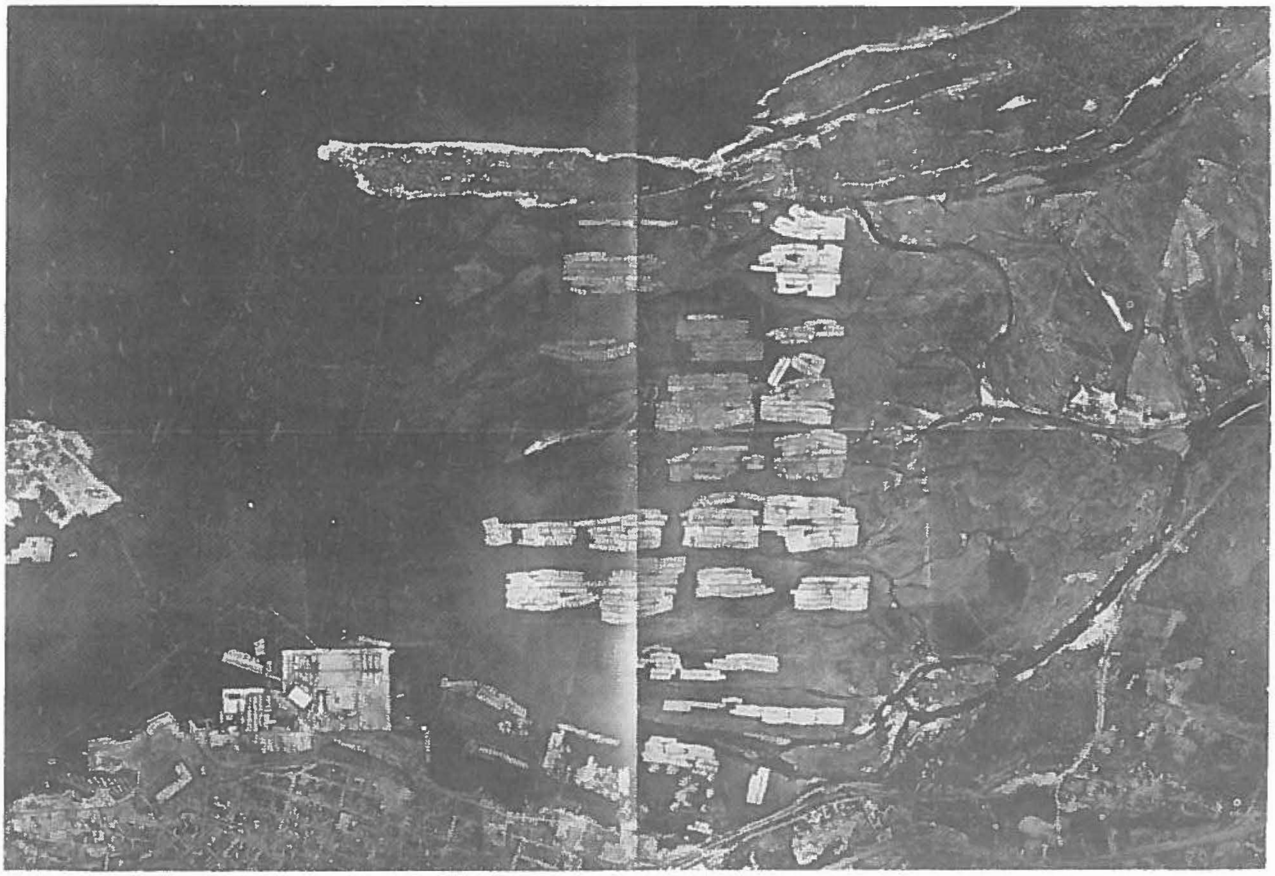
(1) High productivity associated with shallow water and nutrients that are washed in from the land and result from upwelling from deeper water.
(2) Varied habitats (protected, open, rocky, sandy, etc.) resulting in varied biota.
(3) Close to users (fishermen, recreationists, etc.).

Biological Resources of the Estuarine and Nearshore Marine Zones

A. *Vegetation*

Intertidal Marshlands of estuaries are found in the upper intertidal zone. They are among the most productive lands in the world, and being near the base of the food web, provide nutrients to virtually all remaining biota of the estuary [Fig. 12].

The plant species makeup reflects the relationship between the individual species' salt tolerances and the degree of saltwater inundation received from each flood tide. The outer limits are typified by the more salt tolerant species such as the glasswort (*Salicornia sp.*), and saltgrass (*Distichilis sp.*). Intermediate areas are usually dominated by sedge, such as *Carex lyngbei*. The inner portions at higher elevations are characterized by plants with lower salt tolerances, such as plantain (*Alisma sp.*), and cattail (*Typha sp.*).



Photograph 4 Aerial view of the Nanaimo River estuary.

Mudflat Vegetation is restricted to several species of algae. Besides providing some protection, algae are a vital primary producer (photosynthesizer) in the estuarine food chain. During late summer and fall, green algae including the sea lettuce (*Ulva sp.*), green confetti (*Enteromorpha sp.*), and *Ulothrix sp.* can be abundant over the mudflats, extending to the margin of the marsh. These algal communities virtually disappear in December and January, but reappear again in summer. Other green algae and brown algae, including the rockweed (*Fucus sp.*) are fairly common on mudflats, particularly so where there are rocks or other solid points for attachment.

Outer Intertidal Vegetation, along with the seaward fringe of the intertidal zone of both estuaries and nearshore marine areas, can often be in the form of eelgrass (*Zostera sp.*) that is often mixed with brown algae in deeper water. Eelgrass is of value as food and cover for prey species of diving birds and fish, and for spawning herring.

Rocky Shore Vegetation of the nearshore marine environment is composed of numerous plants which offer protection to intertidal fauna from sunlight and drying at low tide, and shelter to a variety of fish and invertebrates. Common species include *Pelvita*, and various species of *Fucus*, kelp (*Laminaria sp.*), and sea lettuce (*Ulva sp.*).

Subtidal Vegetation in the zone beyond the lowest low tide, can consist of an extension of the eelgrass zone, providing plankton and nutrients which are carried over the intertidal zone for use by plants and animals there, and is also used by herring for spawning. Kelp beds (*Laminaria sp.*) are also found in this zone.

B. Invertebrates

Invertebrates are primarily associated with the seabed and vegetation. They occupy a central position in the food chain, feeding on detritus and algae, and making up a significant proportion of the diet for estuarine and nearshore fish and birds. The abundance and variety of shellfish as well as shrimp and crab provide an important recreational resource, and in some cases, support small but important commercial fisheries.

The kinds and abundance of invertebrates living on the bottom vary according to the texture of the bottom, depth and salinity. For example, mudflats support a variety of soft-shelled clams and lugworms. Mussels, barnacles and shore crabs are found in gravel-sand areas, and abalone, scallops and oysters are found in rocky areas. Large numbers of insect larvae (a major fish food) are found in areas most heavily influenced by fresh water.

Some of the smaller invertebrate forms are associated with the mud bottom or the rooted vegetation and are key food items for fish. Some young salmonids feed

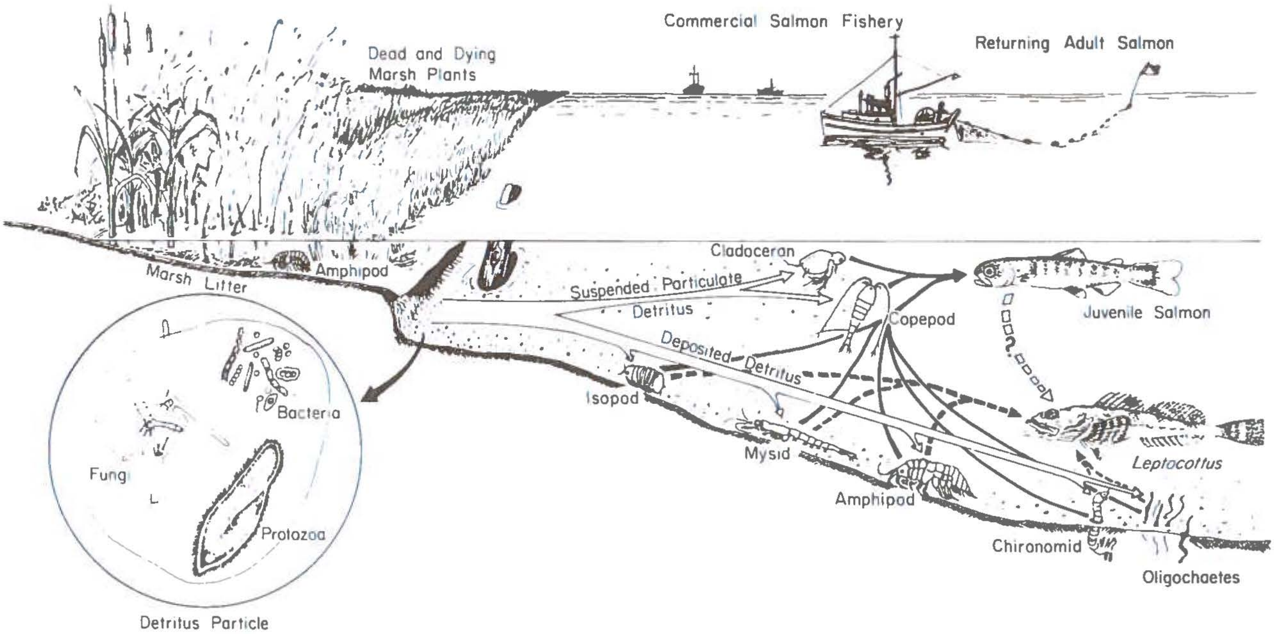


Fig. 12 General Structure of an Estuary Ecosystem (Kistritz, 1978).

heavily on mysids, isopods, and gammarids [Fig. 12] which are produced in areas of intertidal or subtidal vegetation, or woody debris (including the undersides of log booms).

Very small planktonic organisms such as copepods form the major diet of the smaller salmonid young such as chum salmon fry. Although taken in mid-water, copepods and other 'micro fauna' are produced on the bottom, feeding on algae, bacteria and detritus.

Shellfish

Large populations of clams, including butter clams, little neck clams, horse clams, and mud clams are found in sandy and mud beaches. Oysters are found in intertidal and shallow subtidal areas, and scallops and abalone (quickly becoming an important shellfish fishery) are found in the subtidal zone.

Crustaceans

Shrimp are found in subtidal areas. There are five species of commercial shrimp in B.C., and one large species—prawn.

Except for the prawn which is trapped, all commercial species are taken by shrimp trawls at a depth of 20-110 m on a muddy bottom. However, shrimps can undergo vertical migration and come to the surface. The larval stages of shrimp are pelagic, and possibly undergo vertical migration also. Eggs hatch in autumn and winter, and the larval stages drift into water 45-65 m deep.

Crabs are found in subtidal areas, generally associated with vegetation. They are fished commercially and recreationally along the B.C. coast.

Significant populations of Dungeness crab are found off Rose Spit in the Queen Charlotte Islands, off the Fraser River estuary and in Boundary Bay. The Dungeness crab mates in summer, usually in shallow water. The larval stages are pelagic, and are usually found near the surface among floating detritus, from about the beginning of April to the end of August.

Four species of tanner crab are found along the B.C. coast, and king crab are found in a few places in the Queen Charlottes and along the northern coast, but neither is sought commercially.

Other species found along the coast, which could have a commercial value, include the sea urchin, squid, and sea cucumber.

C. *Fish*

Several environmental factors account for the large fish populations found in estuaries:

1) High productivity of estuaries provides ample food
2) Marsh vegetation provides shelter from predation
3) For anadromous fish (i.e. salmon), marshes act as a transition zone for the acclimation from fresh to salt water.

The Fraser is the most important salmon producing river in North America, so its estuary is a critical habitat zone of immense importance. Estuarine and nearshore marine zone fishes include the following:

(i) Anadromous salmonids—Salmon, steelhead trout, coastal cutthroat trout, Dolly Varden char.

These species spend the greater part of their growing adult life in the ocean, returning to the streams and rivers to spawn. The young, after spending several weeks to several years (depending on the species) in fresh water, migrate to sea. On this seaward migration they generally remain in the estuary of their native stream, or perhaps a more productive one nearby, for varying periods of time up to several months, again depending on the species.

It has been shown that survival of anadromous fish in the sea is directly related to the size that individual fish attain upon leaving the parent stream or estuary. Therefore food production and fish growth in the stream and estuary are critical.

Estuarine residence for these fish is predominantly during the spring months, and for some species well into the summer. Food sources in the estuary are generally plankton, benthic (bottom) organisms and other fish.

(ii) Other migratory fish — herring, smelt and anchovy.

These species could be classed as anadromous, in a sense, as they spawn along the shores in brackish conditions. Herring migrate in late winter and early spring to the shallow waters of sheltered bays, rocky shores and sandy beaches to deposit their spawn on a variety of substrates including aquatic vegetation. Herring young remain near shore for a period of time, feeding and growing before returning to sea.

(iii) Non-migratory or resident fish — sculpin, flounder stickleback, sole.

These species occur generally in shallow water along much of the B.C. coast. They are not considered 'estuary' residents in any specific way; however, they will obviously utilize the abundant estuary food sources.

(iv) Marine fishes of the nearshore zone include ling cod, kelp and pointed greenling, black and copper rockfish, dogfish, perch, flounder, wolf eel, sculpin and ratfish.

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Further Reading

The following documents offer more information pertaining to general aquatic ecology.

Freshwater Ecology

D.B. LISTER ASSOCIATES, and KERR WOOD LEIDAL ASSOC. 1980. Stream Enhancement Guide. Prepared for the Salmonid Enhancement Program, Canada Department of Fisheries and Oceans and Provincial Fish and Wildlife Branch. 82 pp.

This Guide describes specific stream requirements for salmonids and methods for stream restoration.

NORTHCOTE, T.G. [Ed.] 1969. H.R. MacMillan Lecture in Fisheries. Symposium on salmon and trout in streams. University of B.C. Press. 388 pp.

This is probably the best single publication available covering a wide range of topics, including general salmonid stream ecology, feeding, habitat requirements, migration, reproductive biology, and effects of logging.

HYNES, H.B.N. 1970. The Ecology of Running Water. University of Toronto Press. 555 pp.

This is a useful text, covering the general topic of stream and river ecology. Physical, chemical and, biological processes are described along with good explanations of their interrelationships.

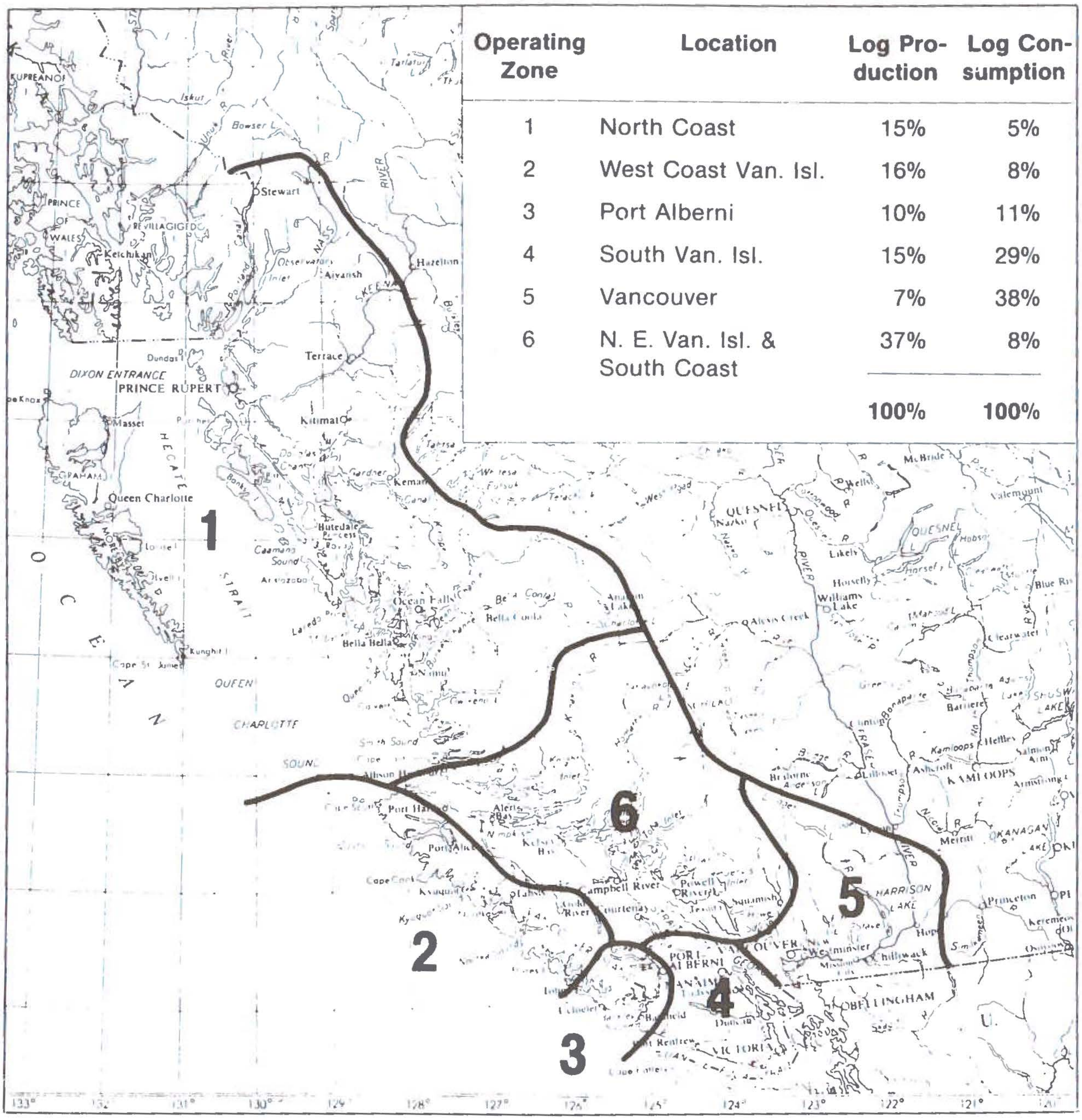
U.B.C. CENTRE FOR CONTINUING EDUCATION. 1974. Symposium on Stream Ecology. Held November 26, 27, 1974. Parksville B.C.

This document is a compilation of papers presented at this symposium. It outlines the general principles of stream ecology, salmonid biology and the impacts of forest harvesting activities on these topics. A very useful background document.

4.6 COASTAL LOG HANDLING AND TRANSPORTATION

A. *Coastal Log Flow And Log Handling Phases*

The log handling phase of forest harvesting applies to the movement of logs from landings in the woods to respective process sites (mills). Because of geography, the coastal forest industry of British Columbia has historically been dependent on the water transport of logs. Each year about 29 million cubic meters of timber is harvested on the coast of B.C. Approximately 80% of this volume is transported through the inside passage, along the west coast of Vancouver Island, and on the lower Fraser River to processing sites [Fig. 36].



Operating Zone	Location	Log Production	Log Consumption
1	North Coast	15%	5%
2	West Coast Van. Isl.	16%	8%
3	Port Alberni	10%	11%
4	South Van. Isl.	15%	29%
5	Vancouver	7%	38%
6	N. E. Van. Isl. & South Coast	37%	8%
		100%	100%

Fig. 36 Distribution of coastal log production and consumption by operating zone. (After D.F.O. *et al*, 1980).

Although there are many variations in the handling of logs resulting from differences in topography, economics, volumes, season and distance, the general pattern of coastal log flow can be summarized as in Figure 37.

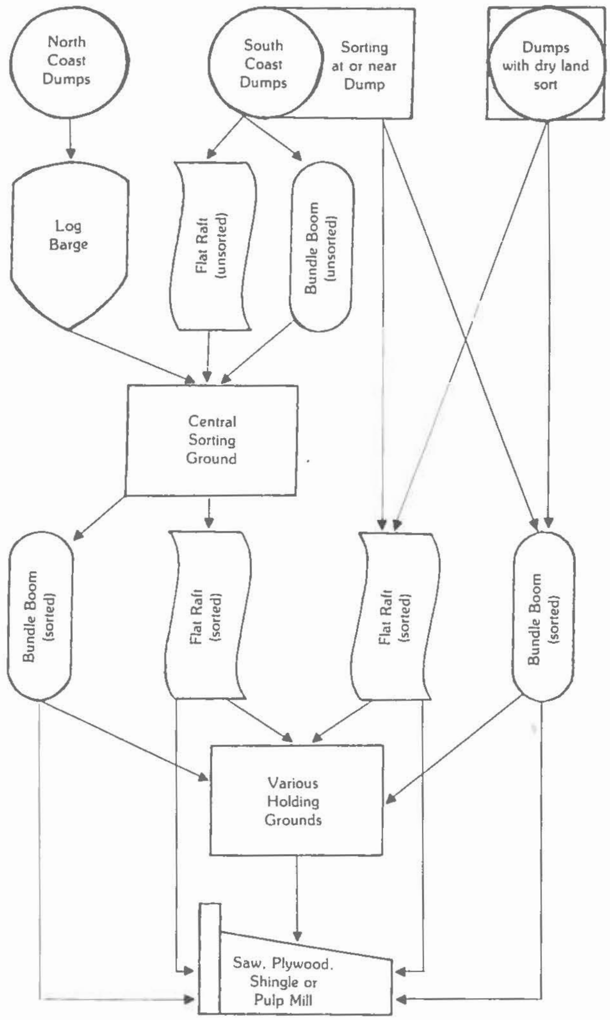


Fig. 37 Coastal Log Flow (After Conlan, K.E.).

Figure 38 depicts the location of the major process sites and log dumps on the coast.

In a typical operation, logs are hauled by truck from active logging areas to coastal dumps. Wherever possible, the logs are scaled, sorted and bundled prior to watering. At northern operations, logs are usually transported to a central wet or dryland sorting facility, then either towed (usually in bundles) or barged to the process sites. On the Queen Charlottes and exposed west coast of Vancouver Island, the towing of booms is not usually feasible, so logs are transported by barge. Table 10 outlines the area and environment leased for each of these activities.

The following briefly describes six major log handling phases:

A.1 Log Dumping

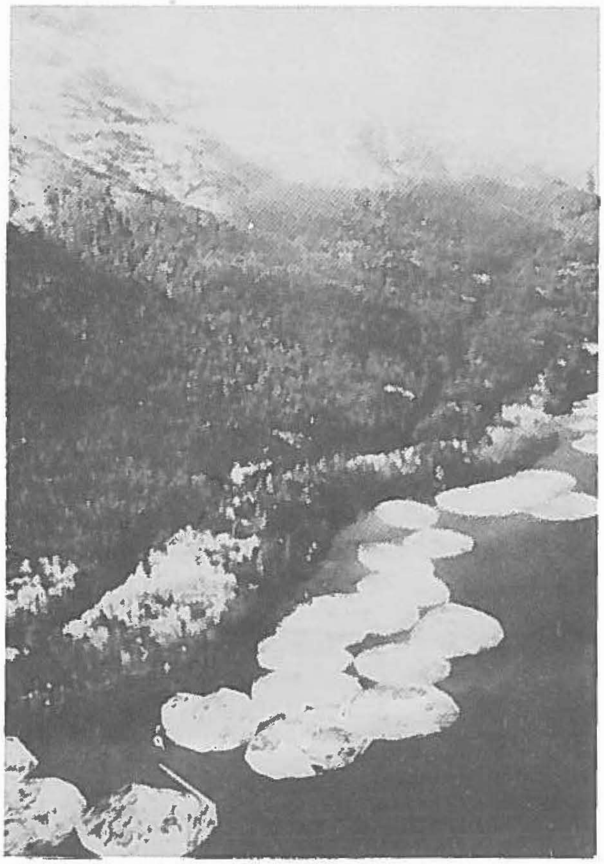
(Watering)

In 1971 there were 94 dump sites in the Vancouver Forest District (79 on Vancouver Island and 15 on the mainland). Of this total, approximately 75% were marine, and located in sheltered salt water inlets.

Methods of log dumping include:

a) Vertical hoist method—such as A-Frame, ginpole and parbuckle crane.
b) Equipment watering—using a cat, skidder, or front end loader.
c) Slide ramp.
d) Cable carriage.
e) Self-tipping barges.

Free-fall dumping associated with any of the above methods is a major point source of bark debris.



Photograph 19 Log booms.

A.2 Sorting

Sorting can be conducted in the woods (i.e. prime sawlogs, pulp or cedar cypress sorts), at each dump site, or in a centralized sorting area. There are two basic types of sorting; a) dryland and b) wet or in water.

For many coastal operations, small dryland sorting yards at the woods dump site can result in cheaper log handling costs than at distant custom sorting grounds. Most companies have therefore opted for small satellite dryland sorts, whenever possible, and for centralized sorting, either wet or dryland, for upcoast production where adequate space is not available at the woods site.

A.3 Scaling

Scaling is the measurement and recording of sizes and amounts of timber harvested, usually logs. Historically, scaling has taken place either in the woods, at the dump, or more often, at the process site.

A.4 Booming

While historically there have been many variations on the theme, currently there are two basic types:

a) Flat raft—logs are stored and towed loose inside a series of chained boomsticks [Photograph 19]. These rafts contain 10 to 20 twenty-one meter square sections, each holding $70m^3$ to $480m^3$. Rafts of up to 30 sections are commonly made.

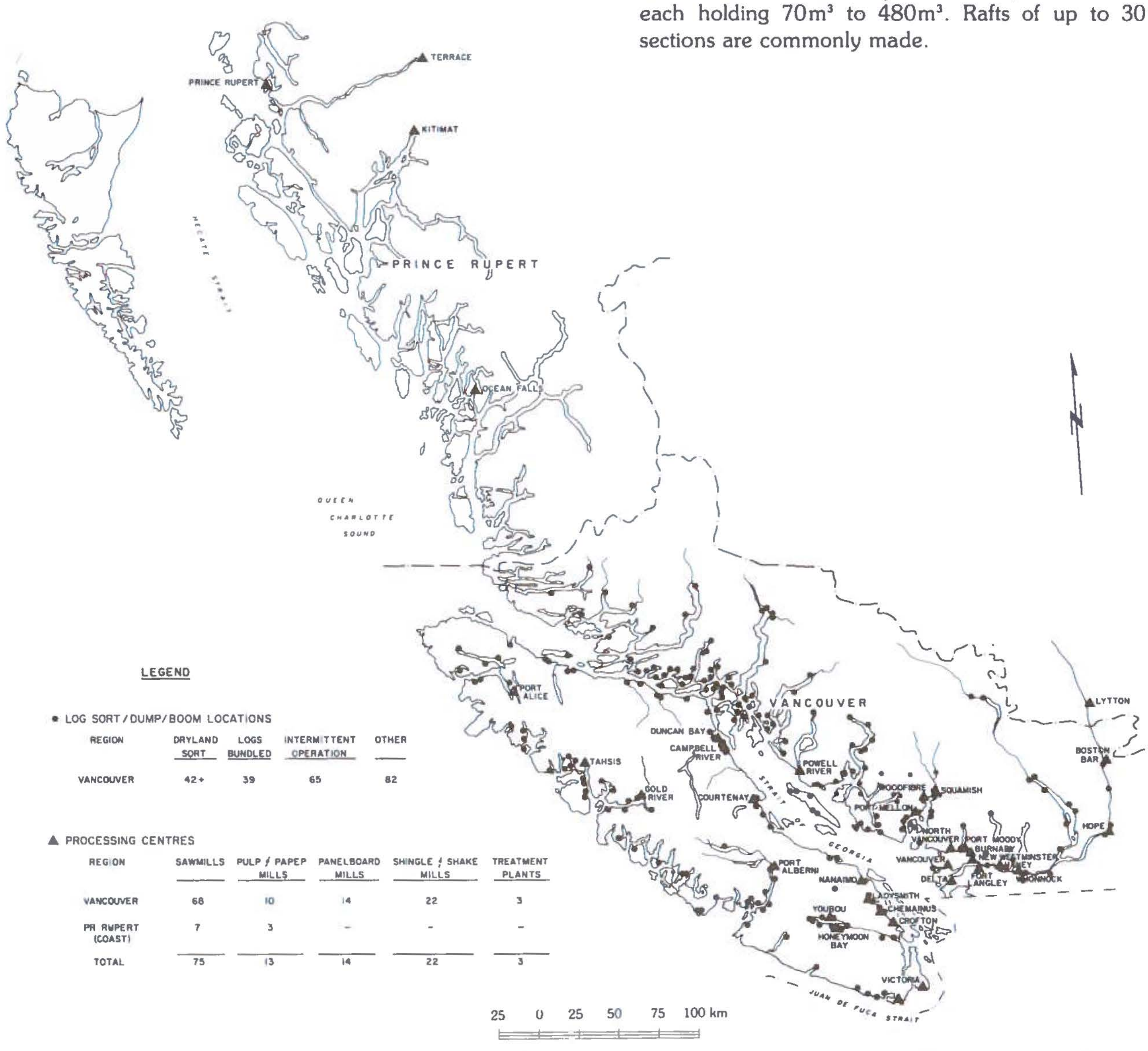


Fig. 38 Log sorting, dumping, booming and processing locations. (Note: Prince Rupert log dump information is incomplete). (After Ainscough, 1979).

TABLE 10 Area and Environments Utilized by Log Handling Practices in Coastal British Columbia (After FERIC,1980).

LOG HANDLING LEASES*

USE	**AREA** (hectares)	**% OF AREA**
Log dumping	204.2	2.3
Barge dumping	132.6	1.5
Barge loading	205.6	2.3
Log sorting/booming	1312.0	14.7
Log bundling	86.0	1.0
Log storage	5696.1	63.3
No present use	796.4	8.9
Other	522.9	5.8
TOTAL	8954.2	100.0

LOCATION	**AREA** (hectares)	**% OF AREA**	**AVERAGE AREA** (hectares)
Lake**	197.8	2.2	12.4
River***	1200.2	13.4	6.3
Estuary	954.6	10.7	25.1
Intertidal	2259.1	25.2	15.5
Deep Water	2997.0	33.5	14.5
River/Estuary	50.9	0.6	25.5
Estuary/Intertidal	164.3	1.8	16.4
Intertidal/Deep water	1083.5	12.1	22.6
Other combinations	48.8	0.5	12.2
TOTAL	8956.2	100.0	

* Based on a questionairre survey of 187 companies with 943 leases; 66% response of B.C. coastal forest industry
** Pitt and Harrison Lakes
*** Fraser River constitutes 98% of this use

b) Bundle booms—logs are bundled loosely with wire or metal bands. Bundles vary from 15 to 20m³ in volume and usually draw 1.5-2.5m of water. The bundles are then stored and rafted similarly to flat rafting.

With increased cutting of smaller second growth timber, and greater volume of high density hemlock, log bundling has become increasingly prevalent in the last 15 years as a means of reducing log losses and making the sorting process more economical and efficient. Hemlock losses due to sinking average 7 to 10% higher than for other species (COFI, 1974).

A.5 Storage

Although log storage can be totally dryland, most log storage has historically taken place in the water, either fresh or salt. Marine storage can be either intertidal, shallow or deep water. Logs are often stored near fresh-water inflow in order to reduce teredo infestation, although the degree of protection afforded by this technique depends on a number of factors, such as salinity, currents, storage time, and season. Reduced storage time is probably the most efficient means of reducing teredo damage.

At 6 sections per acre, the approximate storage capability for flat rafts is 1250-2100m³ ha, and for bundles 2100-4200m³ ha.

A.6 Transport

Methods of log transport include:

a) Truck.
b) River driving—being phased out where possible because of high costs and environmental impacts.
c) Rafting—flat rafts: log losses high, limited to inside waters.
—bundles: log losses reduced, towing limited by weather in exposed areas.
d) Barging—self dumping and/or self-loading barges can be operated year round in exposed areas. Logs can be barged either loose or in bundles.

The technology of barge-mounted cranes capable of handling 22 to 88 tonne bundles is being developed, and should reduce the barging and dumping of loose logs.

B. *Effects Of Log Handling And Transportation On Estuarine And Marine Ecosystems*

The adverse effects of log handling on the aquatic environment have been reasonably well-documented. Most of the studies relating to marine sites have been conducted within the last 10 years in Oregon, Alaska and in B.C. (a list of selected references is provided).

The primary effects of log handling on the marine and estuarine aquatic environments are the physical changes from shading, grounding and scouring by logs, debris accumulations, reduced current and wave action, scour from tugboat propellers and the chemical effects of leachates, H_2S and reduced dissolved oxygen [Fig. 39].

An example of these effects and the biological changes that result from them is given for the Nanaimo River estuary in Table 11.

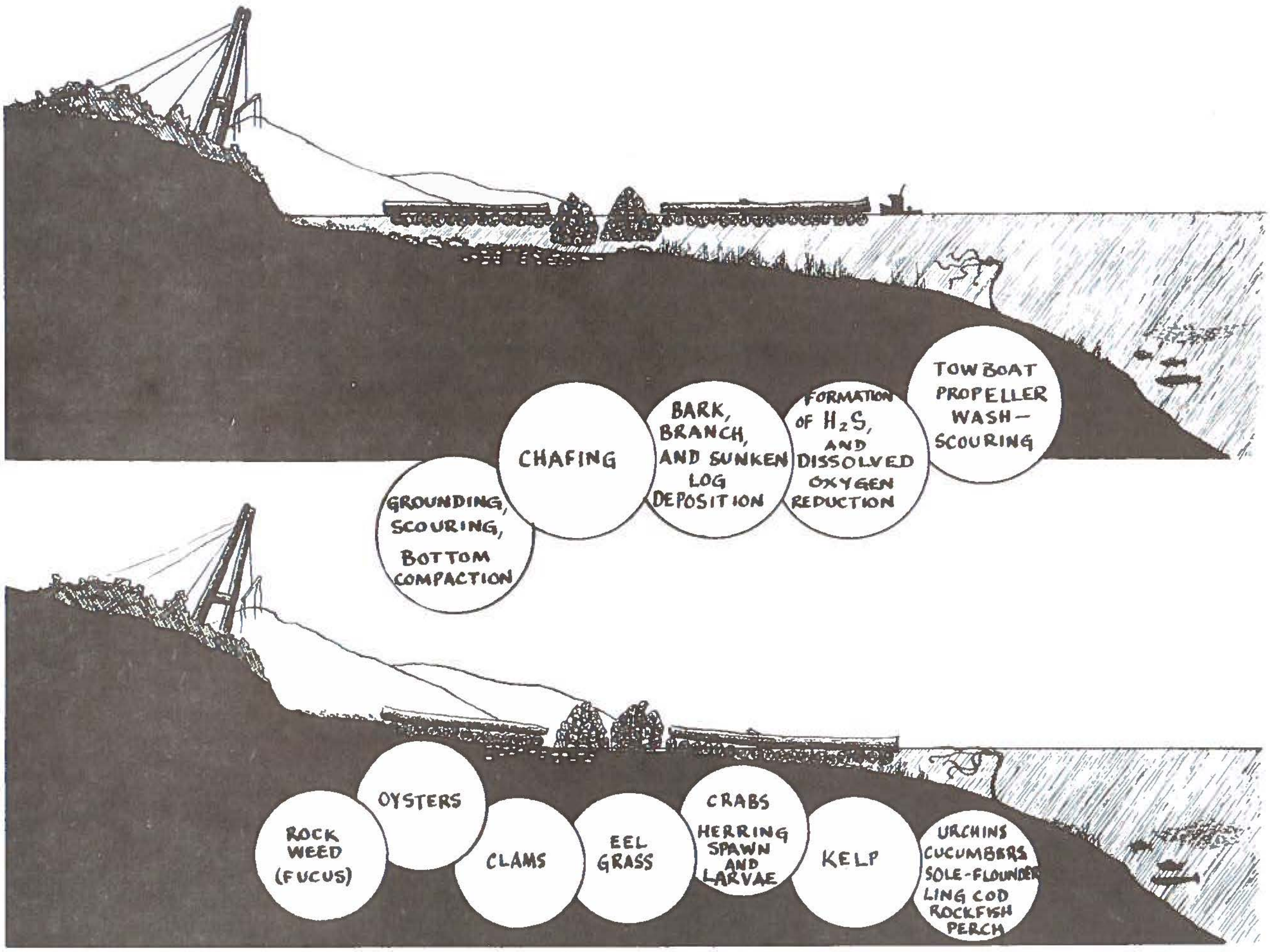


Fig.39 Effects of log handling on estuarine and marine aquatic ecosystems.

TABLE 11 Adverse Impacts of Intertidal Estuarine Log Storage (After D.F.O. *et al*, 1980).

PRIMARY	SECONDARY	TERTIARY	SIGNIFICANCE
Shading	Decreased primary production by microalgae (planktonic, benthic, macroalgae, eelgrass).	Altered food chains.	Less significant.
Grounding, abrasion	Destruction of plants, epifauna, infauna,	Destruction of food chains, lost "living space".	Highly significant
Reduced current and wave action	Increased sediment disposition, increased fines, debris retention, decreased sediment flushing.	Altered food chains, lost living space, chemical changes.	Significant.
Leachates, debris	Toxicity, B.O.D.	Decreased, altered flora and fauna.	Highly significant.
Towboat prop. wash in approaches	Disturbance and destruction of flora and fauna	Decreased production. Altered communities.	Highly significant.

B.1 Physical Effects

a) Bottom Deposits

Perhaps the most obvious impact of log handling on the aquatic environment is the physical alteration of the bottom by accumulations of bark and sunken logs. Deposits of 1m in depth and 60m radius have been observed in log dumping and storage areas [Photograph 20]. Quantitative studies have identified the following factors affecting the generation and deposition of bark debris:

Photograph 20 Debris accumulation below log storage areas.

i) Dumping Method—bark loss for Douglas Fir:

Free dumping (slide ramp)	13.0%
Vertical hoisting (A-Frame)	8.0%
Cable hoist	5.7%
Direct vertical dumping	17.1%

ii) Species—the tendency for bark to be dislodged from logs during unloading and transportation varies with species, (Douglas Fir and Ponderosa Pine for example, have been found to exhibit a 22% and a 6% bark loss respectively).

iii) Sinking rate—bark debris (depending on size) can generally be expected to sink at a rate of 10% the first day, and up to 75% in 2 months.

b) **Reduced light penetration** as a result of suspended wood fibre, turbidity, and shading effect of log rafts.

c) **Bottom compaction** from logs grounding on the bottom in intertidal areas and **scouring** from logs and tug boat propeller agitation.

Compaction under booms has been documented in the Nanaimo River Estuary, (D.F.O. *et al*, 1980), and scouring was found to extend to 5 to 10 cm in depth from propeller agitation only.

d) **Floating debris**, causing damage to fishermen's nets, and hazards to boating safety and aesthetics.

e) **Reduced current and wave action** from the log booms acting as breakwaters increasing deposition and decreasing flushing.

B.2 Chemical Effects

a) **Leachates**

Organic materials, such as tannins and lignins, which leach from logs stored in or near water are toxic to a variety of aquatic organisms. For chinook salmon fry, the toxic level of tannic acid is between 1.73 and 2.85 parts per million (ppm) for a 72 hour exposure in flowing fresh water, and below 1.7 ppm in sea water. For oyster larvae, abnormalities occur at concentrations as low as 1.48 ppm. Spruce and red cedar are the most toxic wood species to pink salmon fry in fresh water, and yellow cedar the most toxic in seawater. Hemlock bark is particularly high in soluble tannins (Pease, 1974).

b) **Reduced available dissolved oxygen** (DO) as a result of:

(i) oxygen uptake by micro-organisms which decompose organic material derived from wood and bark, (bio-chemical oxygen demand or BOD);

(ii) direct chemical combination of dissolved oxygen with soluble organic material leached from wood. (Chemical oxygen demand or COD).

Chronically low dissolved oxygen levels (below about 5 ppm) found particularly in water overlaying deposits of decaying debris, can be limiting for many forms of aquatic life (Servici *et al*, 1971).

c) **Toxic products** resulting from microbial decomposition of wood under anaerobic conditions (low DO), can adversely affect water quality. Hydrogen sulphide H_2S, with its characteristics odour of rotten eggs, is an indicator of such conditions and is highly toxic to fish (0.3 ppm for salmonids).

B.3 Biotic Effects

The most vulnerable of the estuarine and marine nearshore resources and habitats to log handling and storage are marshes and areas of emergent or marine vegetation, shellfish and crustacean beds, herring spawning sites, and productive salmonid rearing areas including estuarine and marine littoral areas.

Of these environments, the estuarine zone is the most sensitive, because the number of species that have adapted to estuarine conditions are few. Therefore estuarine food webs are relatively simple, or of low diversity. Consequently, as an alteration of one component can have a significant effect on the productivity of the whole system, it is important to note that estuarine systems are therefore particularly sensitive to the adverse effects of log handling and storage. [Photograph 21].

a) **Vegetation**

Intertidal vascular vegetation such as eelgrass (*Zostera sp.*) and sedge (*Carex sp.*) can be adversely affected by shading from log rafts and bottom scouring by grounding logs. For example, no eelgrass was found under log booms in the Nanaimo River Estuary, (D.F.O. *et al*, 1980) and vegetation was equally limited in the Point Grey Booming Ground on the North Arm of the Fraser River (personal observations).

Benthic algae can be inhibited by reduced light penetration (shading) and by increased turbidity. Also, scouring and resulting bottom instability was found to result in low standing crops of microalgae in the Nanaimo River Estuary (Naiman and Sibert, 1979).

b) **Benthic Organisms** (fauna)

Scouring from logs and propeller agitation in the Nanaimo River Estuary was found to result in instability and large particle grain size leading to a low abundance of meiofauna and other consumer organisms (Sibert and Harpham, 1979). Compaction was found to reduce the volume of oxygenated habitat available.

Benthic infauna (burrowers and partial burrowers

Photograph 21 Estuary with log handling and storage areas.

such as some oysters and clams) can be reduced in overall abundance (although perhaps not diversity) as a result of:

i) suffocation from woody deposits, reduced levels of dissolved oxygen and turbidity.
ii) toxic effects of leachates and H_2S.

Benthic epifauna (attached to the surface or substrate, including crabs, prawns, abalone, some scallops) can be reduced in overall abundance by reduced dissolved oxygen, toxic effects and turbidity. If there are no chemical effects, some change in diversity and increase in abundance may be realized from the increased number of surfaces for attachment or habitat. In most cases, however, these surfaces (wood pieces) will be unstable, and therefore of limited value.

A list of benthic invertebrates which have been shown to be adversely affected by, or resistant to log

TABLE 12 Species Resistant to and Harmed by Log Handling Practices (After Conlan, 1975).

TAXON	ABUNDANCE INCREASED OR NOT AFFECTED BY LOG HANDLING ACTIVITIES	•Reference Code	ABUNDANCE DECREASED BY LOG HANDLING ACTIVITIES	•Reference Code
CRUSTACEA	*Pandalus danae*	C	*Cancer magister*	L
	Pandalus platyceros	M	*Copepoda*	DFO
	Munida quadrispina	M		
	Amphipod sp.	C		
	Melita sp.	C		
BIVALVES			*Saxidomus giganteus*	M,E
	Bankia setacca	M		P,C
	Nucula tenuis	P	*Protothaca staminea*	M,E
	Parvilucina tenuisculptus	P	*Venerupis japonica*	C
	Thyasira barbarensis	P	*Clinocardium nuttallii*	M,E
			Tresus capax	P,E
			Crassostrea gigas	C
ECHINODERMS	*Pycnopodia helianthoides*	P	*Pycnopodia helianthoides*	M
	Parastichopus californicus	P	*Pisaster brevispinus*	M
ANEMONES	*Metridium senile*	P,C	*Pachycerianthus fimbriatus*	M
			Leioptilus guerneyi	M
TUNICATES	*Ascidia paratropa*	P		
ALGAE			*Chlorophyta*	P
			Rhodophyta	P
			Phaeophyta	P
			Microalgal	DFO
VASCULAR PLANTS			*Zostera*	DFO,P

C - Conlan, 1974
L - Lehman, 1970
M - McDaniel, 1973
P - Pease, 1974
E - Ellis, 1970
DFO - Department of Fisheries and Oceans and Province of B.C., 1980

handlind and storage practices is given in Table 12.

Community changes are typically transitional, from suspension feeders to detritus feeders. Such alterations can affect secondary consumers such as fish which use benthic invertebrates as prey.

c) **Fish**

Fish may leave areas of log handling and storage because of toxic effects, low dissolved oxygen, increased turbidity, and a reduction in invertebrate food organisms. If chemical effects are negligible, some fish may benefit from increased habitat provided by logs and debris on the bottom, or under rafted booms where added food supply may be available.

Of particular concern are the egg and early larval stages of Pacific herring. Eggs laid between late February and mid April, usually on vegetation 2m or so above and below low water are susceptible to abrasion from logs and to chemical toxicity of leachates.

B.4 Coast Handlogging and 'A-Frame' Logging Effects

Added to the general log handling and transportation effects are those from the growing number of small handlogging and 'A-Frame' logging operations along the coast. In these operations, timber is felled directly into the sea, usually into protected bays and inlets where it can be immediately boomed and stored for later transportation to the mill. These operations may have the same impacts on the the nearshore marine environment as the general marine log handling activities, with the addition of sedimentation effects resulting from the upland erosion of disturbed soils in the case of 'A-Frame' logging.

C. Legislative And Administrative Procedures

There are a number of federal and provincial statutes pertaining to the water deposition of debris or other materials associated with coastal log handling and storage. These are outlined with brief explanatory notes in Appendix I. Briefly, these statutes serve to prevent (make unlawful) undue and unnecessarily harmful materials from entering waterways that are important to fish, recreation, commerce and public health and safety. In most cases, these statutes ensure that other resource agencies, including Fisheries and Oceans have an opportunity to comment on or provide input to licences, permits, or approvals for related forestry activities. For some of these forestry activities, specific guidelines or procedures have been established to systematize this input, and it is important therefore to consider the administrative and liaison procedures established for this purpose.

Most, if not all log watering and handling sites are licensed by either a deep water, foreshore or upland lease or licence of occupation with the B.C. Ministry of Lands, Parks and Housing, or by a Special Use Permit with the B.C. Ministry of Forests. The Special Use Permit applies to the upland licensing, particularly in the B.C. Interior, whereas the leases and the licence of occupation apply to activities in aquatic systems.

The new (1980) 'Interim Guidelines for Coastal Log-Handling Applications' by the Ministry of Lands, Parks and Housing is a ". . . staged review process designed to guide Ministry of Lands, Parks and Housing staff, other government agencies and industry in the log-handling application process". This applies to all activities requiring Crown foreshore and to lands covered by estuarine or marine waters and riverine freshwater up to tidal limits. These guidelines provide a screening as well as a review function, so that appropriate attention is paid to each application.

A copy of the "Prospectus" to be filed with each application is provided in Appendix XIII.

Fisheries and Oceans staff have the opportunity to review new proposals or comment on lease renewals (normally 5 years) via referral procedures established with each of the Provincial regulatory agencies. Ministry of Forests Regional and District Offices refer application documents (permits, licences, and leases) to the Fisheries District Offices where comments are forwarded to the originating Office. Should the Fisheries and Oceans District Office note a difficult technical problem or a proposal that may prove a regional issue, the Habitat Protection Division in Headquarters is usually contacted.

While these referral procedures constitute the majority of applications that Fisheries and Oceans receive, there are a number of others that should be mentioned. The Federal Ministry of Transport receives proposals under the Navigable Water Protection Act and by referral to the Environmental Protection Service assures Fisheries of an input opportunity. Another referral source is the proponent (i.e. industry) who contacts Fisheries and Oceans directly for either an initial or formal reaction to a proposal.

A specific initiative has been taken to protect estuarine zones in B.C. The importance of these estuaries as vital rearing areas for juvenile salmon, coupled with the historic use of these areas for log handling, has created a high incidence of fisheries/forestry interactions. In recognition of this and in the context of the amended Fisheries Act, the Minister of Fisheries has recently enunciated a policy with respect to estuaries in British Columbia:

1) There should be no further loss of highly productive fish habitat.
2) Industry should make efficient use of low productivity areas (i.e. deep water).
3) Serious examination should be made of the available options for rehabilitation of degraded estuarine areas.

D. Protective Measures For Coastal Log Handling And Transportation

Log handling, particularly the active phases such as dumping and sorting, are basically incompatible with the maintenance of productive foreshore and estuarine habitats at these sites. Therefore efforts to minimize log handling activities in identified sensitive zones, through location away from sensitive areas would provide long term protection of these important habitats. In view of increasing industrial trends towards dryland operations and reduced log inventories this objective may be somewhat compatible with industrial needs.

For aquatic habitats, primary concerns include accumulation of debris on the bottom and surface and the resulting physical and chemical changes to habitats. The following protective measures are based on a Task Force Report on Log Storage and Rafting in Public Waters (approved by the Pacific Northwest Pollution Control Council) and are designed to minimize the impacts of log handling on the aquatic environment.

1) *Dry land handling and sorting is preferred to water handling and sorting, although the location of dry land facilities should not be in fisheries sensitive zones such as estuaries, salt marshes, herring spawning areas, or shellfish beds.*
2) *The free-fall, violent dumping of logs into water should be prohibited since this is the major cause and point source of loose bark and other log debris.*
3) *Easy let-down devices should be employed for replacing logs in the water, thereby reducing bark separation and the generation of other wood debris.*
4) *Positive bark and wood debris controls, collection, and disposal methods should be employed at log dumps, raft building areas, and mill-side handling zones. This would be required for both floating and sinking particles.*
5) *Log dumps should not be located in rapidly flowing waters or other water zones where positive bark and debris controls cannot be effective.*
6) *Accumulations of bark and other debris on the land and docks around dump sites should be kept out of the water.*
7) *Whenever possible logs should not be dumped, stored, or rafted where grounding, particularly on sensitive habitats, will occur.*
8) *Where water depths will permit the floating of bundled logs, they should be secured in bundles on land before being placed in the water. Bundles should not be broken again except on land or at millside.*
9) *The inventory of logs in water for any purpose should be kept to the lowest possible number for the shortest possible time.*

In addition to these general measures, there are more site-specific measures that can be applied to a particular operation to ensure that protection of aquatic habitat. These will be based on the specific resources present and the details of the operation. A technical assessment of a log handling proposal might therfore include the following considerations:

a) Site sensitivity and uniqueness:
   - resource values present (e.g. shellfish, herring spawn, emergent vegetation, salmonid rearing).
   - physical characteristics of site including substrate, depth, currents, tidal flushing etc.
b) Details of proposal:
   - dumping, sorting, transport methods.
   - log volumes and inventory and seasonal log flow.
   - duration of operation (usually related to upland logging).
   - positive debris control measures (recovery and disposal of both floating and sinking debris).
c) Potential impacts based on a consideration of (a) and (b) for both proposed and alternate sites. Alternate site may include dryland site.

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Further Reading

The following documents offer more information on coastal log handling and transportation and its effect on aquatic resources and habitats.

DEPARTMENT OF FISHERIES AND OCEANS and PROVINCE OF B.C. 1980. Nanaimo Estuary, Fish Habitat and Log Management Task Force, Summary Report. Nanaimo. 44 p.

This summary describes the impacts of log handling activities in the Nanaimo River Estuary on important estuarine plant and animal communties and habitats. Extrapolation to other estuaries is cautioned; however the Nanaimo estuary study gives some valuable insights into some of the types of impacts that might be experienced in other estuaries.

PACIFIC NORTHWEST POLLUTION CONTROL COUNCIL. 1971. Log storage and rafting in public waters. A Task Force Report. Seattle, Wash.

A good overview of the effects of log handling and storage on marine waters. A series of general guidelines are included that are useful in minimizing bark and debris problems in marine waters.

PROVINCE OF B.C., MINISTRY OF LANDS, PARKS AND HOUSING. 1980. Interim Guidelines: Coastal Log-Handling Applications. Land Programs Branch. 40 p.

A review of the application and review process established by this ministry for administering log handling applications for tidal waters. This document explains the development of the Prospectus, its review, and the information required for approvals.

C. ENVIRONMENTAL RESOURCES IN FORESHORE HABITATS

Fisheries

Marine, estuarine and freshwater shore zones in British Columbia directly and indirectly support very significant stocks of commercially and recreationally valuable fishes. The biological productivity of these zones is influenced by a complex of factors, processes and characteristics, including topography and geology. Stocks utilizing these zones exhibit a diversity of requirements. The combination of productive potential and related requirements determines the nature and intensity of use and, accordingly, the importance and sensitivity of a given zone in terms of the integrity of individual stocks, and the total fishery resource. Other factors such as harvesting rates and stream habitat conditions also have a bearing on the total productivity of resources. In view of the focus of this report on shore zones, no further mention of these factors is made in this report.

An increasing volume of data originating from fundamental research and stock management studies and site specific investigations associated with foreshore use proposals or activities has provided a clearer perspective of the role of shore zone ecosystems in the life cycles of salmon, herring and shellfish. While knowledge is far from complete, there are a number of characteristic features of these highly utilized areas which contribute to productive potential. Among the most important are shelter, a relatively wide range of physical and chemical conditions (exemplified in estuaries) and availability of food delivered by tide and currents and produced in a stable and perpetuating ecosystem.

Fish

Salmon, steelhead and cutthroat trout, herring, smelt, sturgeon, shellfish and crabs are all dependent on the quality of British Columbia's foreshore environments for all or portions of their respective life cycles. The magnitude of these fisheries stocks is reflected by the commercial, recreational and native food fish catches. The 1975-1979 average annual commercial and native food fish harvest of salmon, herring, eulachon, crabs and shellfish was approximately 56 500, 73 700, 31, 1 100 and seven tonnes respectively. In addition, the recreational fisheries took an estimated 1.5 to 2.0 million salmon and 1.6 million shellfish in 1979.

Although the life cycles of the five species of Pacific salmon, commonly called sockeye, coho, chinook, chum and pink vary considerably, they have several common characteristics. All species reach maturity in the ocean and return to their "home" streams and lakes in the summer and fall to spawn and die. Steelhead and sea-run cutthroat trout also mature in the ocean and return to spawn in fresh water.

Pink and chum salmon fry which migrate seaward soon after they emerge from the spawning gravel, feed for variable lengths of time in estuarine and nearshore marine environments. Chinook remain to rear in their native stream systems for about three to twelve months before seaward migration. Present information indicates that these races in which the shorter freshwater rearing period predominates, commonly remain in intertidal estuarine and marine nearshore environments for one to five months before assuming a pelagic marine existence. Yearling chinook do not appear to remain in intertidal estuarine areas for extended periods. Coho remain to rear in their native freshwater systems for a full year before migration. The evidence from several major estuary studies indicates that coho yearlings may use estuarine habitats throughout the year. Recoveries of tagged fish have also shown that chinook and coho juveniles occupy estuaries distant from their natal streams. During estuarine residency, juvenile chum, pink, coho and chinook salmon feed extensively and in some instances, exclusively, upon invertebrates and larval fishes which are indigenous to these environments. Most sockeye fry migrate from stream spawning areas to lakes where they remain to rear for one to two years, before migrating to the sea. With minor exceptions, the evidence indicates that juvenile sockeye do not utilize the intertidal estuary or nearshore marine areas following downstream migration.

Mature steelhead and cutthroat may spawn more than once and return to the sea after spawning. The juveniles of these species remain for one to three years in freshwater habitats whereupon they migrate to the ocean. Evidence of spring feeding migrations and juvenile residency indicates that cutthroat are more estuarine-dependent both as juveniles and maturing adults than steelhead.

Smelt and herring migrate on to the shore zone to spawn during the winter and early spring. Major populations of anadromous smelt (eulachon) return from the sea in early spring to spawn in the lower reaches of many of the major rivers of coastal B.C. They deposit their adhesive eggs on the sand and gravel of the river bottom to depths of 8 metres and die. The eggs hatch in a few weeks and the weak-swimming larvae drift passively downstream to the estuaries and ocean.Other smelts migrate to the shore zone to spawn during the winter and early spring. These smelt select intertidal sand and gravel beaches where their eggs are broadcast and become buried by tidal movement. The young apparently move away from the shore zone soon after hatching.

Herring select intertidal and subtidal areas characterized by beds of eelgrass, kelp and fucus upon which their adhesive egg masses cling. The eggs hatch in a few weeks and the young remain in nearshore marine and estuarine environments for variable periods, feeding largely on plankton.

Sturgeon are widely distributed along the coast and ascend the major river systems to feed and spawn. Commercial and sport fishing catches indicate that intertidal riverine habitats are utilized by a wide range of age classes.

Shellfish

Several species of edible clams and related animals are found in the intertidal sands and sediments, common to the bays, estuaries and inlets of the B.C. coast. Their relatively sessile existence and simple reproductive cycle combine to render them highly vulnerable to changes in their environment.

The Pacific oyster grows most productively on lower intertidal flats characterized by small stones, cobbles and shells upon which they are anchored. Their reproductive cycle peaks in later summer and the larvae drift passively in the ocean currents for a short period before actively selecting their individual growing sites.

Crustaceans

Dungeness crabs constitute the major commercial and recreational species in coastal British Columbia. Adult crabs are most abundant on the lower intertidal sand and mud flats and along the delta front and continental shelf commonly to a depth of 90 metres. Spawning takes place in the summer, and the free-swimming, pelagic larvae drift with the ocean currents for several months before changing form and occupying the intertidal and subtidal shore zones characterized by sand, eelgrass and other marine plants to a depth of 10 meters.

Marine Mammals

The extensive array of rocky shores, active beaches, pocket coves, and sheltered bays of British Columbia are biophysical features suitable for a large variety of marine mammals. The major species with nearshore needs include: the harbor seal, sea-lion, killer whale, otter and mink.

Harbor (fur) seals occur along the entire B.C. coast and coastal islands. They frequent water close to shore and are seen in shallow bays and inlets to a far greater extent than other seals. Exposed rocks and sandbars are their favourite haul-out places. Their food is made up entirely of fish and shellfish.

Northern (stellar) sea-lions are frequently found on and around certain rocky islets along the entire B.C. coast - notably Scott Island, Price Island, Cape St. James. In summer, these large rookeries harbor thousands of sea-lions. In winter, sea-lions are often seen in bays, river estuaries, and channels. Their food consists largely of fish. Other species of the same order found in B.C. include the California sea-lion and Northern fur-seal.

The killer whale is the most abundant whale in British Columbia's coastal waters, although the estimated population is less than 300 animals. They commonly inhabit inlets and bays, feeding on a variety of fish and marine mammals. Certain key locations along the coast provide special places for resting, mating and other social activities.

Otters are abundant on the B.C. coast and among the offshore archipelagos. Two species can be found - the river and sea otters. The latter is a less common species and resides solely at sea. Crabs, molluscs, sea-urchins, and fish are the preferred foods of otters.

Mink can often be found among rocks and logs of the coast feeding largely upon marine crustaceans, shellfish and fish.

Birds

The avian component of British Columbia's estuaries and nearshore ecosystems is both varied and abundant. No season of the year on the lower coast is without its regular visiting groups or species. Some arrive in spring to nest, rear young and depart in the fall as other groups arrive to spend the winter. Many are spring, summer or fall migrants and are seen only in passing.

Aquatic birds which frequent protected waters along the British Columbia coast, include divers (loons, grebes, cormorants, alcids), waterfowl (swans, geese and ducks) and gulls. Estuaries and sheltered coastal waters provide essential wintering and staging habitat for large numbers of waterfowl, shorebirds and migrants on the Pacific Flyway.

Use of coastal environments for these activities is highest during the period from October to April.

The habitat requirements of aquatic birds vary from species to species, however, there are some important common characteristics. For example, aquatic birds in British Columbia are generally found on waters of less than 10 metres in depth. Although seasonal and regional differences in the food requirements of most aquatic birds are poorly documented, bottom-dwelling fish and benthic invertebrates are known to be important food items for diving ducks and gulls, while grazers such as brant and geese feed extensively on eelgrass.

The marshbird and shorebird group includes the long-legged, shallow-water waders (herons and bitterns) and the smaller shorebirds (sandpipers, plovers and others). Generally, great blue herons and the smaller shorebirds utilize similar feeding habitat and are found most often on the broad intertidal areas and the wet riparian meadows.

A large songbird group contains many species which are widespread throughout a variety of habitats. These species are difficult to assess in terms of numbers and their use of estuaries. It is unlikely that many species of songbirds visit the exposed intertidal flats, but any areas of emergent vegetation and riparian tree/shrub communities are extensively used.

Raptors require abundant prey species, large open areas for easy hunting, and vegetation for perching, nesting and cover. These species use the upper reaches of the intertidal area, meadows and fields primarily as hunting grounds where prey species are readily available. For example, peregrine falcons, gyrfalcons, goshawks and merlins are attracted by the large numbers of waterfowl and shorebirds. Other hawks and most owls are attracted by the abundant supply of small rodents on the upper fringes of the foreshore and the fields nearby.

Marine Plants

The abundance of animal life in an area largely depends in some complex fashion upon the availability of plant matter to supply nutrients (energy) and to provide shelter and substrate requirements. In nearshore areas the common types of marine plants include seagrasses, seaweeds, and phytoplankton.

Seagrasses and seaweeds are commonly found in shallow coastal waters. Their physical presence often creates a habitat for a large number and variety of marine organisms. Juvenile and adult fish, crustaceans, and molluscs frequently inhabit these areas of plant growth for refuge, spawning, or feeding. Eelgrass, for example, is commonly used as a substrate for the deposition of herring spawn and provides shelter for juvenile fish and crustaceans. Extensive kelp beds and other types of hold-fast seaweeds also create similar habitat needs for other forms of marine life by reducing wave surge and by stabilizing bottom substrates.

Phytoplankton are single-celled algae which provide an essential link in the food chain for many forms of marine life. They, along with seagrasses and seaweeds, produce food energy through photosynthesis and the uptake of dissolved inorganic substances. This energy is the base of food chains and is commonly known as primary productivity.

Research Priorities

The shortfall in knowledge of foreshore ecology has been the subject of research in recent years. These studies have been strongly guided by the types of shore areas most frequently subject to human modification, perceptions of their importance to valuable species, available expertise, and degree of manageability of potential problems. Research has therefore been directed to: (i) determining whether and where sensitive life history stages of important species and their food web components occur in shore zones, (ii) documenting the types of use made of estuaries and shore zones by fish, (iii) identifying the shore zone features essential for use by fish such as food availability, physical, chemical, hydrological, oceanographic, and sedimentary characteristics, as well as vegetational factors, and (iv) investigating the means and opportunities for restoration and development of foreshore and estuarine habitats.

Immediate research priorities currently include: (i) compilation, synthesis and analysis of existing regional data from all sources, (ii) a five year program of specialized work on residency, growth and mortality of important species in selected shore habitats as compared with those forced to utilize alternate habitats; (iii) shore habitat improvements, restoration and development projects, including intensive evaluation; (iv) further investigation of the role of shore vegetation and other nutrient inputs in supporting resource species and food web components in nearshore areas; and (v) development of methods for assessing impacts of the cumulative effects of incremental shoreline degradation on fisheries yields. Added to these basic research priorities is the need for information on direct and indirect relationships among habitat productivity, resource population levels and various types of influences on these habitats and populations.

D. LOG HANDLING AND TRANSPORTATION

The forest industry has developed on the coast of British Columbia over the past one hundred and twenty years. During this period the annual harvest has reached 31 million cubic metres of logs, a level which is expected to be maintained into the future. Conversion plants were developed in areas that had favorable climates, flat land, access to timber supplies, continental rail links and deep-sea terminals. Consequently, there is a heavy concentration of mills on the lower mainland coast and southern Vancouver Island. Harvest areas which initially were close to the mills now extend along the entire mainland coast and over most of Vancouver Island as well as to the Queen Charlotte Islands and numerous smaller islands. These supply areas are separated from milling centers by a mountainous, fjord-dissected coast and open water, which severely limits land transportation. Water log handling and transportation is therefore the vital link between the harvesting areas and the consuming mills.

Log Production and Consumption

The pattern of coastal log production and consumption is stabilizing and there are predictable trends. Table I shows these patterns and trends. Log production is expected to increase on the north coast, Queen Charlotte Islands and west coast of Vancouver Island. This increased production will be offset by declines in the southern areas of the coast resulting in little or no increase in production in the foreseeable future. Log consumption will remain relatively stable and 68 percent or more of the harvest will be consumed in the southern Vancouver Island, Howe Sound and Fraser River areas. As a result of these patterns, the dependency of the coastal forest industry on the coastal waterways will continue.

Foreshore Leases

Historically, log handling activities have been carried out on foreshore areas under lease from the provincial government and various harbor commissions. These activities continue today and are still performed on foreshore lease areas. Due to competing demands from other uses, the forest industry is facing pressure in finding and retaining suitable foreshore areas for efficient and economic operations. As the forest industry is

Table 1

Log Production and Consumption by Area
Coastal British Columbia, 1979

	Production		Consumption	
	Current (percent)	Trend	Current (percent)	Trend
North Coast & Queen Charlotte Islands	15	Up	5	Level
West Coast Vancouver Island	15	Up	7	Level
Northeast Vancouver Island and Mainland	37	Down	9	Level
Alberni	10	Level	11	Level
Southern Vancouver Island	15	Down	29	Up
Howe Sound, Fraser River	8	Down	39	Level
TOTAL	100		100	

(Based on an annual volume of 31 million m^3 of logs)

SOURCE: After Boyd, Kenneth G., Water Transport of Wood: B.C. Coast.

forced to vacate areas historically used for log handling, pressure for leases in alternate areas is increasing.

The forest industry's present and future foreshore lease requirements are summarized, with reference to Figure 1 and Table 2. Based on this information, log handling uses of the foreshore occupy 8957 hectares, of which 2260 hectares are primarily marine intertidal, 1119 hectares are estuarine and 1200 are riverine. While these areas are relatively small compared to the total coastal area in each category, a high concentration of these leases occur on southeastern Vancouver Island and in the Howe Sound/Fraser River area. It is estimated that existing leases will decline by 1181 hectares or 13 percent by the year 2000. As new logging areas are developed an estimated 3030 hectares of new foreshore leases will be required. The changes result in a net increase of 1849 hectares of foreshore leases by the year 2000.

Based on these projections the greatest lease area expansion will occur on the northwest coast of Vancouver Island (Region 11) and the north mainland coast. A net

Table 2

Present and Projected Foreshore Lease Requirements for Coastal British Columbia, 1979

Region (See figure 1)	Present Leases: No. of Leases	Volumes Dumped/yr. (1000 m^3)	1979 Lease Area (ha)	Projected Lease Area to Year 2000 (ha): Retained Lease Area	Additional New Lease Areas	Total Lease Area	Net Change
1	18	851	135	135	18	153	18
2	151	1815	760	716	94	810	50
3	20	5	107	107	24	131	24
4	145	123	474	446	66	512	38
5	75	2107	851	660	156	816	(35)
6	32	1198	167	162	19	181	14
7	52	2797	813	762	26	788	(25)
8	64	3321	1076	1051	265	1316	240
9	19	1476	359	312	32	344	(15)
10	21	4070	293	275	36	311	18
11	109	5560	1454	1330	576	1906	452
12	94	4740	999	831	329	1160	161
13	63	3186	335	168	502	670	335
14	5	433	38	29	113	142	104
15	8	593	162	48	150	198	36
16	37	1430	481	397	420	817	336
17	30	2879	453	347	204	551	98
TOTAL	943	36584	8957	7776	3030	10806	1849

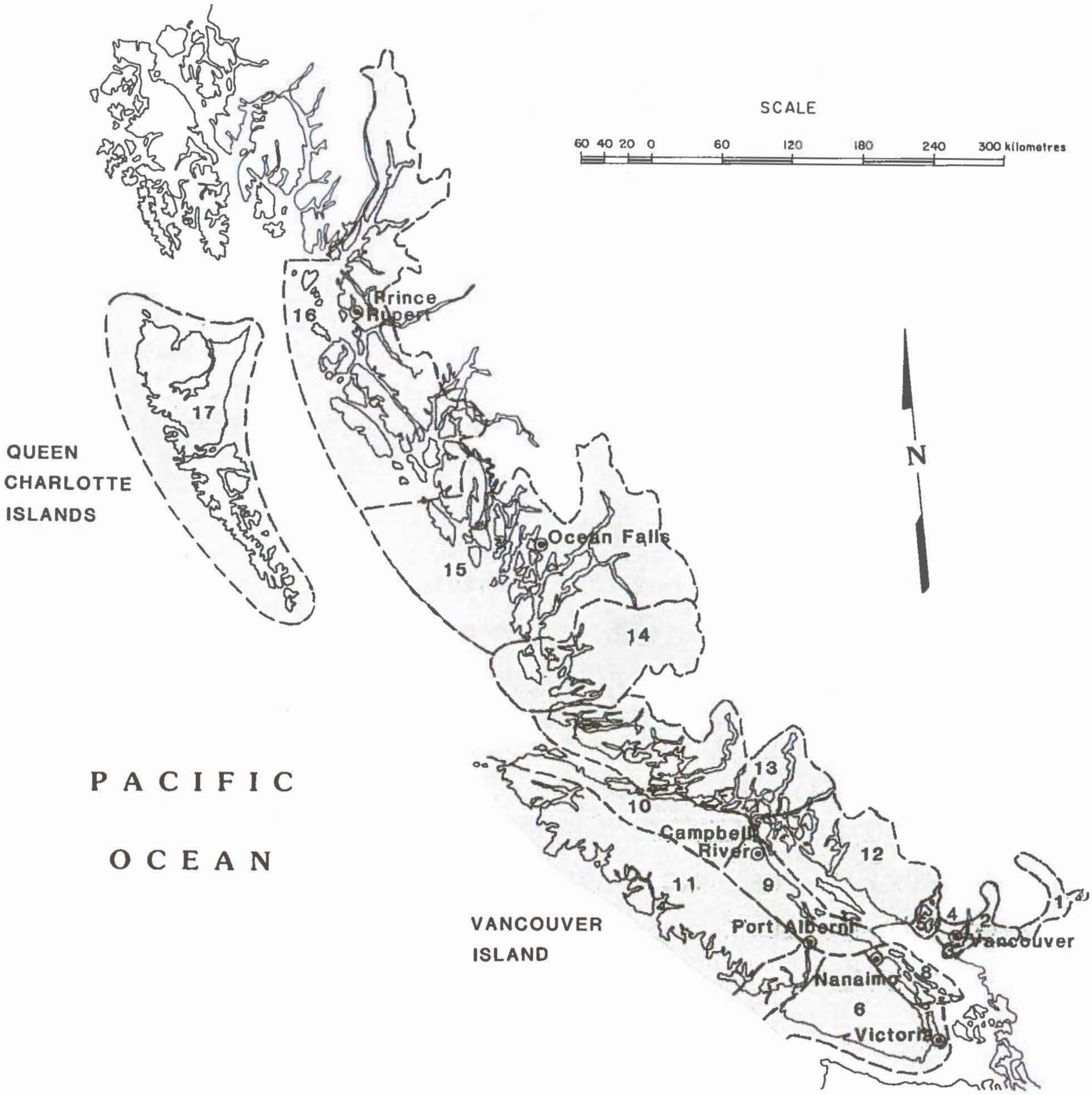
SOURCE: After F.E.R.I.C., 1980 - Compilation and Summary of the Results of the COFI Questionnaires on Logging Use of Foreshore Leases on the Coast of British Columbia.

NOTE: A questionnaire Survey responded to by 187 companies which hold 85% of all coastal foreshore and water lot leases issued for log handling activities.

increase of 495 hectares is expected to occur in the south mainland coast and southern Vancouver Island areas (Regions 1 to 6, 8, 9, 12, in Figure 1) where the conflicting pressures for foreshore use are most acute.

These changes in foreshore lease requirements are based on current log handling technology, and do not reflect the level of activity on leases which varies considerably from continuous use to no use for periods of several years. The point is that lease area requirements are not static. For example variations will result from seasonal operations, intermittent operations and the start-up of new areas of activity. Leases are not necessarily in continuous use at all times. While some existing leases may be abandoned

Figure 1: Regions Used in the FERIC Study of Foreshore Leases



the spreading out of operations may result in a net overall increase in foreshore lease requirements. The statistics presented in Table 2 reflect voluntary reductions in existing leases, rather than any forced reduction in leases caused by pressure from other resource users.

Dumping

Logs are transferred from the land to water in various ways including lift-and-lower, marine rail, log skid and mobile loader systems. Of the total volume 69% is dumped in bundled form. All log dump sites reported in the survey occupy slightly over 200 hectares of water on the entire B.C. coast, which represents about 2.3 percent of the total area of all log handling and storage lease areas. About 46 percent of the coastal log volume is currently dumped by some form of fully controlled system such as a lift-and-lower or marine rail system, whereas 47 percent of the coastal log volume still enters the water by some form of skid system although use of this latter system is declining. Helicopter dumping and other free fall systems account for the remaining seven percent.

Sorting

Logs are sorted by grade, species and size either on land or in water. The amount of sorting completed near a dump depends on the size of the operation. Large volumes of logs are needed to sustain an economic sorting operation, thus logs from smaller operations may first be transported to central sorting grounds. Sorting in water commonly involves pushing logs or bundles into a pocket with a log dozer. Other systems such as floating sort stations have been introduced.

When sorting on land, front-end loaders, log stackers and cranes separate the logs into the various sort categories. Despite greater cost, over 60 percent of the coastal log volume is now being sorted on land. This percentage is increasing, but a lack of available, suitable land areas at most existing concentrations of log handling activity limits opportunities to introduce dryland sorting operations, particularly in the more urbanized areas of southern Vancouver Island and the lower mainland. Topographic constraints in other areas will also require the continuation of water sorting.

Storage

About 65 percent of all water lease areas used by the coastal forest industry are for log storage. Although the industry is attempting to minimize all log inventories for economic reasons, watered inventories remain large and vary from 5 to 8 million cubic metres. These volumes are required to: balance seasonal logging patterns with constant mill consumption; store species or grades that are temporarily surplus because of market conditions; provide in-transit and safety stock so that consuming mills can operate without interruption; and facilitate open market log sales or trading activities.

Water storage requires sheltered water to minimize buffeting and damage to booms. Deep sheltered water as close as possible to converting plants is preferred by most companies within the industry. Low salinity storage areas are required for long term storage to minimize losses resulting from wood-boring teredos and crustaceans. In many instances shallow and medium depth estuaries are the only areas that are sheltered, have low salinity and are adjacent to existing mills.

Land storage is not a practical solution for most mills located on the coast of British Columbia. Often there is insufficient land area adjacent to the mill for storage. If land is available it is extremely expensive on the southern coast. Moreover, there are larger capital costs associated with high density log storage equipment and the majority of existing mills are designed to receive logs from the water.

Transportation

There are three principal methods of moving logs along the coast: flat rafts, bundle booms and log barges. Logs may be made into flat rafts or bundle booms to transport camp-run logs to sorting grounds and to take sorted logs to conversion plants. Bundle booms are generally constructed for tows of 40 km or longer while flat rafts are used for shorter distances in sheltered waters. Bundle booms have become the dominant method of transport primarily for three reasons: tow volumes may be doubled; they prevent logs from escaping or sinking; and they require less storage area. Log barges, which require major capital investments, are usually used to haul large volumes from isolated camps through unprotected waters. Logs are usually loaded by on-board cranes, with logs either loose or bundled. Bundles are preferred to reduce loading time and to minimize log sinkage and breakage. Loading and unloading normally takes place in sheltered waters near storage sites.

E. INTERACTION BETWEEN LOG HANDLING AND TRANSPORTATION AND THE ENVIRONMENT

Coastal waters link most of the existing mills with harvest areas located on the rugged coast and islands of British Columbia. Log handling is critically dependent upon sheltered areas with adequate water depths, sufficient surface areas, minimal tidal currents, low salinity water and access to deep water. As such, the coastal industry must retain most of its existing leases and acquire new leases in developing areas in order to remain competitive in world markets. Yet, these lease areas involve the tidal reaches of rivers, estuaries, wetlands, intertidal zones and coastal zones - virtually all of which are highly productive environments. They support commercially and recreationally important aquatic resources and provide a vital component for restoration and enhancement of many species.

Log handling operations can effectively take environmental considerations into account both in design and operation. The coastal forest industry has developed and is implementing a number of procedures which reduce the impact of their operations on the environment. However, there is a wide range of other factors that have an impact on the nearshore environment. It is generally recognized that over exploitation, urban and industrial effluent, and foreshore development are but a few of the factors that can lead to degradation of the aquatic environment and its related productivity.

Impacts

The most profound environmental impacts of log handling are associated with dumping, sorting and storage, especially when these activities occur in intertidal areas or shallow water. Log dumping results in the introduction of bark and wood debris which can accumulate and physically smother marine organisms and their habitats. The decomposition of accumulated bark and wood releases wood leachate which reacts with the available oxygen further impairing the natural productivity of the environment. The effect of the toxic wood leachates produced under certain conditions in aquatic environments has not been completely documented. The extent and degree of these chemical impacts varies with flushing. Where these log handling activities occur in shallow waters and intertidal areas, marine plant and animal communities may be affected by shading or physical disruption. In some cases, the damage may be irreparable and in others there may be opportunities for restoration depending on the degree of damage and the sensitivity and recoverability of the environments affected.

The degree of impact on benthic and intertidal invertebrates is largely determined by the size of the log handling operation, the handling methods used, the location with respect to sensitive areas, and the ecological, commercial, and recreational importance of affected resources. The most significant adverse impacts of log handling activities on marine benthic invertebrates are the destruction of habitat, and the alteration of benthic infauna habitat and abundance due to wood bark and debris.

Some benthic invertebrate species are beneficially affected by log handling activities. These are primarily epibenthic organisms (wood boring bivalves, isopods, barnacles, tunicates, shrimp). Some of these invertebrates are important fish food organisms. However the creation of habitat for wood boring invertebrates has an adverse affect on the forest industry.

The loss of shallow water and intertidal habitats that are utilized by fish and shellfish is documented. Little quantitative information is available concerning the effects of these losses on rearing juvenile salmonids, herring and other species.

Effects of log handling on shellfish are substantial. Oysters, clams, geoducks and other shellfish are susceptible to bark and debris from log dumping, storage and retrieval sites. Mariculture industries are also subject to significant physical disruption from log handling operations, especially in the intertidal zone.

The impacts of log handling on marine mammals generally are considered minor. Some positive impacts include provision of haul-out areas for otters, seals, and sea-lions. Adverse impacts can stem from changes in the abundance and types of food organisms and from human disturbances. There appear to be no data deficiencies considered serious enough to hamper the assessment of impacts of log handling on marine mammals, with the exception of killer whales where little is known about interrelationships.

The major adverse impacts of log handling on birds stem from localized disturbances associated with human activity, habitat alteration (or alienation) and changes in prey availability. Site specific impacts of log handling on aquatic birds can be very significant - especially if the areas affected are high quality habitat and/or scarce in the region. These potential conflicts between log storage and bird use in estuaries are poorly understood which seriously limits impact assessment. In some situations, positive impacts occur where coastal shores "littered" with debris from log handling and transport losses are resting areas for birds.

The water transportation of logs does not create environmental problems directly. However log losses during transportation contribute to the debris problem. These losses are being reduced through increased use of bundled booms and barges.

Industry Trends and Considerations

Historically, access to a timber supply and suitable shore characteristics were the primary criteria used in determining the location of log handling facilities. As environmental factors were not then perceived to be as important as they are today, they were seldom considered in the design and operation of the facilities. Consequently, these operations often created the environmental impacts noted in the previous section.

In recent years the industry has increased the use of dryland sorts, controlled dumps, deep water sorting and storage, and bundled booms. All of these innovations reduce the amount of bark and debris that can accumulate and consequently the physical and chemical effects associated with their accumulations. In addition, bundling decreases log losses and the surface area required for storage. Even with these changes there remain older facilities which create problems.

Most of the forest companies are establishing dryland sorting facilities at their camps as well as central dryland sorts. These operations decrease the total area required for sorting large volumes of logs and retain the debris on the land. Further, with the trend to bundled booms, companies can store more logs in deeper water. These trends will continue to alleviate environmental disruption.

Even though the industry is becoming more environmentally conscious there are still some trade-off issues that need to be addressed. The industry will continue to rely upon the use of foreshore areas and sheltered waters. Decisions to realize environmental benefits through reducing the size and number of foreshore leases must recognize the associated economic costs. These reductions affect harvesting patterns, operating costs and employment opportunities throughout the industry and within individual companies.

In reviewing any impact on industry, the implications related to both alternative operating methods and locations must also be assessed. In many cases the forest industry does not have feasible alternate sites available. Also, a decision on a specific area can significantly affect the total log flow pattern. For example, insufficient area for storage of the required inventory means that additional storage must be found or that log volume shipped to that mill must be reduced or stored at the point of origin. Due to the complexity of the log flow system between timber supply areas and converting facilities, decisions regarding log handling facilities cannot be made without recognition of the entire system.

In the past, log handling facilities were considered solely in relation to harvesting of old growth timber. It has been the practise to retain a foreshore lease only for the time harvesting takes place. Consideration must be given to the concept of maintaining foreshore areas over a rotation period. Foreshore areas may be required intermittently after initial logging is completed. Intensive forest management activities such as commercial thinning may require log handling facilities. Also, the second and subsequent harvests will, in all probability, require some form of foreshore use. Due to long periods of inactivity, other uses may be considered at these sites when not in use by the forest industry.

Even though the relationships between log handling and transportation and the environment have been generally defined the Committee considers it too simplistic to take a position that the forest industry must avoid or remove its operations from all sensitive areas. As mentioned earlier, the industry is dependent on areas where it has the potential to reduce environmental values. Furthermore, there are projections for increases in the forest industry's need for sheltered waters and shore areas. Thus, even though increased industry attention is being given to move to deep water and to apply new technology to present and future operations, limits will be reached and a balancing of benefits from various uses will be required to allocate shore areas.

This situation of conflicting dependencies and adverse relationships requires that the industry continue to develop technologies and adjust operational procedures both on a coast wide, coordinated industry basis and on a site specific basis, to reduce the environmental impact of activities. At the same time other users must adopt an attitude that recognizes the forest industry's dependence upon coastal log handling and transportation. This challenge is addressed in the concluding sections of this report.

APPENDIX III

Sections 60.02 - 60.20 & 60.238 - 60.262 from "Industrial Health and Safety Regulations", Workers' Compensation Board of British Columbia, July, 1980.

SECTION 60

LOGGING

General Requirements

Planning

60.02. The management of every logging operation shall plan and conduct such operations in a manner consistent with these regulations and with recognized safe working practices.

Working alone

60.04. As required by regulations 8.32 and 60.22 a checking system shall be instituted for all workers who are employed under conditions where they might not be able to secure assistance in case of injury.

Weather conditions

60.06. When weather conditions create hazards to workers such additional precautions shall be taken as are necessary for the safe conduct of the work.

Use and maintenance of hand tools

60.08. (1) All tools shall be kept in good condition, restricted to the use for which they are intended, and used only by those workers who have been instructed in their use.

(2) Wooden handles shall be securely attached to the tools, and shall be of firm, straight-grained, hardwood handle-stock or material of equivalent strength. Tools with defective handles shall be immediately removed from service.

(3) Mushroomed, split, or crystallized iron wedges, chisels, punches, hammers and similar equipment shall be immediately removed from service.

High visibility safety headgear

60.10. Safety headgear worn by all fallers, rigging and loading crew members shall be of a highly visible colour and shall otherwise conform to the requirements of regulation 14.12.

Firearms discharge in logging areas

60.12. The discharge of firearms at, from, or over any active logging area by persons coming within the scope of these regulations is prohibited.

Removal of potential hazards

60.14. (1) Trees, snags and saplings, within reach of landings, spars, logging machines and guy-lines, shall be felled before yarding operations commence.

(2) All trees, snags and saplings, which are hazardous to

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workmen and within reach of camp, shop, or other work areas, shall be felled.

Exception

(3) Where compliance with clauses (1) and (2) is impracticable, alternative work methods or procedures may be used, but shall be directed by a supervisor who has controlled the hazards to which any worker is exposed.

Metal in saw logs

60.16. (1) Spikes, drift bolts, nails, or other metal shall not be left in any recoverable log.

Removal of rigging spikes

(2) Spikes, used for temporary fastening or rigging, shall be removed before the rigging is used.

(3) When a spike, nail, or similar metal fitting is used to secure a swifter line to a bundled boom, a mark shall be made on the end of the log into which the metal is driven, to indicate the location of the metal fitting.

Standing in the bight

60.18. (1) Whenever possible, no worker shall remain within the bight of any running line under tension, nor in a position where he could be struck by a line were it to break or come loose.

Riding on equipment restrictions

(2) No worker shall ride on any mobile equipment, except where adequate and properly protected seats, or other safe facilities have been provided, as specified by regulation 26.34.

Aircraft operations

60.20. All forestry aircraft operations shall be conducted in accordance with the relevant requirements of Section 33 and in compliance with the relevant regulations of the Department of Transport (Canada).

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Night Operations—Illumination

General requirements

60.238. (1) Where logging and related operations are conducted during the hours of darkness, the area shall be provided with illumination which will allow workers to safely perform their duties. The sources of illumination shall be located and directed so as to create a minimum of shadows and glare. The lighting requirements specified by regulation 13.85 apply.

Yarding and skidding sites

(2) At log yarding and log skidding sites, all standing saplings shall be illuminated to their full height. Removal of potential hazards, occasioned by trees, snags and saplings, shall be effected before yarding operations commence, as required by regulation 60.14.

Requirements in poorly lighted areas

(3) Where in the opinion of the Board, it is proven impracticable to provide illumination by other means, local sources of illumination such as headlamps of types acceptable to the Board, shall be worn by all workers required to work in areas where the light intensity is less than 2 foot candles (21.5lux).

Mobile equipment lighting

(4) Mobile equipment shall be provided with lighting facilities as required by regulation 26.04.

Water and Dry Land Log Dumps and Storage

Weigh scale curbs

60.240. (1) All elevated truck weigh scales and associated elevated ramp approaches shall be fitted with substantial bull rails meeting the requirements of regulation 60.228.

House clearance

(2) Weight recording house structures, forming part of a log transporter weigh scale unit, shall be sufficiently offset from the scale balance platform as to provide an adequate margin for log load clearance.

Alternative

(3) As an alternative to the foregoing requirement, an effective barrier may be erected between the weigh scale deck and the house.

Log storage area requirements

60.242. (1) Log storage and sorting on land areas shall be constructed, arranged, maintained, and operated so that workers may work in the clear of moving logs, machines and equipment.

(2) Such areas shall be located on stable and relatively level ground and shall be adequately illuminated in areas where workers are required to work during hours of darkness or other conditions of inadequate illumination, as required by regulation 13.85.

Unloading precautions

60.244. Before binders are released and stakes are tripped on log transporters, logs shall be restrained from rolling off the vehicle as required by regulation 60.220.

Dust control

60.245. (1) An effective method shall be used to control the generation of dust at dry land dumps, sorting, or storage areas.

Dust respiratory protection

(2) When dust, created by vehicular movements at dry land dumps, sorting or storage areas, cannot be effectively controlled, appropriate respiratory protective equipment shall be provided for and worn by operators of mobile equipment, as required by regulation 14.23.

High visibility apparel required

60.246. Jackets or vests of fluorescent red or other high visibility colour shall be worn by all workers who are exposed to the danger of moving vehicles while working on or travelling through log dumps or dry land dumps, sorting, or storage grounds, as required by regulation 14.06.

Unauthorized vehicular or foot traffic

60.248. Unauthorized vehicular or foot traffic shall not be permitted in dry land sorting or storage areas.

Unattended log loader machines

60.250. Lift forks, grapples and arms of mobile log loading macnines shall be lowered to their lowest position and all equipment brakes set, prior to the operator leaving his machine unattended, as required by regulation 26.38.

Moving unloaders with elevated loads

60.252. Log unloader machines shall not be moved with loads lifted higher than necessary to provide unobstructed vision for the operators.

Log dump deck and surface maintenance

60.254. All deck structures, plankways and road or other surfaces of log dumps shall be kept in good repair and free from bark and other debris.

Dump road requirements

60.256. Roads at log dumps shall be sufficiently wide, level and firm, to ensure safe operation of equipment.

Log storage deck height

60.258. Log decks in yards shall not be built to a height greater than that which can be safely handled by the equipment used in stacking and breaking down operations.

Boomboat Operations

Definitions

60.260. (1) (a) For the purpose of these regulations the following definitions apply:

"boomboat"—any boat used to push or pull logs, booms, bundles or bags, in booming ground operations.

"dozer"—a boomboat usually between 14 and 20 feet (4.3 and 6.1m) in length, which pushes logs or bundles of logs in a generally forward direction relative to its fore and aft line.

"sidewinder"—a boomboat, usually between 14 and 20 feet (4.3 and 6.1m) in length, which has the ability to push logs or bundles of logs in any direction relative to its fore and aft line.

"boomscooter"—a small boomboat, usually less than 14 feet (4.3m) in length, equipped with an outboard motor, having directional pushing capabilities similar to a sidewinder.

"tug"—a boat, usually over 20 feet (6.1m) in length, used primarily to pull barges, booms of logs or bags of debris.

Conformity with "Canada Shipping Act"

(b) All small marine craft, employed in operations in and about booming areas, shall be designed, equipped, licensed and operated in accordance with the applicable requirements of the "Canada Shipping Act" and regulations pursuant thereto.

Maintenance

(2) (a) Marine craft shall be maintained in good mechanical and fully seaworthy condition.

Inspection and repair

(b) Marine craft shall be inspected before initial operation daily and thereafter as required. Defects shall be reported immediately in writing to the supervisor and

those which affect the safe operation of the craft shall be remedied before the craft is put to use.

Anti-skid decking

(3) Craft used by workers wearing calked boots shall be fitted with deck matting or covering having anti-skid properties. Such covering shall be maintained in good condition.

Machinery guarding

(4) Machinery shall be effectively guarded in accordance with the requirements of Section 16.

Exhaust stack guarding

(5) Hot exhaust pipes or stacks shall be equipped with effective guards or insulation to prevent injury to workers.

Towline guarding

(6) Operators of boomboats, regularly required to pull logs, booms or barges, shall be protected from injury, resulting from towline breakage, by means of suitable cabins, screens or guards.

Guarding against intrusion by logs or limbs

(7) Operators, subject to injury from intrusion of logs or limbs into the control area, shall be protected by means of suitable cabins, screens, or guards. The means of protection shall be in conformity with W.C.B. Standard G 606 "Boomboat Operator Protective Structures".

Noise protection

(8) Noise emanating from engines and machinery shall be suppressed, where practicable, to levels not harmful to workers. Where safe noise levels cannot be achieved, the exposed workers shall wear hearing protective devices, in accordance with regulations 13.21 through 13.35.

Navigation lights

(9) (a) Craft operated in navigable waters during the period from sunset to sunrise, or in conditions of restricted visibility, shall display navigation lights as required by the "Canada Shipping Act" and regulations pursuant thereto.

Deck and cabin lighting

(b) Deck and cabin lighting shall be provided and used where necessary to provide safe levels of illumination aboard the craft.

Searchlights

(c) Searchlights or floodlights shall be provided and used where necessary to facilitate safe navigation and to illuminate working or boarding areas adjacent to the craft.

Boomboat steering gear requirements

(10) All boomboats equipped with mechanical steering systems, which could cause hazards to the operator through feed-back of rudder reaction, shall be fitted with suitable hydraulic or other steering systems which will not transmit feed-back forces.

Transportation of workers

60.262. (1) Transportation of workers by marine craft shall be in conformity with the requirements of Section 28.

Buoyancy equipment

(2) Buoyancy equipment shall be worn by all workers aboard boomboats, as required by regulation 14.22.

Calked footwear

(3) Calked footwear shall be worn by all boatmen and passengers who are required to walk on logs or booms, as required by regulation 14.10.

Towing limitations

(4) Boomboats shall not be employed to tow booms or barges, which, by reason of weight, wind, current or sea conditions, are beyond the capacity of the towing craft to safely tow or control.

Wind and sea conditions

(5) Boomboats, designed for use in still waters, shall not be operated in conditions of wind or sea which affect their safe operation.

Overloading

(6) Boomboats shall not be loaded with personnel or equipment so as to adversely affect stability or seaworthiness.

Code of hand signals

(7) Where movements of boomboats are regulated by hand signals, the code of signals authorized by the Board (Appendix "I") shall be followed.

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