An Examination of Oriented Strandboard and Medium Density Fibreboard Production in British Columbia

Working Paper

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Canada

BC

An Examination of Oriented Strandboard and Medium Density Fibreboard Production in British Columbia

by

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1.0 INTRODUCTION

Within the wood products industry, panelboards represent a growing segment, and there is a developing interest to establish plants in British Columbia. There are currently five board plants operating in B.C.: three particleboard, one oriented strandboard (OSB) and one hardboard. There is substantial raw material available for additional panelboard plants in B.C., and with growing timber and fibre supply shortages of all types in other producing regions, B.C. is becoming an attractive prospective location.

The Opportunity Identification Program of FRDA II, as part of its objectives to facilitate development of the forest industry, requested the preparation of a broad overview of the feasibility of producing OSB and medium density fibreboard (MDF) in B.C. For each product, three specific regions were assessed.

OSB	MDF
Northwest B.C.	Northwest B.C.
Northeast B.C.	Lower Mainland
Vancouver Island	Vancouver Island

The study assembles basic cost data, capital and operating, as well as price projections, and financial returns. The financial returns are calculated for a single year at full sales volume and are meant to provide a simple comparison only. Wood supply and costs as well as transportation costs of products are evaluated for each region and product and any limitations to development are identified.

Due to the broad nature of the analysis, the various elements of the report were taken mostly from previous work with some checking of various elements where information was lacking. As such, it is not contended that the data is absolutely correct but that it is within a satisfactory range for determining which situations warrant further analysis.

2.0 SUMMARY

The results of the study indicate that there is a viable opportunity for establishing both an OSB and a MDF plant in B.C. The highlights are summarized here for each product.

ORIENTED STRANDBOARD

The best location for OSB is the Northeast where there is a supply of aspen at competitive costs. In the Northwest, the available log supply for an OSB plant is too expensive due to the more rugged terrain and/or of a predominant species (hemlock) which in lab trials has dimensional stability problems. For Vancouver Island, the cost of suitable logs appears to be too high and transportation off the Island in normal quantities is also very high. Further analysis of transportation opportunities may negate this apparent problem.

Only one plant size with an output of 300 MMSF 3/8" per year was evaluated as this is the norm in the industry and anything smaller would not be cost competitive. A larger plant could be proposed but subject to finding enough wood. The wood requirements of the OSB plant are 500,000 cubic meters per year.

Capital costs are estimated at $82,000,000 and manufacturing costs at $113 to $130/MSF (3/8" basis) depending on wood costs. Based on the projected mill net prices, after-tax cash flow returns are as follows:

Northwest	9% - 20%
Northeast	12% - 25%
Vancouver Island	10% - 22%

MEDIUM DENSITY FIBREBOARD

For MDF it has been assumed that the raw material would be 100% sawdust and shavings. This is a divergence from conventional wisdom, however, the Panfibre plant in Quebec manufactures a very high quality product from 70% sawdust and is moving to 100% sawdust after modification of some feed bins. As a result, the returns on MDF are higher than other projections may indicate.

The analysis considered two plant sizes, 60 MMSF 3/4" and 120 MMSF 3/4". The smaller size is similar to the two plants currently operating in Canada, and the large plant is just larger than the most competitive American plants. Wood requirements in sawdust and shavings for the plants are 95,000 bone dry metric tonnes (238,000 m^3 solid wood equivalent) and 190,000 bone dry metric tonnes (475,000 m^3 solid wood equivalent) respectively.

Capital costs are $54,000,000 for the small plant and $80,000,00 for the large plant. Operating costs range from $249 to $261/MSF 3/4" for the small plant and $220 to $231/MSF 3/4" for the large plant. This is against a projected mill net price of $372 to $455/MSF 3/4". After-tax return for the plants are as follows:

	NORTHWEST	LOWER MAINLAND	VANCOUVER ISLAND
Plant A - 60 MMSF 3/4"/Yr			
@ Low Price	12%	13%	13%
@ Average Price	14%	16%	15%
Plant B - 120 MMSF 3/4"/Yr			
@ Low Price	16%	19%	18%
@ Average Price	19%	22%	21%

3.0 ORIENTED STRANDBOARD (OSB)

3.1 PRODUCT DESCRIPTION

Oriented Strandboard (OSB) is a reconstituted panel product used in structural applications as a replacement for sheathing grade plywood. The most common applications are for wall and roof sheathing and floor decking in wood frame construction. Other applications include crating & packaging, web material for wood I-beams, siding, and other specialty products.

OSB panels are graded and rated by various agencies (American Plywood Association in the U.S. and Canadian Standards Association in Canada) and approved for use according to rating by building codes.

Panels are available in thicknesses from 1/4" to 1-1/4" and in sizes up to 8 ft. by 24 ft. The most common size is still the 4 ft. by 8 ft. format used in wood frame construction, but the availability of OSB in much larger sizes is beneficial in uses such as factory housing, mobile home construction and crating where crane assistance is available. The most common thickness is 7/16" which serves the large volume use in wall and roof sheathing.

Another product similar to OSB is waferboard. The two products are similar in all aspects except in waferboard, the individual wood wafers are randomly formed, resulting in equal properties in all directions. The orienting of wood flakes to achieve a plywood type lamination of parallel and cross grain layers resulted in higher strength properties in the length direction to achieve performance equal to plywood. The mechanical method of orientation requires that flakes have a length to width ratio of 3:1 or more. These longer flakes are called strands.

3.2 OSB MANUFACTURING PROCESS

The manufacture of OSB can be broken down into the following six functional areas:

a) Log storage and Conditioning
b) Debarking and Flaking
c) Drying, Screening, and Blending
d) Forming and Pressing
e) Sawing and Finishing
f) Energy Generation and Fuel Handling

LOG STORAGE AND CONDITIONING

It should first be stated that the raw material input to an OSB plant is whole logs or roundwood. Typical sawmill residues are not acceptable as the size is too small. Some experimentation with slabs and edgings has been done with this material which has shown it to be hard to handle with poor results on strand quality.

The receiving, storage, and reclaim of logs is typical of any roundwood operation such as a sawmill or pulp mill. Depending on location and logging practices, wood is received either as tree length logs or 100 inch cordwood.

Variations in log processing arise from two factors, climate and log form received. In cold climate locations, frozen logs must be thawed in conditioning ponds to improve strand quality and yield. Some southern plants installed conditioning ponds to improve strand quality, but most have chosen to eliminate this operation to reduce costs, judging that any quality improvements are not significant.

Plants which receive tree length wood must incorporate slashing operations to generate 100 inch wood suitable for standard width ponds. Where conditioning ponds are not used, it would be possible to process tree length logs through debarking and flaking but is generally preferred to handle 100 inch logs.

Tree length slashing operations create short pieces which are best removed from the process as they do not flake well but rather tend to turn into "fines" instead of strands. These short pieces are hogged and used for fuel.

DEBARKING AND FLAKING

Conditioning can be done in a single set of ponds in which case debarking follows conditioning to optimize bark removal. Alternatively, a two pond system can be used. The first pond is relatively short and is designed to thaw the bark layer only. Debarking follows the pre-thaw pond then the log is put through a second pond to thaw the wood. With the bark removed, the log is better conditioned right to the core, resulting in improved yield of acceptable strands.

Ring debarkers are common in northern plants where thawing is required for effective bark removal. Drum type debarkers have been installed in some southern plants.

After debarking and conditioning (if required) logs are ready for flaking or waferizing. Early flakers could only process logs up to four feet long or 34 inches for some equipment. This required a second slashing operation. The newer flakers, called long log flakers, do not require secondary slashing and have resulted in capital and operating cost savings.

Flakers are either of the drum or disc type. Knives are fixed to the drum or disc surface and the log presented to the moving knives with grain parallel to the knives. Strands are typically three to four inches long, 1/2-1 inch wide, and 27 thousandths inch thick. Flaker knives are regularly changed (every 8 to 16 hours) to maintain strand quality and minimize the production of "fines". Fines are small pieces which are removed after drying in order to improve strength properties. Fines generation detracts from overall wood yield so it is important to minimize them and find ways to utilize them in the board without detracting from board properties.

From the flakers, strands are conveyed to large wet strand storage bins which hold an hour's worth of downstream strand demand. This surge capacity allows for flaker knife changes and downtime on log handling equipment which is prone to maintenance. The bins also serve to evenly meter strands to the dryers.

DRYING, SCREENING, AND BLENDING

Flakes are dried in rotating drum dryers with internal passages that direct strands to travel the drum length three times. Some manufacturers offer single pass dryers. Drum dryers are typically 40 to 60 feet long and 10 to 13 feet in diameter.

The drying medium is hot combustion gases created by burning wood fuel generated at various stages in the process. An induced draft fan draws the hot gases through the dryer which also serves to move the strands. Primary separation of gases from the wood is done in cyclones, and secondary air cleaning devices such as wet electrostatic precipitators or electrified gravel filter beds are use to clean the air stream before discharge to atmosphere.

Dryers operate with inlet temperatures between 800 and 1600°F which is above the char point of wood. Consequently, there is a constant risk of fire, and when fires or sparks do occur, the material is rejected from the process to a dump area.

Dried strands are conveyed to screens where the "fines" are separated from the accept strands and transported to the thermal energy system for use as fuel.

Accept strands are delivered to dry strand storage bins which are identical to the wet strand bins. The dry bins evenly meter strands across weigh scales to the blenders which are large rotating drum tumblers, 20 to 30 feet long and 8 to 12 feet in diameter.

Phenol formaldehyde resin is introduced into the drum either as a dry powder or liquid. Powder resin is simply blown into the drum and tumbled with the strands. Dosage rates for powder resin is around 2% to 2.5% based on dry wood weight. Liquid resin is pumped to spinning discs in the center of the drum that create a fine mist through which the strands tumble. Liquid resin is added at a rate of about 3.5% to 4% of dry wood weight.

Some plants use isocyanate resins which cure faster and at lower temperatures than phenolic resin. Many plants cannot take advantage of the shorter cure times due to other limitations and do not want to undertake its special handling requirements.

Resinated strands are conveyed to the forming and pressing line.

FORMING AND PRESSING

Construction of an OSB panel requires at least three forming stations: one for the cross oriented core layer and two more for the top and bottom length oriented face layers. A forming station consists of a metering section and an orienting section. The metering section delivers strands evenly distributed across the width of the panel and constant over time. The strands then fall onto the orienter which, in most cases, is a set of rotating intermeshing discs.

Strands pass between the discs if oriented parallel to the discs. If not, the discs kick them parallel to the discs, allowing them to pass down to the moving forming conveyor. As the conveyor moves underneath each forming head, a layer of strands is added. The first and third station orient the strands parallel to the travel of the forming conveyor, and the middle station orients the strands perpendicular to the travel. Thus, the OSB mat is constructed.

It should be noted that there are two plants that make a five layered board: the two face layers length oriented, the two intermediate layers cross oriented, and the core layer random or not oriented. This five layered construction allows for use of fines in the core without detracting from board properties.

Mats are formed continuously, typically 8 feet wide (plus trim allowance). A moving cross cut saw cuts the mats to length either 16 or 24 feet long (plus trim allowance) depending on press length. The individual mats are then transport into the press loader.

Multi-opening presses are standard for OSB manufacture. The largest press built to date is 8 by 24 feet with 16 openings. Pressing times have constantly declined over time with four minute cycles being common for 7/16" thick panels.

SAWING AND SANDING

After pressing, the panel edges are pre-trimmed to remove the loose strands which would otherwise fall off in downstream handling and create a clean-up problem. The full size panels are then cooled before sawing into sizes for shipment, most commonly 4 ft. by 8 ft.

Most OSB panels are not sanded. Panels made for floor decking require surface sanding for thickness control and edge matching. The long edges are then machined to produce a tongue and groove profile, a common treatment for floor decking.

All trim and other waste generated at the saws, sanders, and T&G machine are delivered to the energy plant for use as fuel.

ENERGY GENERATION AND FUEL HANDLING.

Thermal energy is required to heat the press, dryers, thaw ponds, and buildings, although southern plants do not require heat for buildings or ponds. The heating medium for the press, ponds, and buildings is most commonly thermal oil.

There are several equipment configurations and strategies for converting the self-generated wood wastes into heat energy. First, there are two basic types of wood wastes produced in the plant: wet waste composed of bark, slasher sawdust, and small ends, and dry waste composed of screen fines, edge trim, and sawdust. Plants handling tree length logs or which have secondary slashers will have additional wet waste.

One fuel use strategy is to combine all the fuels in a single combustion unit. Hot combustion gases flow through tubular heat exchangers to heat thermal fluid and then flow directly into the dryers.

A second strategy is to burn the dry and wet wood fuels separately. Dry fuels, after pulverizing to small (less than 1/8") size, can be burned in special suspension burners connected to the dryers. Heat from the combustion of wet fuel is used to heat thermal oil.

3.3 HISTORICAL DEVELOPMENT OF OSB

The development of OSB goes as far back as 1956 at Sandpoint, Idaho, where the first waferboard plant was built. In 1956, waferboard was truly a product ahead of its time. Plywood was low cost and plentiful, and there was no reason to have a substitute.

The second attempt was in Canada at Hudsons Bay, Saskatchewan. Eventually bought by MacMillan Bloedel, this plant established a steady market for a low cost utility panel that could be used in place of plywood, essentially in the farming industry. Although the plant had some early difficulties, its eventual success was based on the use of low cost aspen trees, as well as, the freight advantage the product had over western plywood.

The establishment of the plants up to 1978 were as much driven by forest management concerns for finding an economic use for aspen as it was to find a replacement for plywood. When plywood prices reached all time highs in 1978-79, it became clear that there was a real economic opportunity to market a plywood substitute based on a substantially lower delivered cost. The logical location for OSB plants was the non-plywood producing areas of Eastern Canada and Northcentral and Northeastern U.S.

By the mid 1980's, OSB was well established in the non-plywood producing regions and began to make a foothold in the plywood areas of the South and West. These plants did not have the freight advantage against plywood as did the plants in the North but still demonstrated that the lower cost structure and product performance was good enough to build market share.

The Southern plants also broke new ground in the use of species other than aspen. Southern pine and gum were shown to be suitable for making OSB and, although not completely successful, attempts were made at using heavy hardwoods such as oak and hickory.

Plants were also built in areas remote to the large markets such as Edson, Alberta, with freight disadvantages (compared to plywood) to western U.S. markets such as California. Difficulties in the plywood industry, essentially with log supplies in the west but also with higher cost structures, opened the door further to OSB penetration.

3.4 CURRENT AND FUTURE MARKET TRENDS

Today, OSB capacity stands at 9.8 billion square feet (BSF) 3/8". Table 1 in Appendix A shows a list of North American OSB plants with various regional totals. Table 2 in Appendix A shows both capacity by 1994 and current and projected consumption of structural panels. The projection data are from Resource Information Systems. The following observations from this table set the stage for future development in OSB.

NORTH AMERICA

Total North American OSB capacity will have to increase 50% to satisfy projected demand by the year 2000 and will have to double by the year 2005. This translates into 15 and 30 new plants by 2000 and 2005 respectively.

OSB growth in demand will come as a result in overall structural panel growth as well as increased market share. OSB market share is projected to go from 30% to 57%.

CANADA

Existing capacity in both western and eastern Canada will be higher than demand in those regions by 2005.

The current surplus of capacity over demand is exported mostly to the U.S. (small amounts to Europe from the East). Canadian exports to the U.S. will continue to fill U.S. regional supply deficits.

U.S WEST

The U.S. west has the lowest OSB capacity among the regions and by 1995 the supply deficit will be larger than western Canadian 1994 capacity (includes Ainsworth Lumber).

U.S. NORTHCENTRAL AND SOUTH

Both these regions have a current surplus of capacity, but this will fall to a deficit by 2000.

A key factor in growing OSB demand is the continuing decline of plywood production, especially in the west. This decline has been brought on by timber supply shortages resulting in rising wood costs to plywood mills. The timber supply issue is a complicated one with both biological and political elements at work.

Removal of forest lands from timber production (mostly old growth forests) has reduced log supplies, resulting in rising log prices. The logs that are available come from second growth forests, and the small diameters are not well suited to most existing plywood plant equipment.

The combination of log shortages, rising plywood manufacturing costs, and competition from OSB has resulted in the closure of many plywood plants. In 1987, U.S. plywood capacity peaked at about 27 BSF with 50% in the west. Current U.S. plywood capacity stands at about 23 BSF and the west's share is only 40%. Whereas Southern capacity has held relatively stable, western capacity has decreased nearly 30% since 1987. Similarly, in Canada, plywood capacity has declined from 3.2 BSF in 1979 to 2.32 BSF in 1991, most of this on the B.C. coast.

Another factor resulting in rising log costs is rising lumber prices throughout the 1990's. Lumber and plywood now compete for the same log. While plywood prices are held in check by substitution of OSB, lumber prices are more free to rise as there are fewer or less attractive substitution options to lumber. Plywood is, therefore, less able to compete with lumber for a common log resource. Technology has provided a way of producing a structural panel product from a low grade wood resource, whereas the replacement of structural lumber is only at the beginning stages with products like LVL, PSL 300, and wood I-beams.

OSB substitution for plywood has been relatively easy since it competed on price at equal or near equal performance. Reconstituted lumber substitutes do not enjoy this cost advantage and compete on the basis of superior performance - always a tougher sale.

The opportunities for building OSB plants are not, however, endless. It is becoming more and more difficult to find a large enough wood supply to support an economic sized OSB plant of 250 to 350 MMSF 3/8". Although it would seem to make sense to build an OSB plant in California or close by in Oregon or Washington, the wood supply conditions are not that attractive. Although the situation is not as acute in other areas of the U.S., finding a suitable wood supply in all regions is becoming more difficult.

New environmental regulations in the U.S. are also placing limitations on where OSB plants can be built, at least within a reasonable time frame and without very expensive pollution abatement equipment.

An indication of these conditions in the U.S. is the recent announcement by Louisiana Pacific to build two OSB lines in Venezuela. In general, more remote (to market) locations are becoming viable prospects for OSB plant locations. The development of OSB plants in Northern Alberta and B.C. also demonstrates that distance to market is not a prohibitive factor and that increasing OSB prices can support higher freight costs.

Remembering the forecast for 30 additional plants in the next 12 years, where there is a good wood resource, there will be an opportunity to build an OSB plant. Given the lack of wood supply in the western U.S., western Canada is well positioned to supply that market.

3.5 TECHNOLOGICAL DEVELOPMENTS

Most of the development in OSB manufacturing has centered around improving and refining process variables, equipment performance, and resin performance. Some of these modifications are summarized as follows.

Strand length has changed from 2.5 inches to 3 inches as the standard and some plants are cutting four inch strands. Longer strands have resulted in lower board densities while maintaining strength properties. The longer strands are more difficult to handle in bulk (without breaking) and equipment modifications were required to accommodate the additional length. Strands longer than four inches will be considered in the future, but new kinds of equipment will have to be developed. The board property gains of further increasing strand length will likely diminish at some point.

New flaker designs have reduced the quantity of fines produced, improving wood yield.

Resin cure times have decreased, resulting in higher output per square foot of press area.

Resin addition and blending techniques for liquid resins have reduced the dosage rates from 5% to 3.5%.

The use of isocyanate resins has been implemented at some plants, yielding further reductions in cure times and hence higher production rates.

Process instrumentation and controls have resulted in better quality control.

Species other than aspen are now used, most notably southern pine. Most softwood species, as well as, the lower density hardwoods are expected to be acceptable. Use of high density or hard hardwoods has been tried without great success.

There are still improvements to be made to the process and product. The most common complaint of OSB is thickness swelling when exposed to moisture. Although strength is not diminished significantly, the thickness increase creates problems in fitting windows, doors, roofing, and siding. The performance of OSB in applications such as siding (developed and marketed by Louisiana Pacific and now International Paper) or other new applications where the product is more exposed is also hindered by thickness swell.

The application of steam injection pressing has shown that thickness swell can be improved significantly. The basic technology has been developed at the lab level but, except for a few situations, has not been implemented in production. The Canadian research group Forintek has developed a simple, effective system for steam injection, and while there are still details to be ironed out, this is a technology to watch in the future.

3.6 OSB IN BRITISH COLUMBIA

The evaluation of various locations in B.C. or indeed anywhere must focus primarily on wood supply and outbound freight costs. Other cost factors such as labor rates, power rates, and resin costs have less impact on overall costs and are, therefore, of secondary consideration.

It is recommended that prospective investors consider a large size plant, 300 MMSF 3/8" per year output or higher. Such a plant requires a wood input of 500,000 cubic meters or 200,000 dry metric tons of wood per year.

The objectives of the study are to assess three regions within B.C. They are:

Northeast B.C.
Northwest B.C.
Vancouver Island

NORTHEAST B.C.

Geographically, Northeast B.C. extends from the B.C.-Yukon border south to Prince George and from the B.C.-Alberta border west to Fraser Lake. The area west of highway 97 between Dawson Creek and Ft. Nelson is mountainous and to the east is flat to rolling hills.

Wood Supply

The area around Prince George, west to Fraser Lake, north to MacKenzie, and southeast to McBride, does not have extensive stands of aspen. Aspen habitat is localized in the valley floors. The main species group here is spruce pine fir (SPF) which is mostly dedicated to sawmill industry with the result that SPF log prices are much higher compared to aspen.

Aspen is most abundant in the Dawson Creek to Ft. Nelson corridor and east. Louisiana Pacific's OSB plant is located in Dawson Creek and utilizes the aspen in the southern part of this area. It is the northern part of the region towards Ft. Nelson which offers a potential wood supply for another OSB plant.

The major use of aspen in the Ft. Nelson area is the manufacture of chopsticks. This plant uses relatively small volumes but requires high quality logs. Much of the total volume is not suitable for the chopstick plant and is left in the woods. These wasted volumes could form part of the supply base for an OSB plant.

Although no formal wood supply study was undertaken as part of this report, it is felt that obtaining 500,000 m^3/year of aspen is achievable. Delivered aspen log costs are estimated to range from \$25 to \$30 per m^3 with a probable average of \$27.

It should be noted that balsam poplar also grows in this region. This has been a difficult species to contend within the past, mostly in drying, but the plant at Slave Lake, Alberta, seems to have overcome the problems. Further attention should be given to the portion of balsam poplar that would make up the total supply.

Transportation

Transportation alternatives from Ft. Nelson include truck and rail. B.C. Rail indicates a boxcar rate for plywood from Ft. Nelson to Vancouver of \$2410. Assuming a payload of 100 MSF 3/8" per car, the unit freight cost is \$24/MSF 3/8". The rate to Los Angeles is \$4850 per car or \$48/Msf.

The rail rate difference between Dawson Creek and Ft. Nelson is about \$300 per car or \$3 per MSF. This difference is quite small and lends credibility to Ft. Nelson as a location for OSB.

NORTHWEST B.C.

This region extends from Fraser Lake west to the coast and north to the Yukon border. Development in the region is along the highway 16 corridor to Prince Rupert. Any plant development would logically be located along this corridor. The region is mostly mountainous, although less so east of Smithers.

Wood Supply

Aspen does grow in the region but mostly east of the coast mountain divide and then, only in the valley bottoms. It is not thought that a supply of 500,000 m^3 per year of aspen is available within a reasonable supply radius, and so other species must be considered.

The available timber, that is timber not wanted by the sawmill or pulp industry, is mostly over mature hemlock. While there are significant volumes, the costs to harvest and deliver it to a mill site are very high, largely due to the mountainous terrain. The cost of this type of wood is not expected to be below \$35/m^3. The presence of rot could also be problematic during processing if present in large quantities and would reduce yields and increase costs.

Previous research with this type of hemlock indicated higher thickness swell compared to aspen boards. The use of steam injection pressing corrected the problem, but recall that this technology has not yet been commercially developed.

Developing a secure and economic wood supply presents the greatest challenge to OSB development in the Northwest.

Transportation

There are two basic transportation opportunities from points along highway 16. One is west to Prince Rupert or Kitimat via rail or truck, then by barge to south coast ports. Alternatively, an all land route by rail or truck. Preliminary inquiries do not indicate any advantage of one system over the other.

VANCOUVER ISLAND

Wood Supply

Wood supply to an OSB plant on Vancouver Island would include pulp quality logs of cedar, hemlock, douglas fir, and balsam. In addition, alder and cottonwood could be used. Such a variation in species represents a risk in that such a mix has not been successfully used in commercial operation. Hemlock has already been identified as a potential problem. While in theory the risks may seem low, it would be prudent to test, at least at the lab level, the viability of this species mix.

It is normally thought that coastal log prices are high relative to the interior of the province. However, pulp quality logs that come with the saw timber is commonly sold on the Vancouver log market. From 1986 to 1989 hemlock and balsam pulp log prices ranged from \$22 to \$35 per m^3.

Coastal log supply is largely controlled by the major forest product companies, and it is questionable if an independent proponent of an OSB plant could really develop a viable wood supply. The opportunities would be more realistic for an existing timber licence holder who would have the ability to trade and make deals with other licence holders in order to develop the supply volumes.

The report authors have previously attempted to develop a cedar chip supply for a Japanese company and found it extremely difficult. The situation is far from "open market" and a thorough wood supply study would be recommended.

In lieu of a more in-depth analysis, a log cost of \$30 to \$35/m^3 has been assumed.

Transportation

From the Island, transportation via rail, truck, and barge are all viable options. One key difference between barge and rail or truck is the quantities that make a shipment unit. Truck and rail quantities are small enough to serve single customers. Barge quantities are 30 to 40 times larger than rail car loads and, therefore, require reload and distribution to individual customers. It is expected that all three modes would be used to serve the customer base.

Identification of the lowest cost method would require an in-depth analysis beyond the scope of this report, and we have, therefore, used the rail rates as the basis for determining mill net prices.

3.7 CAPITAL COSTS

The capital cost for an OSB plant with an output of 300 MMSF 3/8" per year is estimated at $82,000,000 Canadian. The estimate is presented in Table 3 in Appendix A. This size plant is standard in the industry and is thought to be necessary for a B.C. plant to help offset freight costs, especially for the more northern locations. Consideration for a larger plant output is advisable but contingent on available wood supplies.

The equipment configuration envisaged is typical of a large modern OSB plant such as the operations at Dawson Creek, B.C., and Edson and Drayton Valley, Alberta. The environmental control equipment included is representative of what is used by existing plants but does not include expensive thermal incineration equipment currently being considered by some existing and proposed facilities in the U.S. The proposed Ainsworth plant at 100 Mile House does not employ thermal incineration, and it is not expected that a plant in the locations discussed would require such technology.

The estimates include interest during construction but do not include working capital or capitalized start-up costs. The estimates are accurate within ± 10%.

Project management methodology, financing methods, and requirements for process and project guarantees create the largest variations in actual plant construction costs. Companies like Louisiana Pacific, who act as their own managers and general contractors and do not require anything above the standard machinery warranties, build plants for the least cost. It is, therefore, expected that some observers will think the estimates are too low and some will think they are too high.

3.8 MANUFACTURING COSTS

Manufacturing cost estimates are presented in Table 4 of Appendix A and are shown for three levels of wood cost. The estimates are calculated per MSF 3/8" of saleable output. Actual production is about 5% higher than sales.

Estimates are shown for three levels of wood cost representing the range expected throughout the regions under study. All other cost elements are assumed to be equal. A more in-depth analysis might show slight differences in some areas. For example, labor rates on Vancouver Island might be expected to be higher than at Ft. Nelson or in the Northwest, and delivered resin costs would be expected to be two to three cents higher in the north. In all, the variation in costs other than wood are not expected to be more than $5/MSF.

3.9 FINANCIAL PERFORMANCE OF OSB

PRICES

Throughout the 1980's, as OSB was establishing its place in the market and capacity rose in spectacular fashion, prices were mixed with some profitable periods and many unprofitable periods, especially for the higher cost mills. The price of 7/16" f.o.b. Northcentral mill (a bellwether of the industry) averaged around US $145/MSF with lows to $125/MSF and highs to $160. The 90's started poorly with the Northcentral price falling back to $130 7/16". Prices recovered in 1991 and, by September, 1992, reached an all time high of $282. Towards the end of 1992, prices fell back to a more sustainable $210. More price volatility has been seen in 1993, producing another high of $315 in March. In April, however, prices had again fallen to $225.

For a B.C. plant, the prices delivered to Los Angeles and Vancouver are of more interest. The recent price history in these markets, as well as, the bellwether Northcentral mill price is shown in Figure 1 in Appendix A.

In early 1992, the L.A. price was US $165/MSF 7/16". It climbed steeply in January and, until August, averaged around $230. A spike of over $300 occurred in September, falling to $250 by the end of the year. By February of 1993, another spike occurred, this time to $350, falling back to $250 by April.

The price in Vancouver in U.S. dollars paralleled the L.A. price in U.S. dollars until the beginning of 1993. The recent price spike in March saw the Vancouver price rise $50 over the L.A. price to US $400. Although the price fell $50 in April, the price spread remains.

It is also worth noting that the price spread between L.A. delivered and Northcentral mill net is around US $30 to $40/MSF 7/16".

Most authorities agree that the upward price trend of 1992 is here to stay due to the supply constraint reasons discussed above. It is, therefore, thought that average prices (taking out the short term spikes and lows) will not drop below $180 for Northcentral 7/16" or $210 delivered to L.A.

Figure 2 in Appendix A presents price forecasts to the year 2005 as developed by Resource Information Systems. Shown are the Northcentral mill net price in U.S. and Canadian dollars as well as Canadian mill net prices (probably for eastern mills). These projections indicate a Northcentral low price of just under $250. Using the $30 spread to L.A. would indicate a low there of $280.

To arrive at a B.C. mill net price, we have taken the L.A. price for 7/16" board, subtracted 5% for sales commission converted to Canadian dollars at an exchange rate of $0.80. The 7/16" price is then converted to 3/8" basis before subtracting freight. Freight is taken at CDN $45 for Vancouver Island, CDN $55 to the Northwest (Smithers), and CDN $48 to the Northeast region (Ft. Nelson).

The above is calculated for a low L.A. price of US $210 and an average price of US $280. A summary of freight costs and mill net price calculations is presented in Tables 5 and 6 respectively in Appendix A.

RETURNS

Financial returns are presented in Table 7 in Appendix A. Return on capital is calculated based on gross cash flow, after-tax profit, and after-tax cash flow. Returns are calculated for the projected low and average price.

On the basis of after-tax cash flow, returns are as follows:

Northeast (FT. Nelson) - 12% at low price and 25% at average price.
Northwest (Smithers) - 9% at low price and 20% at average price
Vancouver Island - 10% at low price and 22% at average price.

While the differences do not seem great, there is much more uncertainty in the cost and availability of wood supply in the Northwest and on Vancouver Island. For all areas, the firm determination of a suitable wood supply represents the area where further study is recommended.

4.0 MEDIUM DENSITY FIBREBOARD (MDF)

4.1 PRODUCT DESCRIPTION

MDF is a high quality, wood based, reconstituted panel product used in the manufacture of furniture, cabinets, and general millwork applications. Typically, it is made in large panel sizes up to 8 ft. by 24 ft. but sold in standard sizes such as 4 ft. by 8 ft. Thickness can range from 1/8" to 2", the most common being in the range of 1/2" to 3/4". It is used more and more as a substitute for kiln dried dressed lumber in applications such as window frames, door jambs, and decorative moldings. While nearly all MDF is made with non-water resistant adhesives aimed at interior applications, there is continuing development and interest in exterior grade panels and overlay systems which allow MDF to be used outside.

Due to the fine texture and homogenous nature of MDF, it machines cleanly and is easily painted to produce high quality finishes. Since MDF is made and sold as a panel, many furniture and cabinet components can be made from a single piece. The same component made from natural wood requires labor intensive jointing and assembly operations. Whereas particleboard is well suited to automated manufacture of flat panel designed furniture (or perhaps these designs resulted from the limitations of particleboard), the real wood-like characteristics of MDF made possible the return to traditional designs also using automated production techniques.

In many products, MDF is used only for those components which require its special characteristics. For example, the basic box of a kitchen cabinet unit is likely made of particleboard while the doors, drawer fronts, and exposed pieces are made using MDF machined to develop the look of a raised panel or a mullioned glass panel door.

4.2 MDF MANUFACTURING PROCESS

MDF is made by compressing and heating a mixture of roughly 90% wood fibers and 10% thermo-setting resin.

The manufacture of MDF can be broken down into five functional areas as follows:

1. Raw Material Storage, Preparation, and Metering
2. Refining, Drying , Blending, and Storage
3. Forming and Pressing
4. Sanding and Sawing
5. Energy Generation and Fuel Handling

RAW MATERIAL STORAGE, PREPARATION, AND METERING

Raw material is delivered to the plant most commonly by truck either as whole logs and or as mill residues. Two to three weeks of raw wood storage is normally provided to allow for temporary curtailments from suppliers (mostly sawmills) which might result from strikes, unforeseen maintenance shutdowns, or production slowdowns due to poor markets. In the case of logs, storage allowances of up to eight weeks are often made to provide continuity of supply through spring break-up when ground conditions are too soft and wet for heavy traffic or through fire hazard seasons. Wood storage is organized to allow for segregation of the various types of raw material. Chips, sawdust, and shavings are stored separately to allow for a controlled mixing of wood to the plant.

Raw material preparation consists of various cleaning and screening operations to eliminate contaminates such as bark, metal, and dirt. A debarking and chipping operation is required if logs make all or up part of the overall wood supply. Chip screens and washers are often installed when whole log chipping is used but are not necessary if sawmill chips are used as these tend to be cleaner than whole tree chips.

Controlled feeding of the various forms of wood to the plant is very important. Although the process can tolerate a variety of wood forms and species in various mixes, it is critical for the mix to be consistent on a minute to minute or hour to hour basis. Fluctuating wood input conditions will cause the process to go out of control and result in poor and variable board properties. Therefore, independent feed and metering systems are provided for each component of the wood mix. It should be noted that the wood mix can be changed to produce various products, but it must be done in a controlled manner.

REFINING, DRYING, AND BLENDING

After the raw wood has been cleaned and mixed in the proper proportions, it is delivered to the digester refiner machines. Wood is converted to fibre in these machines which are the heart of the MDF process. In the digester section, wood is heated with saturated steams at 100 PSI pressure for three to five minutes. This moist heating plasticizes the lignin in wood without drying it. Lignin can be thought of as the glue that binds together individual wood fibers into a stiff matrix.

With the lignin softened, wood is unraveled into fibre bundles in the refiner as opposed to being ground into a more dust-like material. The refiner consists of two grinding plates held close together, one stationary and one rotating. The wood is fed through the eye of the stationary plate by a high speed screw feeder, and as wood passes between the cutting bars machined into the refiner plates, it is reduced to fibre. The pressure of the digester is maintained through the refiner.

Fibre exits the housing of the refiner through a "blow valve" and "blow line" to the fibre dryer. Conditions in the dryer are near atmospheric, and the pressure drop from the refiner to the dryer provides the motive forces for carrying the fibre through the blow line. The control of steam pressures and plate gap are critical to achieving and maintaining good fibre quality.

The refining process and equipment described here is very similar to that for making thermal mechanical pulp (TMP). TMP, however, requires ten times the power input to yield the fibre fineness required for making paper.

As noted above, fibre discharges directly from the refiner blow line to the dryer. The dryer is a flash type design which, in simple terms, is a hot air conveying system, the moisture being evaporated from the wood by the hot air. Dryer inlet temperatures are kept quite low (about 300 °F) to minimize risk of fires and lower pollutant emission levels.

The adhesive used for MDF is normally urea formaldehyde (UF) resin. UF resin is rated for interior use only, although when mixed with melamine, provides better water resistance. Exterior grade resins such as phenol formaldehyde (PF) or isocyanate (ISO) can also be used but at a higher cost. While the use of PF and isocyanate resins are not in common use, since most applications are for interior use, there is a potential for new applications where water resistance is required. As well, there is virtually no formaldehyde emission from PF and ISO bonded MDF, an issue becoming increasing more controversial.

Resin is added and blended with the fibre in one of two locations. Most commonly, it is injected into the refiner blow line and mixes with fibre as it travels in a turbulent manner through blow line and dryer. Alternatively, resin can be added after the dryer in a high speed paddle type mechanical blender. Although the mechanical blending approach requires slightly less resin, it tends to create balls of resin and fibre which show up as dark spots on the surface of the board. For this reason, it is not commonly used.

Dried and blended fibre is then delivered to a storage metering bin which provides a buffer and control break between the fibre preparation and board forming and pressing section of the plant. It is worth noting that fibre is most commonly transported in pneumatic conveying systems to avoid the dusting and spillage associated with mechanical conveyors. The result is a cleaner plant environment.

FORMING AND PRESSING

Fibre is metered to the forming machine which evenly deposits it on a continuously moving wide belt to form a thick, loose mat. The top of the mat is shaved off with a scalping roll creating uniform density in length and width. The width of the mat can be anywhere from 4 to 9 feet depending on the design of the forming machine. A one foot width variation for any one former is possible to provide some panel size flexibility.

The mat bulk density is very low, two to three pounds per cubic foot depending on mat thickness and type of former. With mat bulk density up to 20 times that of the final board, the mats are very thick. For example, for a 3/4 inch board, the mat thickness out of the former would be 12 to 16 inches. To improve the integrity of the mat for handling and transport, it is cold compressed in a continuous nip roll type precompressor. Mat thickness is reduced by roughly one third via precompression.

In the main hot press, mats are compressed and heated to produce rough MDF panels. Thickness is controlled by press pressure, and heat cures the thermosetting resin into a rigid cross linked polymer which binds the fibers together much like lignin in natural wood.

Two types of presses are used to manufacture MDF. The oldest is the batch type. These presses operate in a cycling or batch manner, pressing one or several panels each cycle depending on the number of openings. A press loader provides the accumulation of the continuously formed mats throughout the pressing cycle. With a batch press, the prepressed mat is cross cut to the prescribed length as determined by the press length. Batch presses are available in a wide range of sizes. Two typical sizes are 8' by 24' 8 openings and 5' by 18' 20 openings. Selection of press size is based on capacity and panel size requirements.

The second type is the continuous press. Here, the fibre mat is pressed between two continuously moving steel belts resulting in an endless ribbon of board. Pressure and heat is applied to the belts by fixed platens. Friction between the moving belt and fixed platen is overcome by long thin roller bars, roller chains, or in one design, a thin film of oil pumped between belt and platen. A second type of continuous press is the Mende drum press. In the Mende design, the mat is pressed and heated between a large diameter rotating drum and backer belt. This technique is only suitable for thin panels (under 1/4"). Thicker panels would retain the curvature of the press surface.

The idea of continuous pressing is not new and several attempts were made before 1960. However, it wasn't until the 1980's, when new materials technology overcame the excessive wear associated with high friction, that the idea took off. It is beyond the scope of this report to discuss the pros and cons of batch versus continuous presses; suffice to say that both have a place and both are here to stay.

Panels are removed from the press, and in the case of continuous presses, the endless ribbon of board is cut to length. The hot boards must be cooled before stacking to prevent thermal degradation of cured resin that can occur in overly hot stacks. It is normal for panels to be cooled in moving racks for 1/2 to one hour before stacking. Stacked, rough panels are stored one to seven days before finishing to allow time for stabilization and further development of bond strength.

SANDING AND SAWING

Panels can be sanded in widths up to nine feet and lengths up to 24 feet. Sanding performs two functions. First, it develops accurate and even panel thickness or caliper, and second, it creates a smooth polished surface suitable for a variety of finishing treatments (painting, printing, overlaying).

Modern sanders use three to four stages or heads. The first head uses very rough sandpaper (30 to 50 grit) to remove most of the material and develop the correct thickness. The following heads use progressively finer papers and are used to achieve a smooth surface. It is not uncommon for plants to sand panels to a 180 or even 220 grit finish.

While panels can be made in sizes as large as 8 ft. by 24 ft., they are sold in smaller sizes such as 4 ft. by 8 ft. This break down is done in the saws. There are two basic types of saws. In the panel saw, single panels are moved through two sets of fixed saw heads. The first set of saws cuts the panel in the length direction. The panel is then moved perpendicular through the second set of saws to be cut across the panel width.

The book type saw cuts a stack of panels which are held stationary as the saw blade travels through them. Normally, there are two saw stations set perpendicular to each other to provide for length and width cutting.

After sanding and sawing, the panels are graded, stacked, and packaged for shipping.

ENERGY GENERATION AND FUEL HANDLING

The MDF process requires large amounts of heat energy for drying the fibre, providing steam to the refiner, heating the press, and building heat. Over half of this energy is generated by burning wood waste produced in the plant in the form of sanderdust, sawdust, and edge trim, as well as, small amounts of reject board and waste fibre. If bark is generated by on-site chipping, the plant will likely be fuel self-sufficient. Supplemental fuels such as natural gas, fuel oil, propane, or outside purchased wood waste (hog fuel) can make up any shortfall in self-generated fuel.

There are many ways of configuring the energy system. The selection depends on site specific factors such as alternate fuel availability and cost, opportunities for disposal or sale of plant wastes (sanderdust, trim, sawdust, etc.), and environmental regulations. Associated with the variety of possible energy system configurations is a wide range of capital and operating costs. As a result, this area of the plant requires thorough analysis to develop the most suitable design.

4.3 RAW MATERIAL CONSIDERATIONS AND TECHNOLOGICAL DEVELOPMENTS

Raw wood for MDF manufacture can be derived from a variety of wood forms. Pulp chips from sawmills or from logs, sawdust, planer shavings, plywood trim, veneer waste, and chip fines are all suitable forms of raw material for MDF. The process is also quite tolerant to various species found throughout the world, although light colored softwood species are commonly thought to produce the best boards.

Although it is accepted that the use of 100% pulp chips results in the best board, many North American plants use sawdust and shavings for over half of the total wood mix. Some use as much as 70% non-chip materials. The economic benefits are obvious, considering pulp chips cost $60 to $100 per tonne compared to $5 to $30 per tonne for sawdust and shavings. The performance of the sawdust shavings boards is certainly adequate, and there is often very little price difference from the chip based boards.

In fact, in North America, Blue Ridge Lumber's "Rangerboard", which is made from at least 50% shavings and sawdust, is considered to be one of the highest quality boards. Even in Europe, Blue Ridge is considered one of the best boards, and this is against all chip boards made in Europe.

A recent development in MDF technology is the use of high power two-stage refining for sawdust and shavings. Although new to the MDF industry, it is the norm in high yield pulping, TMP, and CTMP. The discovery was made almost by accident by the Panfibre MDF plant in Quebec, in cooperation with Canadian refiner manufacturer, Hymac. This was the first installation of a Hymac refiner in an MDF plant and, with application of pulp experience, produced excellent results. Panfibre is now making a very high quality MDF using 70% green sawdust and 30% chips and is aiming at using 100% sawdust.

Although higher power costs are incurred, in most situations in North America, this is more than offset by lower wood costs. The technology is of special interest to areas such as British Columbia which still have large volumes of sawdust and shavings (currently being burned) and hence can be purchased at a much lower price compared to chips and low power costs.

4.4 HISTORY OF MDF DEVELOPMENT AND FUTURE MARKET TRENDS

MDF was developed in North America in 1965 and the first plant built at Deposit, New York, in 1966. Four additional plants were built up to 1974. These facilities represented the early stages in MDF development both in terms of manufacturing and market development. Growth in MDF use was hampered by the operational and financial difficulties of these early plants. In 1974-75, two large plants were built in the West, one in Montana (Plum Creek Lumber) and the other in Medford, Oregon (Medford Corp.). The consistent quality and lower cost of the two western plants led to an increasing use of MDF in the furniture and cabinet industries.

Prior to 1975, North American (mainly U.S.) MDF consumption was below 200 MMSF 3/4" (million square feet). Current consumption is 1100 MMSF 3/4", of which Canada represents 12% or 130 MMSF.

There are currently 16 MDF plants operating in North America, 14 in the U.S., and two in Canada. Table 8 in Appendix B presents a current listing of MDF plants in North America.

In Canada, before 1986, MDF was only available from U.S. manufacturers and with duty, freight, and exchange rates, the Canadian MDF price was nearly double that of particleboard. In the U.S., MDF sold at only a 40% to 50% premium over particleboard. This large price differential hampered the growth of MDF use in Canada. It is estimated that annual Canadian MDF consumption was 18 MMSF to possibly 25 MMSF in 1985.

The situation drastically changed in 1986 after the opening of the Blue Ridge Lumber MDF plant in Alberta (1986) and the Panfibre plant in Quebec (1987). Furthermore, in this same period, two U.S. plants located close to the Canada-U.S. border started operation (Louisiana Pacific at Newberry, Michigan, and the refurbished plant at Deposit, New York. The Newberry plant has since been converted to Oriented Strandboard (OSB)). This new capacity aimed at the Canadian market as well as the rise of the Canadian dollar in 1986-87 led to the lowering of Canadian MDF prices which prompted greater usage.

Since the start of the Canadian MDF plants, Canadian consumption has grown three fold to about 56 MMSF. This level is well below Canadian MDF capacity of 120 MMSF, and the surplus is exported mostly to Pacific Rim markets and some to U.S. and Europe. The Pacific Rim market has proven to be an important outlet, especially for the Alberta plant which is quite far from the bulk of North American markets located in the East. It is estimated that the Blue Ridge plant exports 60% to 65% of its output offshore.

Table 9 in Appendix B shows current North American capacity by region against current and projected regional demand. Table 10 in Appendix B shows regional supply demand balances. The following comments can be made about these projections.

For North America as a whole, current capacity will be greater than domestic demand until just after 2000. However, taking exports into account, there will be an overall shortage by 1995.

For Canada and the U.S., separately, the situation as described for North America also generally holds.

There is a large deficit of supply in the Northcentral which is supplied from the South, Eastern Canada, the U.S. West, and Western Canada.

Most of the exports are from western mills which places further demand on capacity in this region.

The largest MDF demand growth will occur in the Eastern region. With growing wood shortages in the West, new plant construction is likely to take place in the U.S. South to serve this growth.

Some development will take place in Eastern Canada but will be limited by the limited supply of spruce pine sawdust and shavings and high pulpwood costs.

Asian markets represent a growing outlet for North American MDF, especially for plants located in the West. The three major consuming countries are Japan, Taiwan, and Korea, with Hong Kong and Singapore being secondary consumers. Although MDF is produced domestically in Japan and Korea, domestic consumption is far greater than capacity. New domestic capacity is limited by raw material, and in fact, wood is imported to sustain operations of existing plants.

Imports of MDF to these Asian markets come mainly from North America, New Zealand, and Australia. Although North American MDF is considered slightly inferior to the Australian and New Zealand boards which are made of 100% Radiata pine chips, the price of North American MDF is significantly less. North American plants do not suffer on profit margins as a result of the lower price. Rather, the cost structure is lower mainly due to lower wood and power costs. The high volume of container traffic between the west coast and Japan, Taiwan, and Korea results in lower ocean freight rates, further improving the competitiveness of western plants.

There is little opportunity to develop a suitable low cost wood supply in the western U.S. to support an export oriented MDF plant but several locations exist in British Columbia and Alberta.

4.5 MDF IN BRITISH COLUMBIA

British Columbia is not favorably located with respect to the large Eastern markets where the major proportion of demand growth is projected for North America. The disadvantage in transportation costs to these markets can, to some degree, be overcome by lower wood and power costs. The preference of some customers to MDF made from western softwoods will also help western based plants to overcome the large distance from markets.

With respect to Asian markets, B.C. is very well located. Proximity to ocean ports, large supply of low cost sawdust and shavings in desirable species, and low power costs create a favorable operating environment for an MDF plant. Most authorities agree that a B.C. MDF plant must be justified on the basis of marketing the bulk of the plant's output to Asian markets.

As noted earlier, the development of high power refining of non-chip mill residues to produce high quality MDF is of special interest to B.C. B.C. still has large quantities of unutilized sawdust and shavings in many areas, while the chip production from sawmills is fully utilized by the pulp and chip export sector. Consequently, a B.C. plant would have significant wood cost advantages in Asian markets against offshore competitors.

The competitive benefit of high energy refining of sawdust and shavings is further enhanced by low power costs in B.C.

Freight costs to key Asian markets from west coast ports is lower than from other producing regions such as Chile, New Zealand, and Australia. Within western North America, inland freight to ports differs amongst specific locations; however, other than in B.C. and Alberta, there is little raw material available.

Plant capacity or output is another important factor in determining a plant's manufacturing costs. Due to the economies of scale inherent in the production of MDF, larger plants have lower costs in labor, administration and overhead, and financing or capital charges. To some degree, these lower cost items can be offset by higher raw material costs associated in sourcing over a larger supply area resulting from higher inbound freight costs.

4.6 SPECIFIC LOCATIONS IN BRITISH COLUMBIA

The terms of the study targeted three regional areas in B.C. for establishing MDF plants:

Northwest B.C.
Lower Mainland
Vancouver Island

Two plant sizes are considered so that there may be some choice in matching wood requirements with wood availability.

	MDF OUTPUT MSF 3/4"/Yr	WOOD REQUIRED BDMT/Yr
Plant A	60,000	95,000
Plant B	120,000	190,000

The following discussion focuses on assessing the wood availability and cost conditions as well as freight costs of product to market.

NORTHWEST B.C.

The Northwest region is generally synonymous with the Prince Rupert Forest Region. From the coast, this region extends east to Burns Lake and from the north end of Tweedsmuir park north to the B.C.-Yukon border. Development in the region is along highway 16 from Prince Rupert to Prince George. Any MDF plant location would logically be along this corridor.

Wood Supply

Sawmills in the region are located at or near the main towns along highway 16 and with them the available sawdust and shavings. Lumber cut and residuals generation at or close to the main towns are as follows.

SAWMILL LUMBER CUT & RESIDUE GENERATION
LUMBER IN MMFBM/YR RESIDUES IN BDMT/YR

TOWN	LUMBER CUT	CHIP	SAWDUST & SHAVINGS
Terrace	400	220	100
Hazelton	25	150	60
Smithers	250	150	60
Houston	500	275	120
Burns Lake	200	120	50
Total	1,600	915	390

The large MDF plant (120 MMSF 3/4"/yr) consumes about 190,000 dry tonnes per year while the small plant (60 MMSF 3/4"/yr) consumes 95,000 dry tonnes per year. The above data indicate sufficient volumes of sawdust and shavings to support a large MDF plant; however, there are existing users of this material. The Eurocan pulp mill at Kitimat operates a sawdust digester and purchases sawdust from Terrace, Hazelton, and at times, Smithers. There is also the Northwest Panelboard particleboard mill at Smithers which consumes 50,000 to 60,000 dry tons of sawdust and shavings per year. Dry shavings are also used by some of the sawmills to provide heat for dry kiln operations.

While a detailed review of the current use of mill residues would be required to fully understand the volumes available for MDF manufacture, it is felt that the east side of the Northwest region may offer better overall opportunities for wood supply given what is known about current use of sawdust and shavings from Smithers west. East of Smithers, the forest is predominately a spruce, pine, and fir mix, whereas west of Smithers, the mix is predominately hemlock and cedar. The spruce/pine species mix results in a lighter colored board compared to hemlock/cedar which is a marketing advantage.

Based on information from sawmills in the region over the past two years, sawdust and shavings are estimated to cost $5 to $10 per BDMT. Since no single location has enough mill residue for the large plant (190,000 BDMT/yr), a transportation cost of about $15/BDMT must be added to at least 40% to 70% of the total supply depending on plant location: 55% is assumed. For the small plant (95,000

BDMT/yr), the portion requiring transportation would be only 0% to 40% and possibly lower depending on specific location: 20% is assumed.

The average wood cost for the small plant works out to $8 to $13/BDMT and for the large plant, it is $13 to $18/BDMT. To be conservative, the higher costs are used for manufacturing cost projections.

Transportation.

As indicated above, the key market focus for a B.C. MDF plant should be Japan, Taiwan, and Korea. MDF is most commonly shipped to these markets via ocean container and delivered to the customer's door. This avoids any warehousing and distribution on the Asian side that would be associated with break bulk shipping.

There is currently no container shipping from Kitimat or Prince Rupert, so the option of shipping through those ports was not investigated. Development of break bulk systems from these ports may prove to be lower cost than container shipping via south coast ports but should not be considered at this time. For the assessment purposed, the transportation route from the Northwest is via truck to Vancouver and ocean container to Asia. It is recognized that barge shipment from Kitimat or Prince Rupert to Vancouver is a possibility especially for plants located on the west side of the Coast mountains, but initial inquiries into the cost of this method do not indicate it to be lower than trucking to Vancouver.

Trucking from Houston to Vancouver, for example, with B Trains is estimated to cost $1300 per load, $37 per tonne, or $48 per MSF 3/4".

LOWER MAINLAND AND VANCOUVER ISLAND

These two areas are discussed together as they can be thought of one supply area.

Wood Supply

There are significant volumes of sawmill residuals produced in the Lower Mainland and Vancouver Island but there also significant volumes utilized. Current uses include:

M&B's particleboard plant wood supply
Canfor's hardboard plant wood supply
Fletcher Challenge's pulp furnish at Elk Falls
Pulp Mill Boilers
Animal Bedding & Nursery Mulch

Mill residue production, utilization, and disposal were estimated in 1989 for all areas of the province in a study entitled British Columbia Forest Industry Mill Residue. This study estimated production of sawdust and shavings at 3.9 million m^3 solid wood equivalent (SWE), of which 3.0 million m^3 was utilized and 0.9 million m^3 disposed of. Of this, nearly 80% is produced in the Lower Mainland or Chilliwack Forest District and 20% on Vancouver Island.

Compared to the wood demand of even the large MDF plant, 190,000 BDMT or 475,000 m^3 SWE, there appears to be ample volumes of residues available that are currently being disposed of, and at the right price, the total supply could be accessed. In the Lower Mainland, the problem of disposal is more critical, and this, coupled with the much larger production levels, tends to make it more attractive than Vancouver Island for an MDF plant location.

The mill residue study did not provide any breakdown by species, and it is suspected that much of the available material is cedar. While cedar is not currently used for MDF production in operating plants, several trials have been made with positive results. Although the cedar panel is darker in color, tests indicate that it has better dimensional stability. cedar is, therefore, not considered to be a liability.

Sawdust and shavings costs vary from $10 to $20/BDMT. In order to secure the required volumes, the $15 level is assumed for the small plant and $20 level for the large plant. There will also be some transport costs which should be in the order of $5/BDMT. In aggregate, the delivered wood cost should be about $20/BDMT for the small plant and $25/BDMT for the large plant.

Transportation

For lower mainland locations, transportation to port is minimal and is taken to be \$10/BDMT or \$16/Msf 3/4".

From Vancouver Island, the assumption is to ship by container via Vancouver. Delivery cost to Vancouver from the Island is estimated at \$25/Msf 3/4".

OCEAN FREIGHT

Recent inquiries into container rates to Japan, Taiwan, and Korea indicate that the cost of shipping MDF is \$100 to \$120/MSF 3/4" including container stuffing.

4.7 CAPITAL COSTS OF MDF PLANTS

Capital costs have been estimated for two sizes of MDF plants. The estimates are presented in Tables 11 and 12 in Appendix B and repeated here as follows:

Plant A	60 MMSF 3/4"/Yr	$53,400,000
Plant B	1120 MMSF 3/4"/Yr	$79,200,000

The plant design incorporates large, high power refiners necessary to convert low cost sawdust and shavings into high quality MDF. Multi-opening presses have been used for cost estimating purposes, but final selection between multi-opening and continuous press would depend on a detailed market review. A continuous press would add five to seven million dollars to the plant cost.

The estimates include interest during construction but do not include working capital or start-up costs. Capital costs do not include land costs which, for a Lower Mainland location, could be in excess of four million dollars. The estimates are accurate within ± 10%.

The largest variations in actual cost experience arise from fluctuating currency exchange rates, project management, and purchasing methods, as well as, financing methods and requirements for project guarantees.

4.8 MANUFACTURING COSTS OF MDF PLANTS

Manufacturing cost estimates are presented in Tables 13 and 14 in Appendix B for the small and large MDF plants respectively. The estimates for each plant size are shown for the three regional locations.

Key differences are as follows:

Wood costs for the large plants are higher than for the small plants, and in the Northwest, wood costs are lower.

Resin costs are slightly higher in the Northwest and on Vancouver Island as there is added transport cost to those locations.

The average power cost is lower for the large plants due to a better ratio between power demand and consumption.

Fuel costs for the Lower Mainland and Vancouver Island are slightly lower, reflecting the milder climate.

Labor wage rates are assumed to be slightly lower for the Northwest location.

The cost estimates do not include depreciation allowances or any charges for corporate overhead as is common in large companies.

Total manufacturing costs for the two plant sizes for each location are as follows:

	NORTHWEST	LOWER MAINLAND	VANCOUVER IS.
Plant A - 60 MMSF	$249/MSF	$258/MSF	$261/MSF
Plant B - 120 MMSF	$221/MSF	$228/MSF	$231/MSF

The estimates point out the advantage of a large plant of $30/MSF over the smaller output plant. The cost at the Northwest plant is about $10/MSF lower than the Lower Mainland mainly due to lower wood cost and labor costs.

4.9 FINANCIAL PERFORMANCE OF MDF

PRICES

The mill net price level of Western U.S. mills had been in the order of US $320/MSF 3/4" since 1990 until January, 1993. Since January, prices have increased to up to US $375/MSF 3/4", reflecting a shortage in supply mainly caused by fibre supply problems at some mills. While in the long run it is anticipated that the price increase will hold, it could easily come off to US $350/MSF for several months. An appropriate range for evaluation purposes is US $320 to $350/MSF.

Converting these prices to Canadian, adding freight from the Medford plant to Vancouver, for example, puts the Vancouver price at CDN $420 to CDN $460/MSF 3/4".

From another perspective, Statistics Canada reports the average value of MDF exported to Japan, Taiwan, and Korea at around CDN $580/MSF 3/4". Subtracting ocean freight at $120/MSF nets a price in Vancouver of CDN $460/MSF 3/4". This compares well with the first price estimate.

Inland freight must be subtracted to arrive at the mill net price for each location as follows:

VANCOUVER IS.	NORTHWEST	VANCOUVER
Vancouver Price	420 - 460	420 - 460
Inland **Freight**	48	5
Price **$/MSF 3/4"**	372 - 412	415 - 455

RETURNS

Financial returns are presented in Appendix B in Tables 15 and 16 for the small and large MDF plants respectively. Returns are calculated for two price levels (low and average) on the basis of pre-tax gross cash flow, after-tax profit and after-tax cash flow. On the basis of after-tax cash flow, the returns are estimated as follows:

	NORTHWEST	LOWER MAINLAND	
VANCOUVER IS.			
Plant A - 60 MMSF 3/4"/YR			
@ Low Price	12%	13%	13%
@ Average Price	14%	16%	15%
Plant B - 120 MMSF 3/4"/YR			
@ Low Price	16%	19%	18%
@ Average Price	19%	22%	21%

APPENDIX A

OSB TABLES

TABLE 1

NORTH AMERICAN OSB PLANT CAPACITY

Million Square Feet 3/8" Basis (MMSF) | Thousand Cubic Meters (MCM)

REGION	STATE / PROVINCE	COMPANY	CITY	ANNUAL CAPACITY MMSF	ANNUAL CAPACITY MCM
EASTERN CANADA					
	New Brunswick	Atlantic Waferboard	Chatham	200	70
	Quebec	Waferboard Corp.	St. Georges	160	113
		Norbord	Val D'or	160	140
			La Sarre	100	90
		Lanofor Inc	St. Michel	250	220
			Chambord	300	265
	Ontario	Grant Waferboard	Engelhard	500	440
		Waferboard Corp.	Timmins	100	90
		Weldwood	Longlac	150	130
				1920	1558
NORTHEAST U.S.					
	Maine	Louisiana Pacific	Houlton	185	165
		J.M. Huber Corp.	Easton	185	165
		Georgia Pacific	Woodlands	175	155
				545	485
NORTHCENTRAL U.S.					
	Michigan	Weyerhaeuser	Grayling	345	305
		Louisiana Pacific	Newberry	110	95
			Sagola	350	310
	Wisconsin	Louisiana Pacific	Hayward	460	405
	Minnesota	Norbord	Bemidji	350	310
		Potlctch	Bemidji	490	435
			Cook	225	200
			Grand Rapids	350	310
		Louisiana Pacific	Two Harbors	130	115
				2810	2485
SOUTHEAST U.S.					
	Virginia	Georgia Pacific	Skippers	310	275
	North Carolina	Georgia Pacific	Dudley	180	160
		Weyerhaeuser	Elkin	250	220
	Georgia	J.M. Huber Corp.	Commerce	285	250
		International Paper	Cordele	300	265
		Langboard	Valdosta	150	135
		Louisiana Pacific	Athens	320	285
	Mississippi	Georgia Pacific	Grenada	310	275
				2105	1865

TABLE 1 (Continued)

NORTH AMERICAN OSB PLANT CAPACITY

Million Square Feet 3/8" Basis (MMSF) | Thousand Cubic Meters (MCM)

REGION	STATE / PROVINCE	COMPANY	CITY	ANNUAL CAPACITY (MMSF)	ANNUAL CAPACITY (MCM)
SOUTHWEST U.S.					
	Louisiana	Martco Partnership	Lemoyen	150	135
	Texas	International Paper	Nacogdoches	190	170
		Louisiana Pacific	Corrigan	140	125
			New Waverly	100	90
			Silsbee	320	285
				900	805
WESTERN U.S.					
	Colorado	Louisiana Pacific	Montrose	125	110
	Idaho	Louisiana Pacific	Chilco	135	120
	Oregon	Oregon Strandboard	Brownsville	60	55
				320	285
WESTERN CANADA					
	Saskatchewan	McMillan Bloedel	Hudson Bay	200	107
	Alberta	Weyerhaeuser	Slave Lake	170	150
			Adson	300	265
			Drayton Valley	300	265
	British Columbia	Louisiana Pacific	Dawson Creek	300	265
				1270	1052
REGIONAL TOTALS					
	NORTH AMERICA TOTAL			9870	8535
	CANADA TOTAL			3190	2610
	U.S. TOTAL			6680	5925
	EASTERN NORTH AMERICA			8280	7198
	WESTERN NORTH AMERICA			1590	1337
	EASTERN CANADA & U.S. NORTH			5275	4528
	U.S. SOUTH			3005	2670

TABLE 2

NORTH AMERICAN STRUCTURAL PANEL CONSUMPTION BY REGION
BILLION SQUARE FEET 3/8" BASIS

	Capacity by 1994	Consumption 1992		1995		2000		2005	
Eastern Canada									
OSB	1.92	0.81	37%	0.90	43%	1.37	57%	1.70	68%
Plywood		1.38	63%	1.20	57%	1.04	43%	0.80	32%
Total		2.18		2.10		2.41		2.50	
Western Canada									
OSB	1.57	0.14	23%	0.20	33%	0.39	48%	0.47	57%
Plywood		0.47	77%	0.39	67%	0.41	52%	0.36	43%
Total		0.62		0.59		0.80		0.83	
U.S. West									
OSB	0.32	1.50	26%	1.96	32%	2.85	43%	3.8	53%
Plywood		4.25	74%	4.14	68%	3.77	57%	3.39	47%
Total		5.75		6.1		6.62		7.19	
U.S. South									
OSB	3.5	2.71	28%	3.59	35%	5.09	45%	6.3	55%
Plywood		6.85	72%	6.78	65%	6.1	55%	5.17	45%
Total		9.56		10.37		11.19		11.47	
U.S. Northcentral									
OSB	2.8	1.95	31%	2.48	38%	3.8	49%	4.62	59%
Plywood		4.39	69%	4.1	62%	3.9	51%	3.2	41%
Total		6.34		6.58		7.7		7.82	
U.S. Northeast									
OSB	0.55	1.26	30%	1.76	36%	2.76	47%	3.19	57%
Plywood		3.00	71%	3.15	64%	3.08	53%	2.38	43%
Total		4.25		4.91		5.84		5.57	
Total North America									
OSB	10.66	8.37	29%	10.89	36%	16.26	47%	20.08	57%
Plywood		20.34	71%	19.76	64%	18.3	53%	15.3	43%
Total		28.70		30.65		34.56		35.38	
Total Canada									
OSB	3.49	0.95	34%	1.1	41%	1.76	55%	2.17	65%
Plywood		1.85	66%	1.59	59%	1.45	45%	1.16	35%
Total		2.80		2.69		3.21		3.33	
Total U.S.									
OSB	7.17	7.42	29%	9.79	35%	14.50	46%	17.91	56%
Plywood		18.49	71%	18.17	65%	16.85	54%	14.14	44%
Total		25.90		27.96		31.35		32.05	
Western Canada & U.S. West									
OSB	1.89	1.64	26%	2.16	32%	3.24	44%	4.27	53%
Plywood		4.72	74%	4.53	68%	4.18	56%	3.75	47%
Total		6.37		6.69		7.42		8.02	
Eastern Canada & U.S. North									
OSB	5.27	4.02	31%	5.14	38%	7.93	50%	9.51	60%
Plywood		8.77	69%	8.45	62%	8.02	50%	6.38	40%
Total		12.77		13.59		15.95		15.89	

Source: Resource Information Systems

TABLE 3

CAPITAL COST ESTIMATE OF OSB PLANT

PLANT OUTPUT – 300 MMSF/YEAR 3/8" BASIS

Equipment Costs and H.P. Requirements				HP	MC$
Log Handling, Ponds And Debarking				1,700	3,900
Waferizing And Green Storage				1,700	3,500
Drying And Screening				1,600	4,000
Dry Bins And Blending				400	2,700
Forming And Pressing				3,700	14,600
Sawing And Tongue And Groove				1,100	2,900
Thermal Energy Transfer				2,000	5,800
General Mechanical Services				1,100	1,500
Transformers, Switchgear, MCC's, PLC's Etc				0	2,000
Spare Parts				0	1,000
Freight And Duty Allowance				0	2,000
Sub Total Equipment Delivered Cost				13,300	43,900
Installation Cost	Hours	@C$/h	Labor	Matl	Total
Mechanical (incl Pneumatics)	70,000	35.00	2,450	1,200	3,650
Electrical	48,000	35.00	1,680	1,600	3,280
Piping	22,000	35.00	770	800	1,570
Sub Total Installation Cost	140,000		4,900	3,600	8,500
Site Development, Building And Structures					
Site Preparation and Development Allowance					2,800
Buildings Erected On Foundations (25,000 m2 @ 320 C$/m2)					8,000
Equipment Foundations And Pits and structural Steel					3,000
Sub Total Site Development Cost					13,800
Sub Total Direct Costs					66,200
Engineering And Project Management @		5%			3,300
Contingency Allowance @		10%			6,500
Total Capital Cost (Excl Interest During Construction)					76,000
Allowance For Interest During Construction @		8%			6,000
TOTAL CAPITAL COST					MC $82,000

TABLE 4

OSB MANUFACTURING COSTS

PLANT OUTPUT 300 MMSF 3/8" PER YEAR

	LOW WOOD COST		MEDIUM WOOD COST		HIGH WOOD COST	
Wood Input: 200,000 ODMT/year 500,000 m3/year	$/Msf 3/8"	M $/Yr	$/Msf 3/8"	M $/Yr	$/Msf 3/8"	M $/Yr
Raw Material Costs:						
Wood – 1.65 m3/Msf 3/8" @ $25/m3	41.25	12375				
@$30/m3			49.50	14850		
@$35/m3					57.75	17325
Resin – Liquid Phenolic @ 3.5%, or 50 lbs/Msf 3/8" @ $0.45/lb	22.50	6750	22.50	6750	22.50	6750
Wax – 1%, or 15 lbs/Msf @ $.22/lbs	3.30	990	3.30	990	3.30	990
Edge Seal (experience figure)	0.50	150	0.50	150	0.50	150
Total Raw Material	67.55	20265	75.80	22740	84.05	25215
Operating Costs:						
Electrical Power – 160 Kwh/Msf 3/8" @ $0.032/Kwh	5.15	1545	5.15	1545	5.15	1545
Fuel – Self generated bark, fines, plus some auxiliary gas	2.00	600	2.00	600	2.00	600
Hourly Labor – 100 men @ $50,000 per yr/man (incl. fringes)	16.65	5000	16.65	5000	16.65	5000
Operating and maintenace supplies	12.00	3600	12.00	3600	12.00	3600
Administration and supervision	6.00	1800	6.00	1800	6.00	1800
Taxes and Insurance (about 1.5% of capital)	4.00	1200	4.00	1200	4.00	1200
Total Operating Costs	45.80	13745	45.80	13745	45.80	13745
Total Manufacturing Costs excl. depreciation, interest and Corporate overhead	113.35	34010	121.60	36485	129.85	38960

TABLE 5

OSB FREIGHT RATES

	Originating Town					
	Vancouver Is.		Smithers		FT. Nelson	
Destination	$ PER Boxcar	$/MSF 3/8"	$ PER Boxcar	$/MSF 3/8"	$ PER Boxcar	$/MSF 3/8"
Vancouver						
B.C. Rail					2500	25
CP Rail	1500	15				
CN Rail			3000	30		
Los Angeles						
B.C. Rail					4800	48
CP Rail/BN	4500	45				
CN Rail			5500	55		

Note : Boxcar payload 100 MSF 3/8" or 125,000 lbs

TABLE 6

OSB MILL NET PRICE CALCULATION

Based On Los Angeles Prices

	Vancouver Is.		Smithers		Ft. Nelson	
	Low	Ave.	Low	Ave.	Low	Ave.
7/16" delivered Los Angeles U.S.$	210	280	210	280	210	280
Less 5% Commissions	200	266	200	266	200	266
7/16" price Converted to 3/8" basis	171	228	171	228	171	228
Converted to CDN$	205	274	205	274	205	274
Less Freight	45	45	55	55	48	48
Mill Net	160	229	150	219	157	226

Based On Vancouver Prices

	Vancouver Is.		Smithers		Ft. Nelson	
	Low	Ave.	Low	Ave.	Low	Ave.
7/16" delivered Vancouver US$	220	300	220	300	220	300
Less 5% Commisisons	209	285	209	285	209	285
7/16" price Converted to 3/8" basis	179	244	179	244	179	244
Converted to CDN$	215	293	215	293	215	293
Less Freight	15	15	30	30	25	25
Mill Net	200	278	185	263	190	268

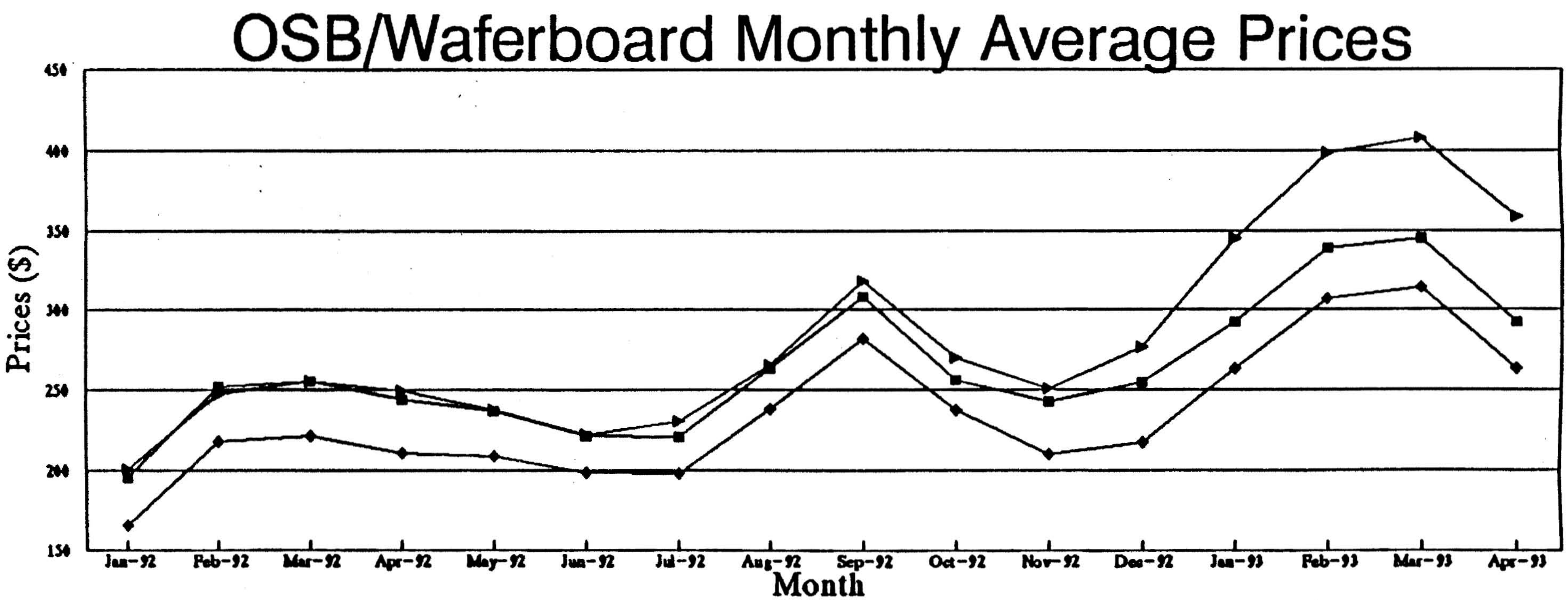
TABLE 7

FINANCIAL PERFORMANCE OF OSB PLANTS

	Vancouver Island		Smithers		Ft. Nelson	
	Low Price	Average Price	Low Price	Average Price	Low Price	Average Price
Sales	300	300	300	300	300	300
Mill net Price (L.A.)	160	229	150	219	157	226
Costs	130	130	130	130	114	114
Margin	30	99	20	89	43	112
Gross Cash Flow	9000	29700	6000	26700	12900	33600
Depreciation 10 year	8200	8200	8200	8200	8200	8200
Taxable Profit	800	21500	0	18500	4700	25400
Tax on Profit @50%	400	10750	0	9250	2350	12700
Capital Tax @ .3%	250	250	250	250	250	250
After Tax Profit	150	10500	−250	9000	2100	12450
After Tax Cash Flow	8350	18700	7950	17200	10300	20650
Gross Cash Flow as % of Capital	11%	36%	7%	33%	16%	41%
After Tax Profit as % of Capital	0%	13%	−0%	11%	3%	15%
After Tax Cash Flow as % of Capital	10%	23%	10%	21%	13%	25%

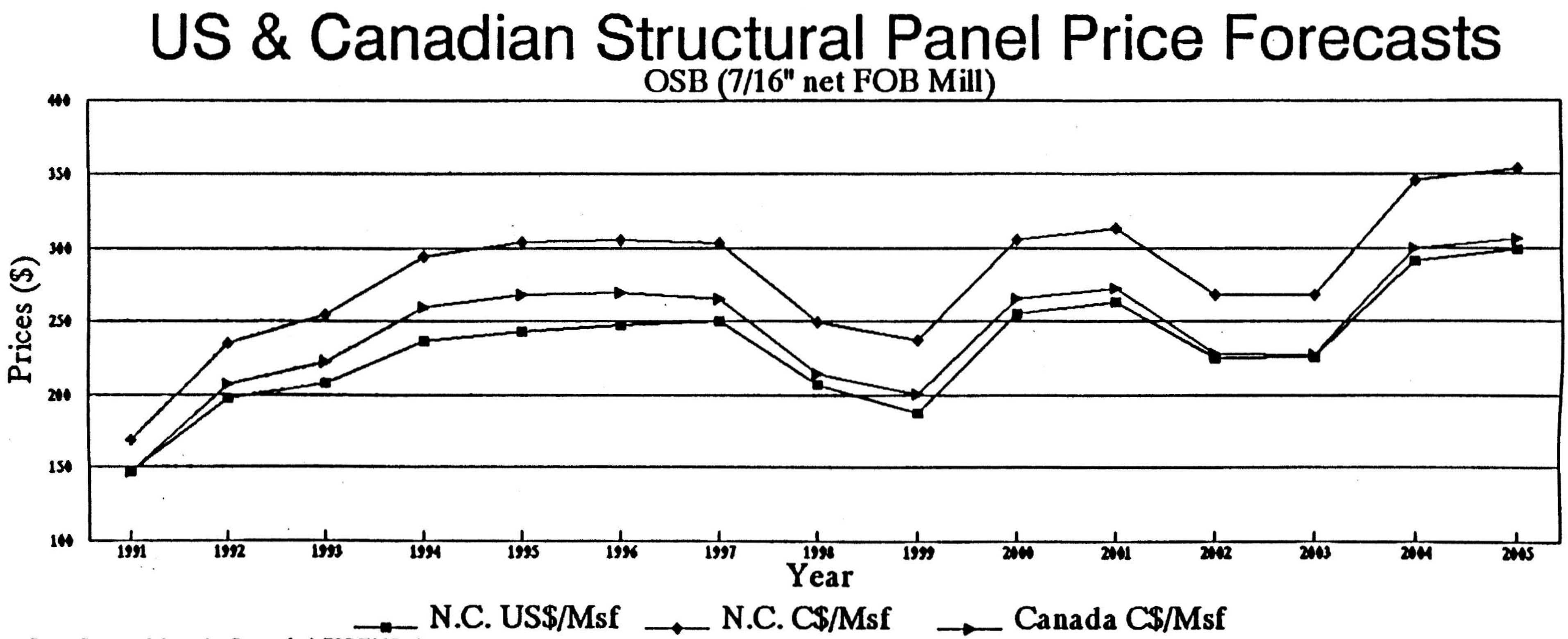
Note: Capital Cost $82,000,000

Figure 1



Source: Crows Weekly Statistics

Figure 2



Source: Resource Information Systems Inc's FORSIM Review

APPENDIX B

MDF TABLES

TABLE 8

NORTH AMERICAN MEDIUM DENSITY FIBREBOARD PLANT CAPACITY

Million Square Feet 3/4" Basis (MMSF) Thousand Cubic Meters (MCM)

REGION	STATE / PROVINCE	COMPANY	CITY	ANNUAL CAPACITY MMSF	MCM
NORTHEAST U.S.					
	New York	Norbord Industries Inc.	Deposit	55	97
EASTERN CANADA					
	New Brunswick	Flakeboard Co.	St. Stephens	40	70
	Quebec	Panfibre	Mount Laurier	65	113
SOUTHEAST U.S.					
	Alabama	Louisana Pacific	Eufaula	130	230
	Arkansas	Willamette Industries	Malvern	120	212
	North Carolina	Masonite Corporation	Spring Hope	65	115
		Weyerhaeuser	Moncure	75	133
	South Carolina	Georgia Pacific	Holy Hill	100	177
		Masonite Corporation	Marion	60	107
		Willamette Industries	Bennettsville	95	170
	Virginia	Bassett Furniture	Bassett	20	35
SOUTHWEST U.S.					
	Louisiana	Louisana Pacific	Urania	50	89
WESTERN U.S.					
	California	Louisiana Pacific	Oroville	65	115
		Sierra Pine Ltd.	Rocklin	80	141
	Montana	Plum Creek	Columbia Falls	110	195
	New Mexico	Medite Corporation	Las Vegas	85	150
	Oregon	Medite Corporation	Medford	95	168
WESTERN CANADA					
	Alberta	Blue Ridge Lumber	Blue Ridge	60	107

REGIONAL TOTALS	MMSF	MCM
NORTH AMERICA TOTAL	1370	2424
CANADA TOTAL	165	290
U.S. TOTAL	1205	2134
EASTERN NORTH AMERICA	875	1548
WESTERN NORTH AMERICA	495	876
EASTERN CANADA & NORTHEAST U.S.	160	280
SOUTHEAST & SOUTHWEST U.S.	715	1268

TABLE 9

NORTH AMERICAN MDF CONSUMPTION VERSUS CAPACITY BY REGION
MILLION SQUARE FEET 3/4" BASIS

	Capacity by	----------Consumption----------			
	1994	1992	1995	2000	2005
Eastern Canada	105	38	57	98	122
Western Canada	60	17	27	35	65
Canadian Exports	--	77	175	214	259
U.S. West	435	124	136	160	191
U.S. South	715	461	526	623	709
U.S. Northcentral	0	209	250	308	347
U.S. Northeast	55	51	66	85	102
US Exports	--	209	194	205	241
Total North America					
Domestic	1370	900	1062	1309	1536
Exports		286	369	419	500
Total Canada					
Domestic	165	55	84	133	187
Exports		77	175	214	259
Total U.S.					
Domestic	1205	845	978	1176	1349
Exports		209	194	205	241
Western Canada & U.S. West					
Domestic	495	141	163	195	256
Eastern Canada & U.S. North					
Domestic	160	298	373	491	571
Eastern North America					
Domestic	875	759	899	1114	1280

Source: Resource Information Systems

TABLE 10

NORTH AMERICAN MDF SUPPLY DEMAND BALANCE BY REGION
MILLION SQUARE FEET 3/4" BASIS

	Capacity by	--- Supply Surplus or Deficit (–) ---			
	1994	1992	1995	2000	2005
Eastern Canada	105	67	48	7	–17
Wsetern Canada	60	43	33	25	–5
Canadian Exports	0	–77	–175	–214	–259
U.S. West	435	311	299	275	244
U.S. South	715	254	189	92	6
U.S. Northcentral	0	–209	–250	–308	–347
U.S. Northeast	55	4	–11	–30	–47
US Exports		–209	–194	–205	–241
Total North America					
Domestic	1370	470	308	61	–166
Exports		184	–61	–358	–666
Total Canada					
Domestic	165	110	81	32	–22
Exports		33	–94	–182	–281
Total U.S.					
Domestic	1205	360	227	29	–144
Exports		151	33	–176	–385
Western Canada & U.S. West					
Domestic	495	354	332	300	239
Eastern Canada & U.S. North					
Domestic	160	–138	–213	–331	–411
Eastern North America					
Domestic	875	116	–24	–239	–405

Source: Resource Information Systems

TABLE 11
CAPITAL COST OF MDF PLANT
PLANT OUTPUT – 60 MMSF 3/4" BASIS PER YEAR

Equipment Costs and Horseposer Requirements				HP	MC$
Raw Material Storage & Handling				800	1,200
Refining & Blending				7,000	3,500
Drying & Surge Bins				800	2,000
Forming & Pressing				2,200	10,000
Sawing & Sanding				1,800	4,500
Thermal Energy Transfer				900	4,200
General Mechanical Services				600	1,200
Transformers, Switchgear, MCC's, PLC's Etc				0	1,300
Spare Parts				0	700
Freight And Duty Allowance				0	700
Sub Total Equipment Delivered Cost				14,100	29,300
Installation Cost	**Hours**	**@C$/h**	**Labor**	**Matl**	**Total**
Mechanical (including Pneumatics)	45,000	35.00	1,575	750	2,325
Electrical	30,000	35.00	1,050	900	1,950
Piping	15,000	35.00	525	600	1,125
Sub Total Installation Cost	90,000		3,150	2,250	5,400
Site Development, Building And Structures					
Site Preparation and Development Allowance					1,750
Buildings Erected On Foundations (15,000 m2 @ 350 C$/m2)					5,250
Equipment Foundations And Pits and structural Steel					1,200
Sub Total Site Development Cost					8,200
Sub Total Direct Costs					42,900
Engineering And Project Management @		5%			2,200
Contingency Allowance @		10%			4,300
Total Capital Cost (Excluding Interest During Construction)					49,400
Allowance For Interest During Construction @		8%			4,000
TOTAL CAPITAL COST				MC	$53,400

TABLE 12
CAPITAL COST OF MDF PLANT
PLANT OUTPUT – 120 MMSF 3/4" BASIS PER YEAR

Equipment Costs and H.P. Requirements				HP	MC$
Raw Material Storage & Handling				1,000	1,800
Refining & Blending				14,000	6,500
Drying & Surge Bins				1,500	4,000
Forming & Pressing				3,500	15,000
Sawing & Sanding				2,300	5,000
Thermal Energy Transfer				1,200	6,500
General Mechanical Services				800	1,500
Transformers, Switchgear, MCC's, PLC's Etc				0	2,000
Spare Parts				0	1,000
Freight And Duty Allowance				0	1,000
Sub Total Equipment Delivered Cost				24,300	44,300
Installation Cost	**Hours**	**@C$/h**	**Labor**	**Matl**	**Total**
Mechanical (including Pneumatics)	60,000	35.00	2,100	1,000	3,100
Electrical	40,000	35.00	1,400	1,500	2,900
Piping	20,000	35.00	700	800	1,500
Sub Total Installation Cost	120,000		4,200	3,300	7,500
Site Development, Building And Structures					
Site Preparation and Development Allowance					2,500
Buildings Erected On Foundations (20,000 m2 @ 350 C$/m2)					7,000
Equipment Foundations And Pits and structural Steel					2,000
Sub Total Site Development Cost					11,500
Sub Total Direct Costs					63,300
Engineering And Project Management @		5%			3,300
Contingency Allowance @		10%			6,600
Total Capital Cost (Excluding Interest During Construction)					73,200
Allowance For Interest During Construction @		8%			6,000
TOTAL CAPITAL COST				MC	$79,200

TABLE 13

MDF MANUFACTURING COSTS

PLANT OUTPUT 60 MMSF 3/4" PER YEAR

Wood Input: 95,000 ODMT/year 238,000 m3/year	NORTHWEST		LOWER MAINLAND		VANCOUVER ISLAND	
	$/Msf 3/4"	M $/Yr	$/Msf 3/4"	M $/Yr	$/Msf 3/4"	M $/Yr
Raw Material Costs:						
Wood – 1.6 BDMT/Msf 3/4" @ $13/BDMT	20.80	1248				
@$20/BDMT			32.00	1920	32.00	1920
Resin – Liquid Urea @ 10% or 325 lbs/Msf 3/4" @ $0.23/lb	74.75	4485				
@ $0.21/lb			68.25	4095		
@ $0.22/lb					71.5	4290
Wax – 1%, or 15 lbs/Msf @ $.22/lbs	3.30	198	3.30	198	3.30	198
Total Raw Material	98.85	5931	103.55	6213	106.80	6408
Operating Costs:						
Electrical Power – 900 Kwh/Msf 3/4" @ $0.035/Kwh	31.50	1890	31.50	1890	31.50	1890
Fuel – Self generated sanderdust and trims, plus auxiliary gas	8.00	480	7.00	420	7.00	420
Hourly Labor – 65 workers @ $45,000 per yr/man (incl. fringes)	48.75	2925				
@ $50,000per yr/man (incl. fringes)			54.17	3250	54.17	3250
Operating and maintenace supplies	30.00	1800	30.00	1800	30.00	1800
Administration and supervision	18.33	1100	18.33	1100	18.33	1100
Taxes and Insurance (about 1.5% of capital)	13.33	800	13.33	800	13.33	800
Total Operating Costs	149.92	8995	154.33	9260	154.33	9260
Total Manufacturing Costs excl. depreciation, Interest and Corporate overhead	248.77	14926	257.88	15473	261.13	15668

TABLE 14

MDF MANUFACTURING COSTS

PLANT OUTPUT 120 MMSF 3/4" PER YEAR

Wood Input: 190,000 ODMT/year 475,000 m3/year	NORTHWEST		LOWER MAINLAND		VANCOUVER ISLAND	
	$/Msf 3/4"	M $/Yr	$/Msf 3/4"	M $/Yr	$/Msf 3/4"	M $/Yr
Raw Material Costs:						
Wood – 1.6 BDMT/Msf 3/4" @ $18/BDMT	28.80	3456				
@$25/BDMT			40.00	4800	40.00	4800
Resin – Liquid Urea @ 10% or 325 lbs/Msf 3/4" @ $0.23/lb	74.75	8970				
@ $0.21/lb			68.25	8190		
@ $0.22/lb					71.5	8580
Wax – 1%, or 15 lbs/Msf @ $.22/lbs	3.30	396	3.30	396	3.30	396
Total Raw Material	106.85	12822	111.55	13386	114.80	13776
Operating Costs:						
Electrical Power – 900 Kwh/Msf 3/4" @ $0.032/Kwh	28.80	3456	28.80	3456	28.80	3456
Fuel – Self generated sanderdust and trims, plus auxiliary gas	8.00	960	7.00	840	7.00	840
Hourly Labor – 90 workers @ $45,000 per yr/man (incl. fringes)	33.75	4050				
@ $50,000per yr/man (incl. fringes)			37.50	4500	37.50	4500
Operating and maintenace supplies	22.50	2700	22.50	2700	22.50	2700
Administration and supervision	10.83	1300	10.83	1300	10.83	1300
Taxes and Insurance (about 1.5% of capital)	10.00	1200	10.00	1200	10.00	1200
Total Operating Costs	113.88	13666	116.63	13996	116.63	13996
Total Manufacturing Costs excl. depreciation, Interest and Corporate overhead	220.73	26488	228.18	27382	231.43	27772

TABLE 15

FINANCIAL PERFORMANCE OF MDF PLANTS

PLANT OUTPUT 60 MMSF 3/4" PER YEAR

	NORTHWEST		LOWER MAINLAND		VANCOUVER ISLAND	
	Low Price	Average Price	Low Price	Average Price	Low Price	Average Price
Sales	60	60	60	60	60	60
Mil net Price	372	412	415	455	404	444
Costs	249	249	259	259	261	261
Margin	123	163	156	196	143	183
Gross Cash Flow	7380	9780	9360	11760	8580	10980
Depreciation 10 year	5400	5400	5400	5400	5400	5400
Taxable Profit	1980	4380	3960	6360	3180	5580
Tax on Profit @50%	990	2190	1980	3180	1590	2790
Capital Tax @ 0.3%	170	170	170	170	170	170
After Tax Profit	820	2020	1810	3010	1420	2620
After Tax Cash Flow	6220	7420	7210	8410	6820	8020
Gross Cash Flow as % of Capital	14%	12%	17%	14%	16%	13%
After Tax Profit as % of Capital	2%	4%	3%	6%	3%	5%
After Tax Cash Flow as % of Capital	12%	14%	13%	16%	13%	15%

Note: Capital Cost $54,000,000

TABLE 16

FINANCIAL PERFORMANCE OF MDF PLANTS

PLANT OUTPUT 120 MMSF 3/4" PER YEAR

	NORTHWEST		LOWER MAINLAND		VANCOUVER ISLAND	
	Low Price	Average Price	Low Price	Average Price	Low Price	Average Price
Sales	120	120	120	120	120	120
Mil net Price	372	412	415	455	404	444
Costs	221	221	228	228	231	231
Margin	151	191	187	227	173	213
Gross Cash Flow	18120	22920	22440	27240	20760	25560
Depreciation 10 year	8000	8000	8000	8000	8000	8000
Taxable Profit	10120	14920	14440	19240	12760	17560
Tax on Profit @50%	5060	7460	7220	9620	6380	8780
Capital Tax @ 0.3%	240	240	240	240	240	240
After Tax Profit	4820	7220	6980	9380	6140	8540
After Tax Cash Flow	12820	15220	14980	17380	14140	16540
Gross Cash Flow as % of Capital	23%	29%	28%	34%	26%	32%
After Tax Profit as % of Capital	6%	9%	9%	12%	8%	11%
After Tax Cash Flow as % of Capital	16%	19%	19%	22%	18%	21%

Note: Capital Cost $80,000,000