ECONOMIC FEASIBILITY OF BASIC CHEMICAL MANUFACTURING IN THE PROVINCE OF BRITISH COLUMBIA

by

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ABSTRACT

The requirements for an investment in a chemical manufacturing plant to be economically feasible have been investigated. The items studied included the market which exists for chemicals, the resources required to manufacture chemicals, and the finances commited to the investments in manufacturing plants. The chemical plants investigated were confined to that sector defined as basic and intermediate chemicals, further, the study was restricted to the geographic region of British Columbia.

Three sources of information were pertinent to this study. These were the external trade data for the province of British Columbia, available through Victoria from the Dominion Bureau of Statistics; the growth in the forest industry, available from journals and news releases; and specific expense information, obtained or confirmed from private communication with various individuals in the industries pertinent to the study. Other miscellaneous books, publications, and unpublished materials were used as required to complete the analysis of the study.

The perinent information including markets and prices (revenue), resources (expenses), and capital commitment were combined to determine rate of return on investment. Return

was considered to be the principal criteria for the evaluation of the economic feasibility of a chemical manufacturing plant.

The results of the study indicated that the growth of the forest industry accounted for the feasibility of chemical plants in the province in the recent past and the near term future. The chemical pulp exports especially to Japan and Europe are expected to sustain growth in pulping and bleaching chemicals. A declining per capita consumption for plywood and increased exports of this material are expected to sustain a straight line growth in plywood resin chemicals in the near term future. The possibilities for opportunities in basic aromatic chemicals, and plastics, and synthetic detergent intermediates were outlined, all of which would require market development.

Resources and capital commitment were not found to be a restriction upon economic feasibility. Sulphur and petroleum are available within the province, but the majority of the mineral raw materials are imported. Technology was in each case the organization's own. Capital for the investments made in British Columbia has been provided by the routine operations of the parent organization, and funds flow from the local plants operations should sustain expansion.

The return on investment for the basic chemical plants which have been established recently in British Columbia was found to be modest in the short run. Various factors contributed to reductions in rate of return including rate of incremental expansion, market structure change, price reductions, and competition.

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CHAPTER I

INTRODUCTION

I. PURPOSE OF STUDY

This thesis studies the growth in a sector of the chemical industry in the province of British Columbia. As evidence of this growth, approximately 30 million dollars have been invested in four chemical plants in the lower mainland area since 1957.[1] What this investment contributes to the economy of the province may not be fully recognized because the chemicals do not reach the consumer directly. The chemicals are consumed primarily in the manufacture of pulp and paper, and plywood, which are products of the forestry industry--the most important industry in the province.

Chemical plant investments such as the four examples mentioned must be economically feasible. The criteria for their success would be the concern of business management. Therefore, the criteria for the economic feasibility of such plant investments is to be studied. Market forecasting, revenue and expense prediction, capital commitment, and the

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[1]Hooker Chemicals Limited, $21 million, North Vancouver and Nanaimo; Electric Reduction Co. of Canada Ltd., $4 million, North Vancouver; and Dow Chemical of Canada Ltd., $5 million, Ladner, B.C.

respective time patterns of each are assumed to be the essential criteria. Investigation of this information for the recent examples and other near term possibilities would indicate the impact of the defined sector of the chemical industry on the economy of British Columbia in the next few years.

II. REASON FOR STUDY

Chemicals and allied products were approximately five per cent of the nation's total expenditure on goods and services at the time of the Royal Commission on Canada's Economic Prospects.[2] Heavy chemicals manufactured in British Columbia are currently estimated to be about two per cent of the value of manufacturing shipments.[3] The chemical industry will expand in British Columbia if a combination of resources is economically efficient. In the interests of the economy of British Columbia, one might ask why four chemical plants

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[2] J. Davis, The Canadian Chemical Industry, Royal Commission on Canada's Economic Prospects No. 15, March, 1957, p. 1. Hereafter referred to by the title only.

[3] Summary of Business Activity, Bureau of Economics and Statistics, Victoria, 1963, p. I. shipments--$2,335 million, and the writer's estimate of heavy chemical sales--$53 million by Hooker, Electric Reduction, Dow, Allied, and Consolidated Mining & Smelting.

were built when they were by the firms involved. With continued interest one would consider the extent of growth in or additions to chemical plants to be expected beyond these recent additions.

Limitations of Study

Many manufacturing establishments employ chemical processes. Examples of chemical process industries in British Columbia include metals, wood pulp, petroleum products, cement, sugar, fermented liquors, leather, glass, industrial gases, and ceramics. A broad collection of industries results which cannot be defined concisely. The Dominion Bureau of Statistics classifies a large group of industries including many of the above as Chemicals and Allied Products. The chemical industry also may be divided into broad product categories: raw materials, primary chemicals, intermediates, and finished products. Raw materials are usually basic minerals, but may include agricultural products. Coal and petroleum are also most important as chemical raw materials although their principal use is in the production of energy. Finished products are fabricated into consumer articles. The stages between raw materials and finished products are usually thought by the general public to include chemical materials. These materials are consumed or destroyed in the manufacture of finished products so that they are no longer recognizable. The recent chemical plant additions in the lower mainland area, which are studied in this thesis, have products in this intermediate sector. The study of the raw material sector for expense prediction and the finished product sector for market forecasting is treated only in sufficient detail to obtain relevant information for the intermediate chemical sector.

The number of chemicals which might be manufactured number in the thousands. All the possibilities cannot be extensively explored, but a logical expansion beyond those chemicals which are presently manufactured can be attempted. Those chemicals with a sufficient market to justify corporate investment are considered pertinent to this study.

The specific references to local manufacturers are intended to provide practical examples for business decisions. Predictions of local firms' expenses are not precise, but serve as a guide. An individual firm can combine actual usage and cost figures to derive more precise historical data. Also, the examples are not examined beyond the regional boundaries of British Columbia. Because the corporate boundaries are not this clear cut the influence of the adjacent areas of the United States, Canada, and beyond can only be implied and is not studied here.

Definitions

The chemical industry as defined will not include raw materials. Raw materials, which are defined best by example, include such important basic minerals as salt, limestone, sulphur, phosphate rock, pyrites, bauxite, and potash. Raw materials obtained from agriculture include cornstarch, vegetable and animal oils, and milk.

Primary or basic chemicals may be thought of as those which are produced directly from raw materials. Intermediates are produced from primary or basic chemicals. The primary industry is characterized by few manufacturers and large investments. One can easily visualize volume production of low-cost products in this setting.

The term basic is used mostly by the chemical industry and other industries. The term heavy initially applied to bulky primary chemicals manufactured from minerals (inorganic raw materials). Heavy now includes primary chemicals manufactured from coal and petroleum (organic raw materials). Three modifiers now characterize the sector of the chemical industry in this study--primary or basic or heavy. A subdivision into inorganic or organic chemicals may also be used.

Finished products or end use completes a definition of the chemical industry. For the purposes of this study the manufacture of finished products may provide a market for the primary industry. Products representative of this sector which are within the chemical and allied products industry are fibers, plastics, coatings, adhesives, pharmaceuticals, fertilizers, and soaps. Other industries which provide markets or end use for chemicals in British Columbia are mining, pulp and paper, petroleum refining, and agriculture.

Diversification of a firm's product line can be sought to reduce the risk to or improve the level of rate of return on investment. Thus, vertical integration in the chemical industry would accomplish diversification through manufacture of primary, intermediate, and finished product chemicals. Petroleum which was mentioned earlier as a raw material provides a complication. A chemical plant manufacturing a basic chemical from petroleum, or a petroleum refinery using its raw materials to produce chemicals offer little distinction within the immediate product area. Products in this area are called petro-chemicals. The total activities of the chemical or petroleum firm would characterize their classification, however, overlap inevitably exists. In the other direction, vertical integration with finished products is also generally considered outside the scope of the chemical industry, although chemical companies may actively manufacture finished products or manufacture these products into consumer articles.

In contrast with vertical integration, horizontal integration would normally keep a chemical firm within the bounds of the basic chemical industry. Such practice might be referred to as rounding out the line when one raw material is used, or it might include additional lines utilizing other raw materials.

III. ORGANIZATION OF STUDY

The market for heavy chemicals in British Columbia, one of the first essentials to determine the economic feasibility of manufacturing a product, is investigated in the next two chapters. The two chapters are necessary to establish a historical perspective before attempting a forecast. The supply of chemicals to end use industries, whether through local manufacture or import, is reviewed over the period of the last ten years[4] and projected from this historical base beyond 1970. Projections include the market growth for the chemicals which are presently manufactured and for related new products. (i.e., horizontal integration).

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[4] The reason for this time period will be more apparent when the actual historical growth is considered in Chapter 2.

A second essential of economic feasibility is an analysis of revenue and expense data as well as intangibles. Chapter IV, in the study, includes detailed information on the resources and their resultant expense which are necessities for chemical manufacturing. Included are the variable items raw materials, labor and supervision, utilities, transportation, technical requirements, and service. Notes on timing and tariffs are included to complete the discussion. Revenue is deferred until Chapter V when price is discussed and this information is combined with the earlier market data to provide the counterpart of expense for income determination.

The third essential of economic feasibility is capital commitment. Referring to isolated examples falling within the boundaries of the province of British Columbia is practically impossible. The first part of Chapter V therefore refers to national and international organizations and compares organizations on this basis. The investment in the local manufacturing facilities must then be related within this context. The financing transactions of large organizations provide more funds than the requirements of the local facilities, but funds flow may be interpreted within the local context or the consolidated organization accounts. Thus, return on investment is calculated within the local context and then related to the whole.

Return on investment calculations are not possible until those items not discussed in earlier chapters are reviewed. The second part of Chapter V reviews chemical prices and the "fixed" expenses which follow as a result of the investments; specifically, depreciation, taxes, insurance, debt, and general expense. Investment, revenue, and expense are then combined and representative profits determined for the current examples of heavy chemical manufacturing investments in British Columbia. The profit for additional near term possibilities is also calculated.

IV. RESUME OF HISTORY OF THE CHEMICAL INDUSTRY

The earliest manufacture of a chemical product in the province was associated with the building of the transcontinental railroad at Yale, B.C. in 1881. Sulphuric acid and nitric acid were supplied from a small temporary chemical plant nearby at Emory for use in the manufacture of explosives.[5] The raw material sulphur came from Japan and the saltpetre from Chile. Other early explosives plants existed

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[5] C.J.S. Warrington and R.V.V. Nicholls, A History of Chemistry in Canada (Toronto: Sir Isaac Pitman and Sons (Canada) Limited, 1949), p. 301.

at Nanaimo, Victoria, and Bowen Island to supply the mining industry. In 1913 a new plant was started on James Island to consolidate manufacturing in a more efficient plant.[6] In 1961 operations were suspended at this plant, the closest manufacture by more efficient continuous processing now existing in Calgary.

Sulphuric acid manufacture for the explosive plants was begun at Barnet in 1908 using Japanese sulphur.[7] In 1927 operations were converted to iron sulphide ore from the Brittania Mine. In 1962 operation for sulphuric acid was suspended and the acid is now shipped from Trail. Alum manufacture for pulp and paper mill use and water treatment was begun at Barnet in 1957 and continues, although a competitor entered the market area in Alberta during 1962.[8]

Large scale sulphuric acid manufacture was begun at Trail in 1931, after research into fume elimination.[9] Operations have expanded greatly since that time into several heavy chemicals for metal refining and fertilizer manufacture.

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[6] Ibid., pp. 306-7.

[7] Canadian Chemical Journey (London: Canadian Section, Society of Chemical Industry, 1958), p. 60.

[8] Private communication.

[9] C.J.S. Warrington and R.V.V. Nicholls, op. cit., p. 52.

At present, capacity for sulphuric acid is over 1200 tons per day (T/D) at Trail, more than 1600 T/D fertilizer capacity at Trail, 200 T/D fertilizer capacity at Kimberley, and 300 T/D fertilizer capacity at Calgary.[10] Expansions in 1964 which will add to this capacity are discussed later.

Synthetic resin glue, a finished product, was manufactured in New Westminster for the first time in 1948 followed by a plant at Marpole in 1949 and later a plant in Port Moody. Phenol, one of the heavy chemicals for this finished product, was produced for the first time in British Columbia in 1963 by Dow Chemical Company of Canada. The principal market is the local plywood glue plants, but some phenol is shipped to Dow operations near Edmonton, and the balance to eastern Canadian markets.[11] The other basic chemical required in large quantities for synthetic glue manufacture is formaldehyde. Reichold Chemicals Ltd., one of the glue manufacturers, started operating a plant in 1964 which produces formaldehyde for captive use. Expansion which will provide formaldehyde for sale is contemplated.

The manufacture of caustic soda and chlorine by Hooker

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[10] Moody's Industrial Manual (New York: Moody's Investors Service, 1961), p. 1549. Hereafter referred to as Moody's Industrials.

[11] Private communication.

Chemicals (Canada) Ltd., and sodium chlorate by Electric Reduction Company of Canada, Ltd. (Erco) began in North Vancouver in 1958. Caustic soda and chlorine manufacture was extended to Nanaimo by Hooker Chemicals in 1964. Consolidated Mining and Smelting Co. started a small plant for caustic and chlorine manufacture at Trail in 1961. These heavy chemicals are consumed primarily in the manufacture of chemical pulps from wood.

The Canadian Chemical Industry, a volume of the Royal Commission Report published in 1957, consolidated in one place an economic study of the chemical industry.[12] The study is of course national and general, and not regional and specific. Comparisons with its predictions can now be made. The value of production increased roughly fivefold from 1929 to 1955 and the conservative estimate in the report was for another fivefold increase by 1980. Canadian Chemical production was $0.7 billion in 1950.[13] In 1962, $1.7 billion in chemicals were shipped.[14] The Royal Commission report

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[12] Op. cit.

[13] The Canadian Chemical Industry, p. 20.

[14] "Market Data," Canadian Chemical Processing, 47 (July, 1963), 37.

anticipated about $2 billion by this time.[15]

The industries annual investment in new plant and equipment is over $100 million per year. The amount was $124 million in 1961, $114 million in 1962,[16] and $158 million in 1963.[17] The $30 million invested in British Columbia in four plants in approximately 6 years may be compared to these total figures (an average of $5 million per year). Vancouver was not a chemical center at the time of the Commission's report, although Edmonton had been added as a center to a chemical industry concentrated in the central provinces. "Fully 90 per cent of those finding jobs with this industry are employed in Ontario and Quebec."[18]

The heavy chemical group as a whole appears to be largely market oriented. "Its future growth will therefore tend to parallel that of industrial development generally."[19] Looked at in another way, "It has been estimated recently that some 60 per cent of all Canadian inorganic chemical

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15 The Canadian Chemical Industry, p. 87.

16 "Capital Budgets and Capital Markets," Chemistry in Canada, 14 (Sept. 1962), p. 8.

17 "Market Data," op. cit.

18 The Canadian Chemical Industry, p. 21.

19 Ibid., p. 29.

production is being used in the manufacture of products which themselves are subsequently sold abroad.[20] The inorganic industry is about one-seventeenth the size of its counterpart in the United States, but has grown since prewar days at an actual rate of 8 per cent compounded annually.[21] Establishment of the Vancouver plants in the late 1950's makes the inorganic industry in Canada largely self sufficient, and as the historical development indicated this is a recent turning point.

Heavy organic chemicals are somewhat different. The majority of these chemicals are used in finished products and consumer products. Many of the organics are imported. "In this category Canadian production is continuing to follow, sometimes after a decade or more, the manufacturing patterns which have been initiated elsewhere."[22] With less significant transportation costs for the higher priced organics, Canadian production once established is often capable of competing with imported chemicals across the country.

The Department of Industrial Development, Trade and Commerce for the province in Victoria has produced pamphlets

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[20] Ibid., p. 33.

[21] Ibid., p. 36.

[22] Ibid., p. 34.

from time to time concerning the chemical industries. Petrochemicals[23] stated that the volume of the market within British Columbia would not support a major petrochemical complex. Some valid conclusions are reached, but the extent of the chemical industries' diversification, often integrating with itself, and the possibility for additional market developments can be explored differently at this time.

Pamphlets have also been published in the United States northwestern states regarding the chemical market in that area. The difficulty with pamphlets generally, is that they are often isolated publications which present data for a point in time, but are of little value as a means to project and forecast market growth.

Present developments in the heavy chemical industry of this province include continued increases in fertilizer capacity at Trail, and announced increases in caustic-chlorine production near Prince Rupert to supply expanded and projected pulp and paper mills in that area. There are no announced plans in the Vancouver area,[24] and Dow as

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[23] Petrochemicals, Department of Industrial Development, Trade, and Commerce, Victoria: April, 1962, p. 6.

[24] A news release in July, 1964 states that Ford Machinery Corporation will build a $10 million plant for caustic-chlorine production immediately at Squamish. See page 118.

expressed in Petrochemicals will be "forced" to continue importing toluene, its basic petrochemical raw material.[25]

V. SOURCE DATA

As stated earlier, the pertinent information required for an economic feasibility study is market data, expense information, and capital commitment. The market data must be related to the regional market. Trade journals and statistics usually indicate national production. To obtain regional chemical figures, extensive discussions must be held with local manufacturers to piece together and check the figures. For the pulp and paper industry market, to indicate pulp production, the plant capacity increases which have occurred in the past within British Columbia were followed in the journals, and future expansion plans were followed through news releases. Some pulp and paper trade association figures were available, but these are confidential. The Dominion Bureau of Statistics import and export figures were available for British Columbia only, and because few operations and end uses are presently involved a fairly accurate picture can be ascertained.

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[25] *Op. cit.*, p. 19.

Information on prices and costs may be taken from journals and textbooks. Although data on selling prices are satisfactory most cost data are inadequate. Discussions with local manufacturers and transportation companies again is required. Available published data on costs can be very misleading. Price information for materials, labor, and overhead items is desired on a local basis, and must be obtained directly from local sources. Marine transport is involved for which tariff rates do not exist such as are available for the railroads. Discussions with the personnel of local shipping firms is again required.

Financing the local heavy chemical operations has occurred initially through the international parent organizations. The financial statements of the parent organizations were reviewed to elicit what information they contained. No direct contacts were made concerning this phase of the economics of the chemical industry in the province. The magnitude of the investments in the local operations is compared with the consolidated funds flow of the parent organizations. Commitment of capital in British Columbia is one of many choices the parents could consider.

The information gathered concerning markets and costs is combined to calculate rate of return on investment by recognized procedures. The returns calculated indicate how satisfactorily economic requirements have been combined as measured against a recognized standard of profitability.

The study is concluded with a review of market trends framed within regional supply and demand. International consequences which cannot be ignored can only be inferred. The outlook for the industry in the near term can be shown readily. The long run expectations must continue to follow a consideration of all developments. Further study would consider the development of a sales-service organization in a region, and the possibility of international marketing.

CHAPTER II

PRESENT HEAVY CHEMICAL USE

I. CONSUMERS

The preparation of a market forecast is supported by what has gone before. A market survey for heavy chemicals consumption begins with the past requirements of the province's industries. Data from journals and Dominion statistics for the external trade of the province are compiled for this purpose. The local chemical plants are then introduced to this framwork, and the differences accounted for by shipments from other provinces or countries.

Forestry

Pulp and Paper. To determine the market for chemicals in the pulp and paper industry in British Columbia, it is necessary to distinguish between the various types of pulp manufactured. Pulp is firstly classified as chemical or mechanical. As the names imply, mechanical pulp is of little concern to the study[1] except to the extent that chemical pulp

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[1]Groundwood pulp is bleached with zinc hydrosolphite, which is manufactured with waste zinc from Trail and sodium sulphite or soda ash and sulphur dioxide. Imports of sodium sulphite were 1030 tons in 1962. Current requirements of zinc hydrosulphite are estimated to be 3000 Tons/yr.

is mixed with it for newsprint manufacture. The chemical pulps are divided into kraft and sulphite pulps. The kraft pulp is further roughly subdivided, according to the amount of bleaching, into fully bleached, semi-bleached, or unbleached. Sulphite pulps as well as bleached and unbleached subdivisions, have another major subdivision called dissolving pulp. These classifications, which follow Dominion Bureau of Statistics classifications, are utilized in this study.

A further simplifying assumption is used to compile the chemical requirements for chemical pulps. All the existing pulp mills do not use similar bleaching processes and do not have similar efficiencies. Such details are important for the chemical firm to properly service its market at the various pulp mill sites, but are omitted in this study.[2]

The national production and export of pulp has been summarized for the years 1951 to 1962 by <u>Canadian Pulp and Paper Industry</u>.[3] The April issues of this journal were consulted to determine the changes in British Columbia pulp mill

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[2]The average chemical consumption figures used were found to check with the total market information closely. Further refinements from the effect of individual pulp mill methods would add little to the total accuracy and would soon be out of date.

[3]"Annual Review and Outlook for 1963," <u>Canadian Pulp and Paper Industry</u>, 16 (April, 1963), 41.

capacity over a similar period. The actual production of chemical pulps in British Columbia during 1962 when the mills were producing near capacity was available from a private source. The results for selected years are shown in Table I. The figures from the Royal Commission report on Canada's Economic Prospects are included for comparison. The total Canadian figures compared with the initial Royal Commission predictions indicate a lag in newsprint and a lead in chemical pulp. The general attitude of the Canadian pulp and paper industry has been pessimistic over the years, but a different situation has existed in Briish Columbia. In relation to Canadian production, British Columbia's production of newsprint and especially kraft pulp has shown substantial gains. In a 14 year period British Columbia, as a percentage of Canadian capacity, grew from 6 to 13 per cent.

The chemical pulp capacity for the existing eleven pulp mills in British Columbia is summarized in Table II. The rapid growth of the total kraft production capacity from 305,000 tons in 1953 to 1,680,000 tons in 1964 is apparent. Sulphite pulp was actually in decline before 1958 when the sulphite plant at Woodfibre was shut down. This is not shown in Table II, but a modest growth instead is indicated from this new turning point.

Using the pulp capacities that have been summarized,

TABLE I

PRODUCTION OF PULP IN CANADA AND BRITISH COLUMBIA
FOR SELECTED YEARS

in thousands of tons

Year	PRODUCTION[a]			GORDON REPORT[c]		BRITISH COLUMBIA PRODUCTION			
	Total	Chemical	Newsprint	Newsprint	Pulp & Misc.	Newsprint	Pulp	Kraft	Sulphite
1955	10,151	4,359				585[c]	749[c]		
1960	11,183	5,324		7,100	4,894				
1962	11,855	5,964	6,691			988[b]		1,240[d]	410[d]

Sources:

[a] "Annual Review," <u>Canadian Pulp and Paper Industry</u>, April issues.

[b] Production capacity, <u>Ibid</u>.

[c] The Forestry Study Group, <u>The Outlook for the Canadian Forest Industries</u>, Royal Commission on Canada's Economic Prospects No. 26, March, 1957.

[d] Private communication.

TABLE II

CHEMICAL PULP CAPACITY OF BRITISH COLUMBIA PULP MILLS

in thousands of tons

Years	1953	1954	1955	1956	1957	1958	1960	1961	1962	1964[b]	1966[b]
Sulphite	c	c	c	c	300	340[a]	340	340	360	390	440
Kraft Bleached	c	c	c	c	120	205	300	305	460	605	685
Semi-bleached	c	60	c	165	210	240	275	285	365	595	635
Total Kraft	305	410	600	635	680	865	865	1,140	1,240	1,680	1,940

[a]Woodfibre shutdown in 1958 excluded.

[b]Includes announced expansions from news releases.

[c]Not available.

Source: "Annual Review," Canadian Pulp and Paper Industry, April Issues.

and multiplying by average chemical consumption for each grade of pulp, an average chemical consumption for pulp manufacturing is calculated. Typical details are given in Appendix A-2. The results from this calculation are shown in Table III.[4] The validity for such an approach to chemical consumption in the pulp and paper industry is more evident when the details of growth in each pulp sector is reviewed in the next chapter. Table III does not include the requirements for the raw materials sulphur and limestone. Alum was imported in the amounts of 3200 and 4000 tons in the years 1955 and 1956. The quantity for 1963 is 7000 tons which is a supplier estimate. The quantity consumed is not consistent with the pulp produced even when the pulp process is known because consumption depends upon water quality at each mill site. The above figures, therefore, are not shown in Table III.

Plywood. The plywood manufacturers in British Columbia use synthetic resin to make the glue used in the ply bonding process. A mixture is compounded at the plywood mills using

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[4]The capacity, production, or other figures concerning caustic in this thesis are based upon 100 per cent caustic (NaOH). This basis is also used in Dominion Bureau of Statistics reports. The trade, however, typically sells on a 76 per cent Na_2O basis (approximately 98 per cent NaOH).

TABLE III

HEAVY CHEMICAL REQUIREMENTS OF BRITISH COLUMBIA PULP MILLS

in thousands of tons

Year	Salt Cake	Caustic Soda	Chlorine	Sodium Chlorate	Sulphuric Acid
1957		69.5	42.0		
1958		74.5	49.0		
1959		78.0	53.5		
1960		81.5	58.2		
1961		90.0	69.7		
1962	59.0	94.0	75.0	14.5	11.1
1963	67.3	100.6	83.0	17.2	13.3
1964[a]	82.0	112.7	98.4	20.5	15.9
1965					
1966[a]	94.0	118.0	105.0	22.3	17.2

[a] Includes announced expansions from news releases.

Source: As calculated. Typical details in Appendix A-2.

resin and a small amount of caustic soda with water and filler. Phenol-formaldehyde resin is by far the predominant resin used. Comparative figures for 1962 for three types of resin are 67,705,768 pounds of phenol-formaldehyde, 1,152,419 pounds of urea-formaldehyde, and 42,398 pounds of melamine-formaldehyde.[5]

Members of the Plywood Manufacturers Association of British Columbia produce nearly all the British Columbia plywood. In 1962, the production from 11 plants in the association was estimated to be 91.5 per cent of the total.[6] The total production of member mills for the period 1950 to 1962 is shown in Figure 1. A steady increase in production is shown except in the late 1950's when a combination of other industrial activity combined with strikes in the plywood mills caused irregularities.

A close parallel between plywood production and phenol and formaldehyde requirements in British Columbia is shown by early 1950 figures when all requirements were imported before production began in Canada. This parallel is clearly shown

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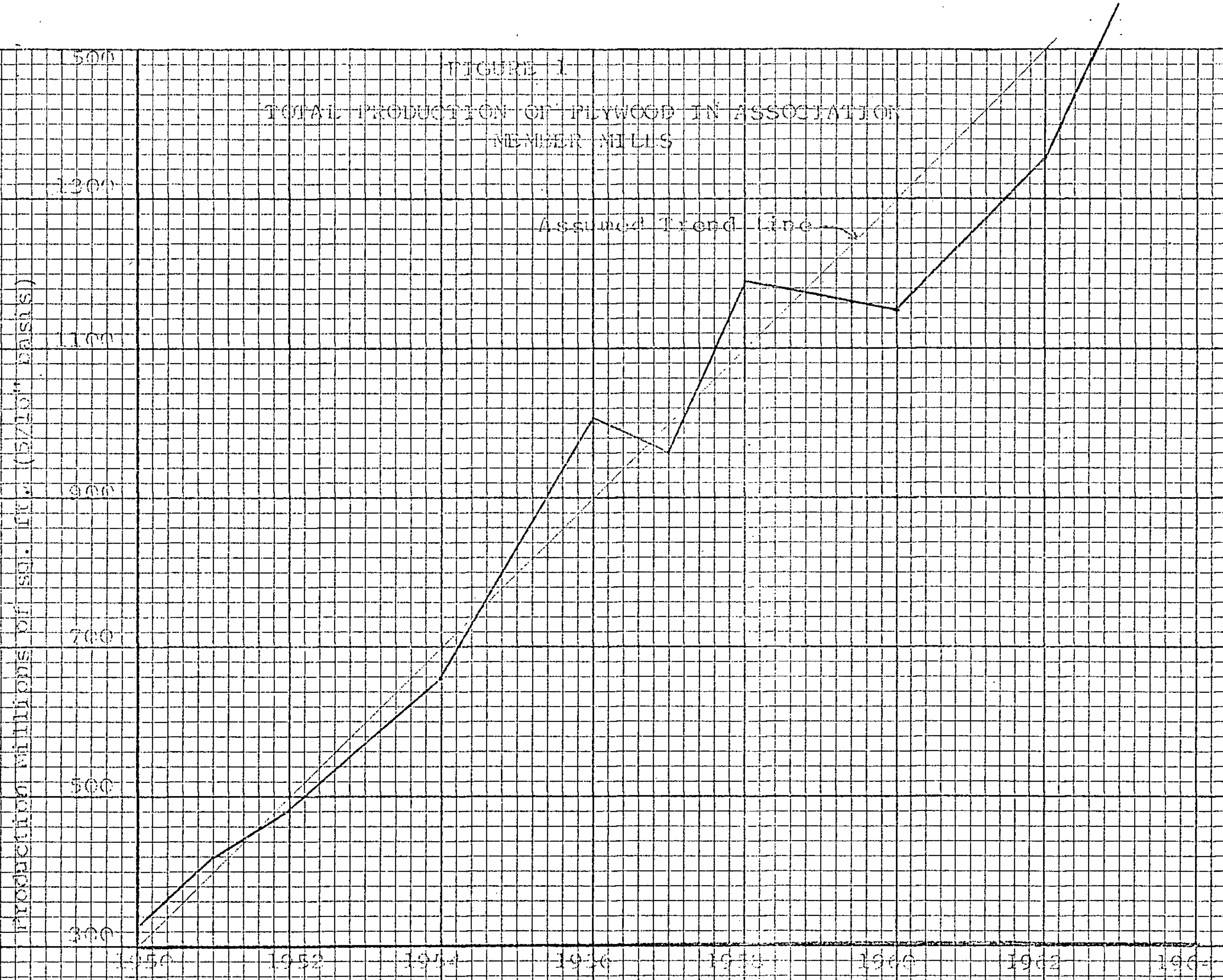
[5] Submission to the Tariff Board, Plywood Manufacturers Association of British Columbia, January, 1963. Table III.

[6] W.L. Oostrenbrink, "An Economic Analysis of the B.C. Softwood Plywood Industry," graduating thesis B. Comm., The University of British Columbia, April, 1962. p. 8.

FIGURE 1

TOTAL PRODUCTION OF PLYWOOD IN ASSOCIATION MEMBER MILLS



Source: Plywood Manufacturers Association of British Columbia. Annual Report. Vancouver: Plywood Manufacturers Assoc., 1962.

in Figure 2 from 1950 to 1956. An estimate of the majority of the market growth for the basic chemicals phenol and formaldehyde is derived therefore from the plywood production figures. The proportion of glue required for plywood manufacture has remained stable (11,988,513 pounds in 1949 and 68,903,085 pounds in 1962) compared with the plywood production.[7] The solids in the resin averages 41 per cent, and breaking this into the requirements for the two basic chemicals results in requirements of 15,900,000 pounds of phenol and 13,600,000 pounds of formaldehyde[8] per year for requirements in 1963-64 of 72,000,000 pounds of resin.[9]

Mining and Metallurgy

Concentration of ores by flotation uses Xanthates. Requirements of more than one million pounds per year of these chemicals had been imported into British Columbia until 1961 when production began in Edmonton, Alberta. Recent vigorous mining development in British Columbia which includes concentration of copper and molybdenum ores does not consume in

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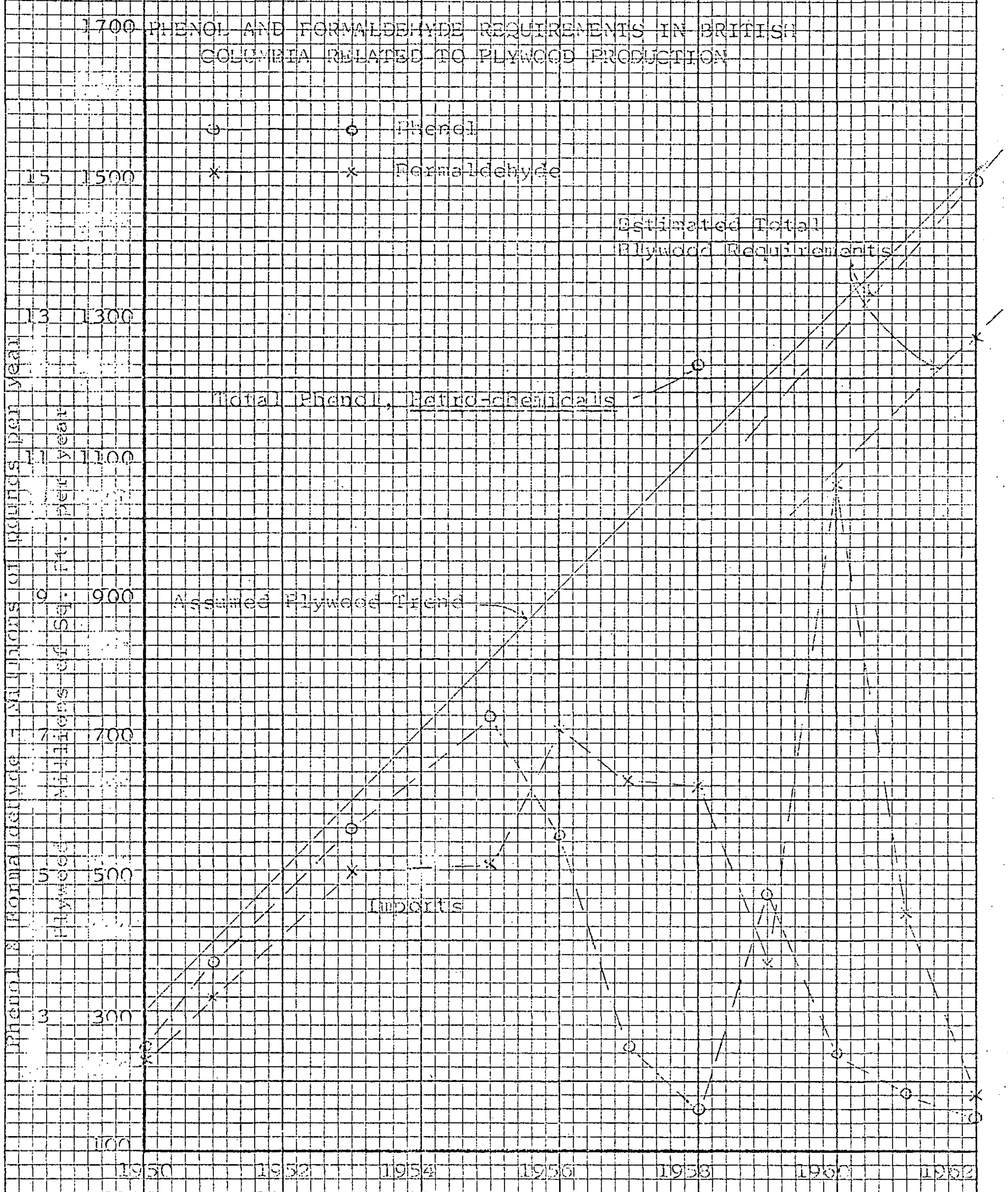
[7] Plywood Manufacturers Association, op. cit.

[8] 100 per cent basis is used in this thesis. Formaldehyde is usually sold on a 37 per cent solution basis. Manufacture is usually in a range from 35 to 50 per cent solution.

[9] Private communication.

FIGURE 2

PHENOL AND FORMALDEHYDE REQUIREMENTS IN BRITISH COLUMBIA RELATED TO PLYWOOD PRODUCTION



Source: Preliminary State of External Trade, Victoria: Bureau of Economics and Statistics, Annually. Petrochemicals, Victoria: Department of Industrial Development, Trade, and Commerce, 1962.

volume any basic chemicals.

Chemical consumption for metallurgy is associated extensively with the refining phase. The only refining operations in the province at Trail produce much of the chemical requirements on the site. The lead-zinc market and ore refining are not investigated here. Another refining process pressure leaching with ammonia has been developed and is now employed near Edmonton, Alberta. No such applications have been employed in British Columbia.

Miscellaneous

Additional consumption of chemicals by other industries is next briefly reviewed to indicate their consequence as a market within British Columbia. These industries include plastics and resins, agriculture, soap, and oil and gas.[10]

The plastics industry has four broad end use categories: (1) component parts, (2) packaging, (3) construction, and (4) consumer items.[11] Construction and consumer items

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[10] The usual history of chemical production begins with industries in need of chemicals. Steel refining may develop in a small way in the future. Textiles and rubber are assumed to be doubtful for the present in British Columbia.

[11] Chemical Marketing in the Competitive Sixties (No. 24 Advances in Chemistry Series, Washington: American Chemical Society, 1959), p. 124.

(toys and containers) would appear to be the present manufacturing outlets in British Columbia. Reinforced plastic sheet currently manufactured uses about 150,000 pounds of chemicals (polyesters, styrene),[12] and another 200,000 pounds is imported.[13] Imports of resins for use in coatings included 500,000 pounds of polyester resins in 1962.[14] Typical raw materials for polyester resins include maleic anhydride (fatty acids and drying oils are added to produce alkyd coatings), phthalic anhydride, styrene (produces thermosetting plastics for reinforced plastics), and alcohols and glycols.[15] The current market for maleic anhydride is estimated at 300,000 pounds per year, and for polystyrene (precursor styrene) is estimated at 80,000 pounds per year.[16] These two chemicals will be discussed further later in the study. Polyethylene which is used in toys and containers is manufactured in Edmonton. Other plastic products, laminated

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[12] Private communication.

[13] Preliminary Statement of External Trade (Bureau of Economics and Statistics, Victoria, B.C., 1962), p. 221. Hereafter referred to as External Trade.

[14] Ibid., p. 219.

[15] J. Bjorksten et. al., Polyesters and their applications (New York: Reinhold Publishing Corporation, 1956), pp. 11 and 21.

[16] Private communication. Petrochemicals estimated styrene requirements of 16,000 pounds per year in 1958.

plastic, and several film types are imported, but details for these products are not significant in themselves at this time.

Despite the large production of fertilizer materials in Trail a small amount of fertilizer materials including nearly 8000 tons of nitrogen, phosphorus, and other types were imported in 1962. Another class of chemicals imported for agricultural purposes are sprays which have a value of one million dollars.[17]

Consumption of soap powders should parallel population. Industries such as textiles and leather also use large amounts of these materials. Detergents are produced in eastern Canada, shipped throughout the Dominion, and imports have been small since 1962. Dry synthetic detergents had factory shipments in Canada of 172 and 182 million pounds in 1961 and 1962 respectively.[18] The intermediate chemicals used in approximately half of the dry synthetic detergents manufactured are alkylaryl sulphonate and sodium tripolyphosphate. The sulphonate in turn is derived from the basics benzene, either a petroleum cut or tetramer, sulphuric acid, and caustic soda: the sodium tripolyphosphate is derived from the basics

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[17] _External Trade_, 1962.

[18] "Market Data," _Canadian Chemical Processing_, 47 (July, 1963), 46.

phosphoric acid and caustic soda.

Oil and gas production and manufacture result in a small amount of basic chemical consumption as far as British Columbia chemical manufacture is concerned. Hydrochloric acid, glycols, and amines are consumed in the producing oil and gas field area of northern British Columbia, and these chemicals are shipped from plants in Alberta which are centrally located in the western Canadian oil and gas area near Edmonton. Oil refineries in British Columbia use small amounts of caustic soda and acids.

Summary

Recapitulating, the industrial use of heavy chemicals in British Columbia may be summarized as follows:

1. Pulp and Paper has provided a large growing market for chemicals.

2. Plywood has provided a large growing market for chemicals.

3. Mining and Metallurgy provides one outlet which is captive.

4. Plastics provide a small market.

5. Fertilizers are a small market, though one large supplier exists.

6. Soap provides a substantial market supplied from

eastern Canada.

7. Oil and Gas has provided a growing market in the northern part of the province, and the chemicals are supplied from Alberta.

The end use for chemicals in British Columbia is limited primarily to the market provided by one industry. This is more apparent when industrial market shares are calculated as percentages and the resulting end use patterns are tabulated as shown in Appendix A-1. In British Columbia, pulp and paper is estimated to consume 94 per cent of the caustic soda and 99 per cent of the chlorine. Resins primarily for plywood consume 100 per cent of the phenol. Future growth and integration could result in heavier use of chemicals by the chemical industry itself which shows up in the Canadian figures both in the past (1948) and more so in recent figures (1961), and which shows up especially in the figures for the United States (1958). Growth in the future of other industries which require chemicals would be necessary in British Columbia before such integration in the chemical industry takes place.

II. PRESENT HEAVY CHEMICAL MANUFACTURERS

The local chemical plants are now introduced which supply the consumers described in the first part of the chapter.

Salt raw material

The present manufacturing of basic chemicals from salt includes facilities for caustic, chlorine, and sodium chlorate. Caustic and chlorine were imported from the Tacoma area before manufacturing facilities were established in Vancouver, and imports continued quite extensively up to the present time. Caustic is used primarily for kraft pulp and dissolving pulp. Caustic and chlorine combined are used extensively to bleach kraft pulp. Sodium chlorate is used in a more recently developed method for pulp bleaching. This chemical was shipped from eastern Canada before it became available in Vancouver. The existing plant capacities which can supply the present requirements of the pulp industry for caustic, chlorine, and sodium chlorate, as well as miscellaneous requirements are shown in Table IV. The Vancouver caustic-chlorine plant started production initially in 1958. The capacity of 35,000 tons per year chlorine was increased to the present capacity of 60,000 tons in 1963. Chlorine is normally shipped as a liquid, but the Nanaimo plant does not liquefy

TABLE IV

CAUSTIC, CHLORINE, SODIUM CHLORATE
PLANT CAPACITIES IN BRITISH COLUMBIA

in thousands of tons per year

LOCATION	CAUSTIC	CHLORINE	SODIUM CHLORATE
Vancouver	68	60	20
Trail	12	10	
Nanaimo	40	35	

Source: Private communications.

chlorine for shipment to various pulp mills, transferring the chlorine as gas only "over the fence" to the adjacent pulp mill. Some of the capacity at Trail which began operations in 1961 is used independently to produce caustic potash and chlorine as well as caustic soda and chlorine. The process is similar, uses potash feed, and produces a caustic for use in fertilizer manufacture instead of wood pulping.[19] How the manufacturing capacity for caustic-chlorine has grown in relation to the pulp industry demand is shown in Figure 3. This figure shows that capacity in 1964 in British Columbia is sufficient for demand for the first time.[20]

Sulphur and sulphide raw material

Sulphur is consumed by the pulp industry for the manufacture of sulphite pulps from wood and for the bleaching primarily of sulphate pulp. Such direct consumption of a raw material is not a concern of this study.

Manufacture of sulphuric acid, as noted under history in Chapter I, was begun using sulphur. The raw material for

[19] An example of horizontal integration in an additional line made possible by a captive market.

[20] The majority of the chemical processes reviewed including caustic-chlorine and sodium chlorate are continuous processes, so that the maximum production possible is only a little greater than the nominal capacities.

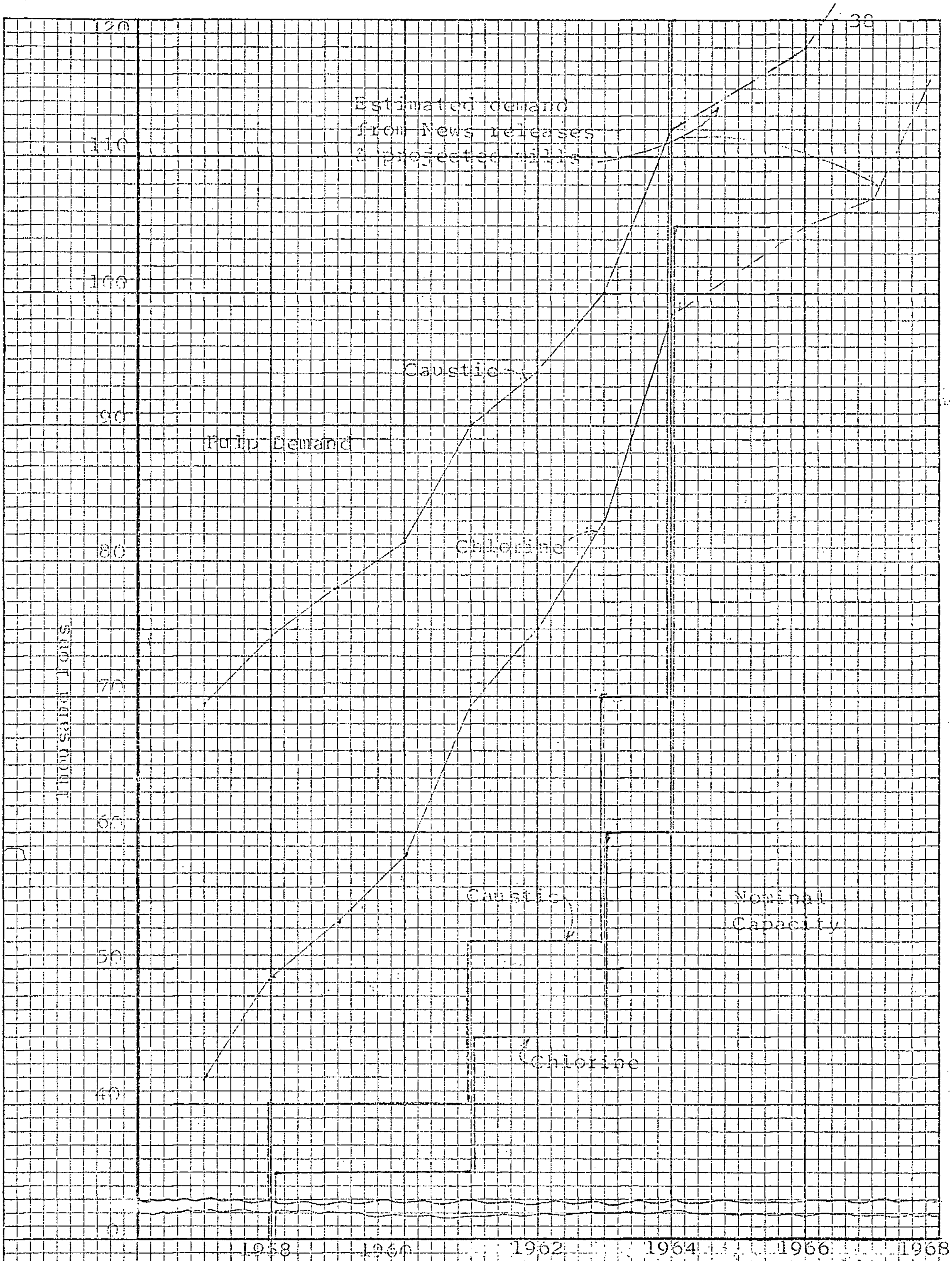

FIGURE 3
BRITISH COLUMBIA CAUSTIC CHLORINE CAPACITY
IN RELATION TO PULP DEMAND

Source: Chemical requirements as estimated
Plant capacity; private communication

the past 35 years has been sulphide ores. The small plant at Barnet used an iron sulphide from Brittania Beach until the plant was shut down. Iron oxide as a byproduct was sold to cement manufacturers. Plant scale is too small to build new facilities at Barnet.[21] The smelter in Trail utilizes the acid gas generated in the smelting of lead-zinc concentrates. The capacity after an expansion of 275 tons per day will be approximately 1500 tons per day, largely for captive use as well as supplying miscellaneous requirements in the province including pulp and paper.

Other inorganic raw materials

Alum is manufactured at Barnet in a batch plant utilizing alumina and sulphuric acid. A plant capacity of 14,000 tons per year is sufficient to supply the present pulp mill market of 7000 tons per year.[22]

The manufacture of caustic potash at Trail which is used in fertilizers has been mentioned. In addition a large volume of phosporic acid is manufactured at Trail. The capacity after an expansion of 200 tons per day will be about 700

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[21] See further discussion of economics in Chapter V.

[22] A small amount, about 200 tons is consumed by waterworks. Canada. Dominion Bureau of Statistics, Waterworks, Provincial, 1958-1959, Table II.

tons per day. The acid is used captively to manufacture fertilizer, and the expansion is supposed to supply this material to new facilities for fertilizer manufacture in Regina.[23]

Organic raw materials

Two facilities exist in Vancouver which supply intermediate chemicals for the manufacture of plywood resin glues. Phenol manufacture began at Ladner during 1963 with a plant capacity of 24 million pounds per year which is more than enough to supply the present British Columbia market of 17.7 million pounds, although a small amount is still being imported, and some phenol is shipped from the other Canadian producer in Montreal. Benzoic acid, at an intermediate step in the process, can be purified, and this is done to the extent of 600,000 pounds per year which will supply Canadian requirements in the east. Formaldehyde manufacture began at Port Moody during 1964 with a capacity of 4½ million pounds per year in captive use and this does not supply British Columbia requirements of 15.1 million pounds.[24] The balance of the formaldehyde is supplied from outside the province.

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[23] "Chemical Expansion," Chemistry in Canada, 16 (Jan., 1964), 16.

[24] 100 per cent basis.

Ammonia is manufactured at Trail utilizing natural gas for captive consumption in metal refining and fertilizer manufacture. Present capacity is in excess of 500 tons per day.

Other basic organic chemicals are not manufactured in a form suitable for further use in British Columbia. The overlap between oil refinery and chemical operation for petrochemicals becomes involved. The six refineries in British Columbia (one at Taylor, one at Kamloops, and four at Vancouver) manufacture a mixture of organic chemicals in their reforming units. These organic chemicals are at present a part of the motor gasoline pool. Extraction and separation from such refinery streams would be necessary to complete manufacture of basic chemicals in a pure form. Also, three of the Vancouver refineries manufacture polymerized gasoline. These units, if desired, could easily manufacture tetramer, a basic chemical for detergent alkylate manufacture.

III. HEAVY CHEMICALS NOT MANUFACTURED IN BRITISH COLUMBIA

Xanthates are consumed in British Columbia in the mining industry for concentration of ores, and they have been produced since 1962 at Edmonton, Alberta. Several other organic chemicals are manufactured at Edmonton. Previously mentioned were the glycols and amines as well as inorganic acid for oil and gas production and manufacturing. Other chemicals are alcohols, aldehydes, ketones, and acids which are used as well as glycols for plastics manufacture amongst other things.

Many other primary organic and inorganic chemicals are consumed in small amounts. They may be manufactured in Ontario or Quebec and transported west, or they may be imported from the United States or many other countries in the world. No special consideration of these chemicals, some of which have been mentioned earlier in the thesis is considered necessary at this time.

CHAPTER III

FORECAST OF FUTURE REQUIREMENTS

I. GROWTH OF BRITISH COLUMBIA INDUSTRIES CONSUMING HEAVY CHEMICALS

In the previous chapter, the present heavy chemicals consumption and the present heavy chemical manufacturing capacity were described. The purpose of this chapter is to forecast the growth in chemicals consumption in the near future. After this information is presented, the market which might be served with British Columbia chemical manufacturing capacity will be evident. To present growth in the consumption of chemicals presently manufactured in British Columbia a forecast is made of the growth of the pulp and paper and the plywood industries. The importance of other miscellaneous uses for chemicals besides their use above must also be considered. For chemicals required but not manufactured in British Columbia, market considerations and growth characteristics are investigated for those industries previously discussed in Chapter II; namely, plastics and resins, agriculture, soap, and oil and gas.

Pulp and paper

The volume and rate of growth in newsprint, sulphite pulp, and the three grades of sulphate pulp serve as predictors in the market area for chemical pulp. Each is treated separately in turn.[1]

Projections which have been utilized for newsprint markets are straight line consumption for per capital income, and straight line consumption for Gross National Product.[2] Such predictions assume a general increased consumption of newsprint per capita. The newsprint market is largely export, principally to the United States (94 per cent of exports in 1962),[3] and although an increased per capita consumption has not occurred generally, and the consumption has remained fairly static in the United States at 80 pounds per capita per year from 1955 to 1962,[4] the western region has continued large gains in newsprint production exceeding the growth of

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[1]The inventories of pulp are not known, but may be quite low. The Canadian inventory change during 1961 was 0.83% of production. Reference Tables, Canadian Pulp and Paper Association, Aug. 1963, p. 5, Table 16.

[2]The Forestry Study Group, The Outlook for the Canadian Forest Industries, Royal Commission on Canada's Economic Prospects, No. 26, March, 1957.

[3]External Trade, 1962.

[4]Note the Food and Agricultural Organization stated in 1959 that past estimates of population growth and income elasticity were wrong (elasticity declines as income rises). Pulp and Paper Demand, Supply, and Trade (Food and Agricultural Organization of the United Nations, Sept. 1959), pp. 2, 3.

population alone.[5] The total growth in the near term based upon population increase and no change in per capita consumption is estimated to be 126-150,000 tons per year.[6] Consumption in California during 1962 increased a "staggering" 90,000 tons which was 60 per cent of the total United States gain. This trend in the western United States region will probably continue in the near term to sustain the increase in British Columbia newsprint exports averaging 60,000 tons per year in the past 8 years and accounting for some of the three announced increases of newsprint capacity totalling 300,000 tons per year through 1965. In Figure 4, the relationships of production, capacity, and exports is clearly shown. The difference between the current figures for external trade and production is accounted for by exports through other ports (about 50 thousand tons by the earlier all port figures), and

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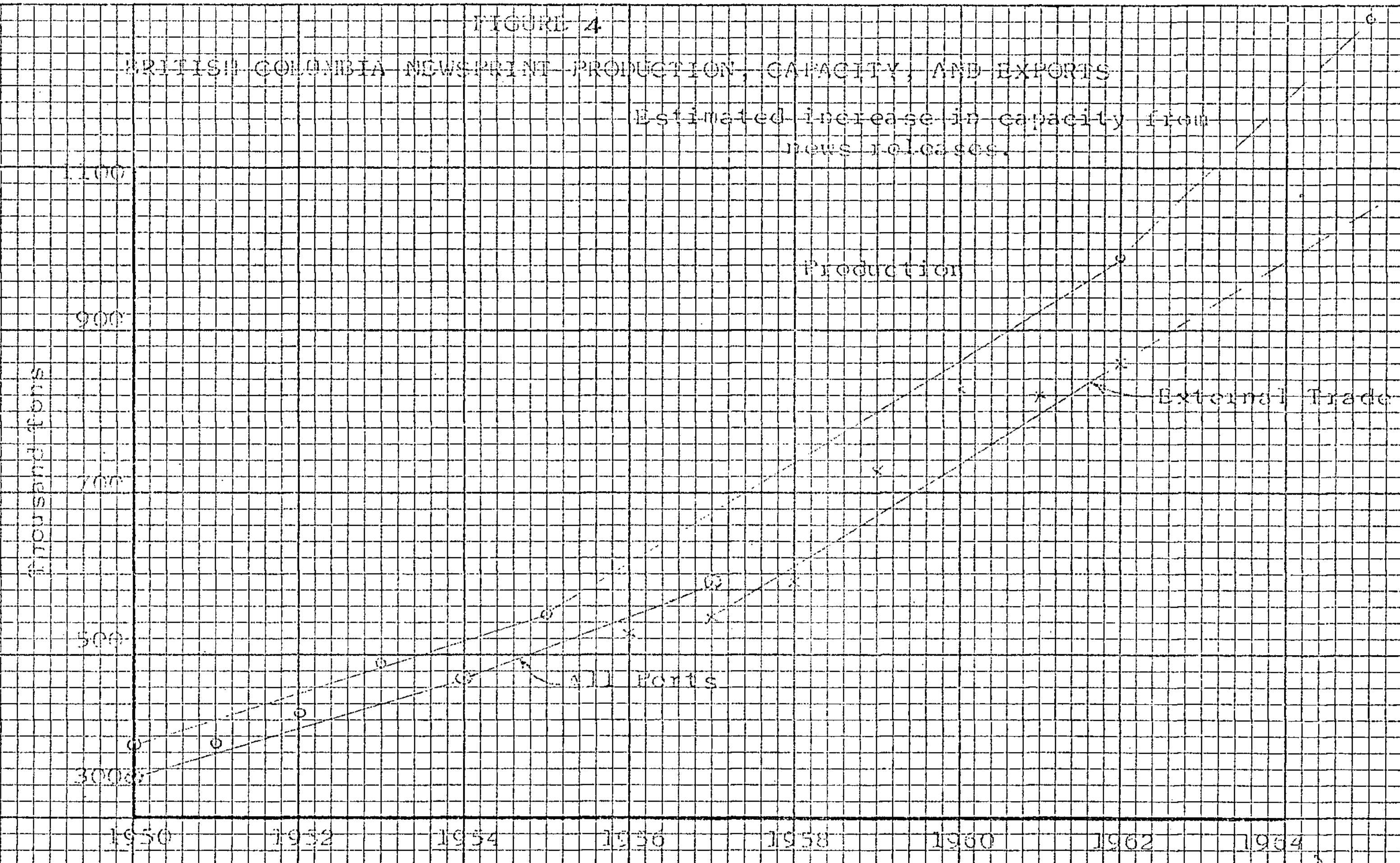
[5] Canadian Pulp and Paper Industry, 16 (April, 1963), p. 26.

[6] Canadian Pulp and Paper Industry, 17 (April, 1964), p. 36. The Gordon report for the Canadian newsprint supplied to the United States forecast increases totalling 460,000 tons from 1960 to 1965 and 670,000 tons from 1965 to 1970. The Forestry Study Group, op. cit., p. 117. About 95,000 tons per year Canadian supply or 475,000 for a 5 year term would be expected with the 69 per cent Canadian share in the growth of the United States market given in the Canadian Pulp and Paper Industry article.

FIGURE 4

BRITISH COLUMBIA NEWSPRINT PRODUCTION, CAPACITY, AND EXPORTS



Source: Preliminary Statement of External Trade, Victoria: Bureau of Economics and Statistics, Annually. Potential Pulp and Paper Mills in B.C., Victoria: Department of Industrial Development, Trade and Commerce, 1959. The Forestry Study Group, The Outlook for the Canadian Forest Industries, Royal Commission on Canada's Economic Prospects, No. 29. Ottawa: Queen's Printer, 1957.

domestic consumption.[7] The percentage of Kraft pulp in 60,000 tons per year increased newsprint production will be used for increased chemical pulp requirements.

The sulphite pulp market appears stable since readjustment prior to 1958. A stable amount used in newsprint is expected with growth occurring in the use of kraft pulp rather than sulphite pulp. A large volume of dissolving pulp is utilized captively to manufacture cellulose acetate (snythetic fibre) at Edmonton. To trace the demand in this area would be too far afield from the study: involved are the viscose rayön produced in eastern Canada, the United States market, competition from other synthetic fibres, primarily nylon, and other industries such as film and other plastic products. Sulphite pulps are exported predominantly to the United States with lesser amounts to Asian countries, and still smaller amounts to other countries in the world. Figure 5 summarizes the data discussed with the relative proportions of various grades indicated in Table V. Announced capacity increases at Prince Rupert until 1967 and an 8th digester at Port Alice are keeping pace with a growth in

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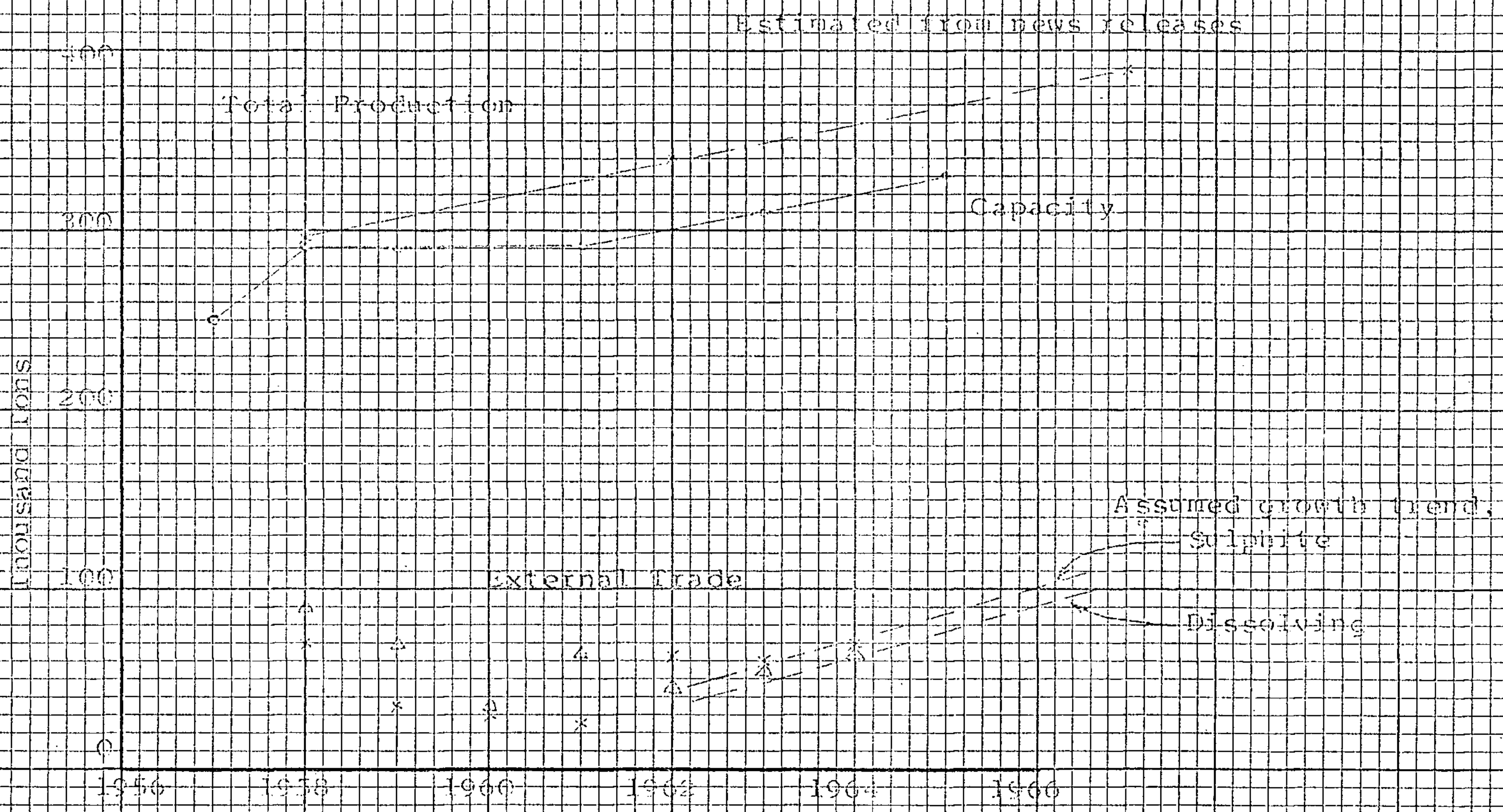
[7] Reference Tables, Canadian Pulp and Paper Association Aug. 1963, Table 50, p. 21. The large British Columbia and Alberta newspapers consumed 54.2 and 56.5 thousand tons in 1961 and 1962 respectively.

FIGURE 5

BRITISH COLUMBIA SULPHITE PULP PRODUCTION, CAPACITY, AND EXPORTS



Sources: Exports - *Preliminary Statement of External Trade*, Victoria: Bureau of Economics and Statistics, annually. Capacity - "Annual Review," *Canadian Pulp and Paper Industry*, April issues. Production - private communication and news releases.

TABLE V

SULPHITE PULP GRADES PRODUCED IN BRITISH COLUMBIA DURING 1962

GRADE	TONS[a]	MARKET[b]
Unbleached	19,500	Export
Bleached	60,000	3/4 Export
Newsgrade	110,000	Newsprint
Dissolving	220,000	70,000 Export

Source:

[a]Private communication.

[b]Export proportion from Preliminary Statement of External Trade, Victoria: Bureau of Economics and Statistics, 1962.

exports of about 25,000 tons per year in various grades, and this increase will be assumed to continue.

The sulphate pulp market has shown a continued growth through the 1950's. Statistics have subsequently changed with kraft and sulphite production capacity indicated separately since 1953 and semi-bleached kraft added to the former bleached and unbleached classifications since 1959. Annual production of all kraft pulp has increased from 360,000 tons per year in 1955 to 1,240,000 tons per year in 1962 or an average of 125,000 tons per year.[8] The annual production capabilities for the three general grades can be compiled from those annual figures given in Canadian Pulp and Paper Industry, the April issues. The export market is available from statistics. Manufacturing of paper and board from unbleached, and newsprint from semi-bleached accounts for the difference in these two grades. A small amount of bleached pulp is consumed in paper: the balance is exported through other provinces. Using past figures in bleaching capacity and announced expansions to project future capacities all three grades of sulphate pulp appear to be growing equally in the near term. The industry generally expects the proportion

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[8]"Annual Review," Canadian Pulp and Paper Industry, 9 (April, 1956), 62; and private communication.

of bleaching to increase, but trends have not shown a significant gap as yet between unbleached, semi-bleached, and bleached capacities. These relationships are portrayed in Figure 6 showing production of the three kraft pulp grades as well as the total to 1966 for which definite construction is underway. Four other expansions are shown through 1970 for total capacity only. These northern British Columbia projects are uncertain until construction begins. At present they are in the planning and tree farm application stage only.[9] Also, for the present calculations, bleaching proportions are not known, but will be considered equally distributed among the three grades. This should yield a conservative chemical consumption estimate, but because of possible improvements in bleaching efficiency this is justified. The timing of the large northern projects is staggered and accelerates the production trend of the recent past which is also increased for 1962 to 1966. Recent experience with mills at Castelgar and Prince Goerge indicates 5 years can elapse from the time of tree farm license application until pulp is produced, and with hearings just underway for these northern projects the timing

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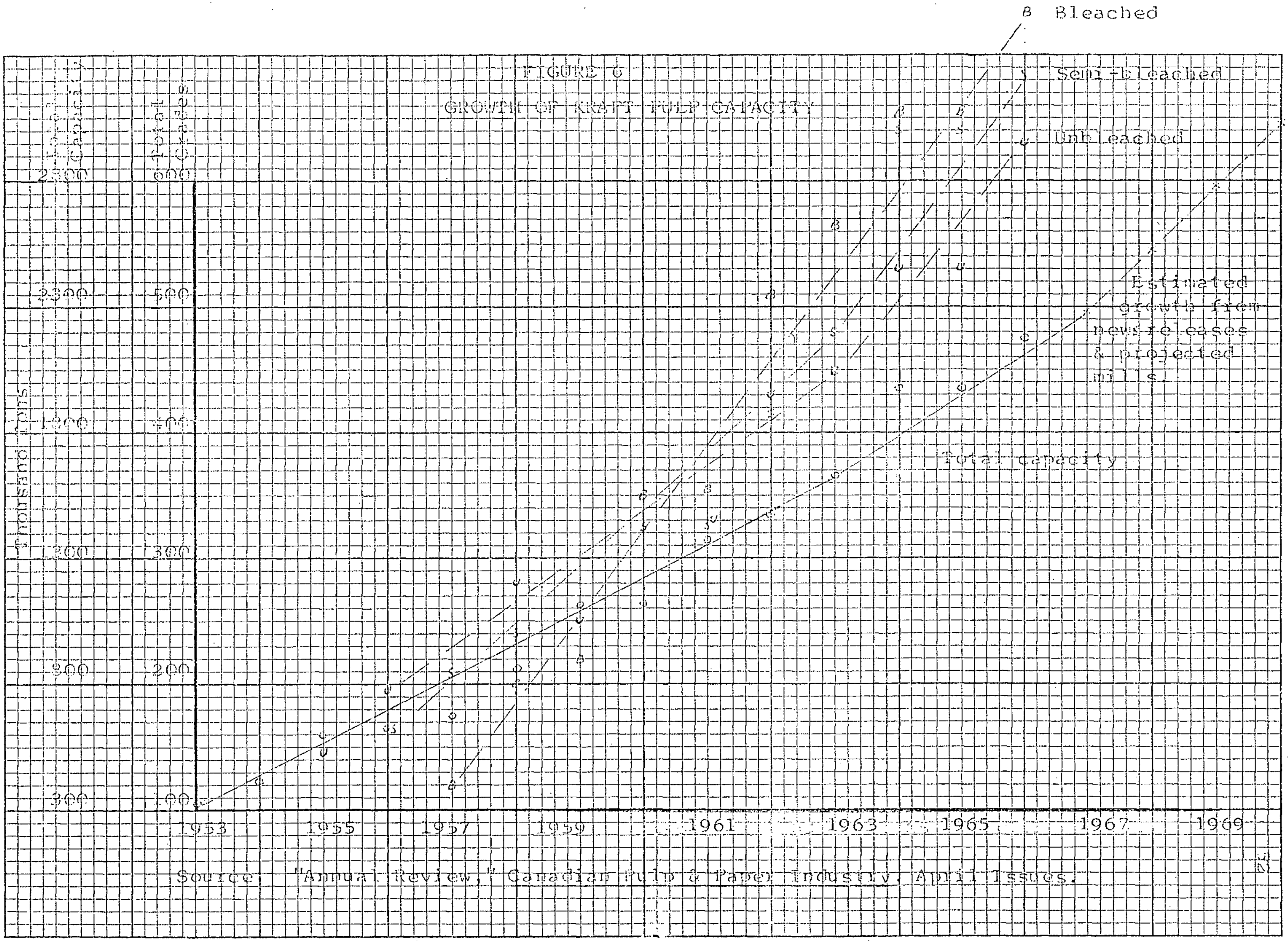
[9]Sites include Kamloops, Kitimat, Prince Rupert, Prince George, and Bulkley Valley. The small planned mill at Kamloops is estimated for 1967, and three of the large northern mills are estimated for 1968, 1969, and 1970.

FIGURE 6

GROWTH OF KRAFT PULP CAPACITY



Source: "Annual Review," Canadian Pulp & Paper Industry, April Issues.

suggested is felt to be realistic. Also, a project for the Peace River area has been announced recently, which is not considered in this forecast. Some pulp from this area would find a market in the United States different from the United States and overseas distribution of the present predominantly coastal mills.[10] Further aspects of this northern interior development will be considered in Chapter V.

To justify the growth in kraft capacity, the various end uses of the kraft pulp are next investigated. An increased newsprint market of 60,000 tons per year previously discussed would take 12,000 tons per year of semi-bleached pulp. Increases in exports of unbleached kraft papers and container board indicate an additional market for 10,000 tons per year. The domestic market for total kraft is a stable 30 per cent share of production,[11] but this share will probably decline in future with the importance of export markets. The growth in the export pulp market is clearly shown when all grades are considered together in various world regions (Europe including Great Britain, Asia, United States, Latin

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[10]The development of interior pulp mills in future will require a knowledge of pulp exports through other Canadian ports and will not show up in the external trade figures for British Columbia.

[11]Private communication.

and South America, and Australia). The experience in the various grades of pulp is summarized regionally in Table VI. The results are combined and portrayed for total kraft in Figure 7. An earlier rapidly increasing trend of exports from British Columbia to the United States has levelled off at an increase of 10,000 tons per year. This is a modest increase which should be maintained or even accelerated in the future. This does not include exports of British Columbia pulp through other Canadian ports. A large upswing in exports to Europe occurred in the late 1950's which has abetted the past few years, but increased exports still averaged 20,000 tons per year to this region. The assumption that large gains will continue is supported by corporate moves to acquire paper converters in England, and an arrangement to ship a large part of the output from a recent 150,000 tons per year expansion to an affiliate in Holland. Increases in shipments to South America and Asia have both averaged 10,000 tons per year recently. South America is a special problem in national economics. The trend line in Figure 7 does not include recent experience in Cuba to whom shipments of unbleached sulphate were 6000 tons in 1960, 22,000 tons in 1961, and nothing in 1962. A few other South American countries showed weakness in 1962 (Brazil, Colombia) while other

TABLE VI

KRAFT PULP EXPORTS THROUGH BRITISH COLUMBIA TO VARIOUS WORLD REGIONS, 1956-1962

in thousands of tons

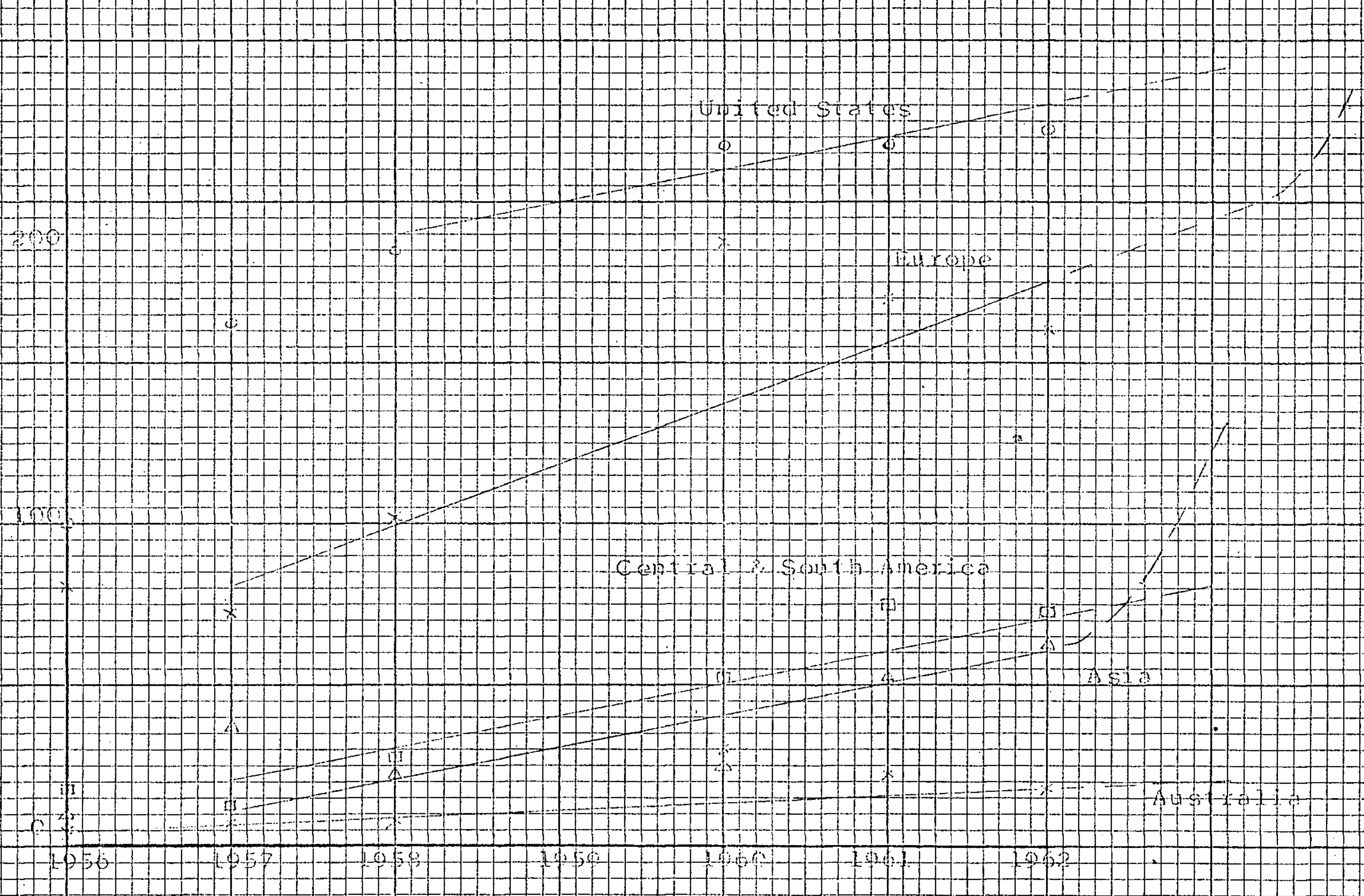
YEAR	BLEACHED					SEMI-BLEACHED					UNBLEACHED				
	Eur.	Asia	U.S.	S.A.	Aust.	Eur.	Asia	U.S.	S.A.	Aust.	Eur.	Asia	U.S.	S.A.	Aust.
1962	100	25	78	28	11	42	10	28	15	3	20	28	116	30	3
1961	104	18	66	18	10	39	7	30	12	3	27	27	120	45	6
1960	111	8	71	15	19	41	1	29	4	2	35	19	116	31	9
1958	84	8	98	11	8	a	a	a	a	a	20	13	87	16	-
1957	58	11	69	1	8	a	a	a	a	a	16	28	94	11	-
1956	60	3	54	4	5	a	a	a	a	a	21	9	45	13	-

[a] Semi-bleached not reported before 1959.

Source: Preliminary Statement of External Trade, Victoria: Bureau of Economics and Statistics, annually.

FIGURE 7

KRAFT PULP EXPORTS FROM BRITISH COLUMBIA



Source: Preliminary Statement of External Trade, Victoria: Bureau of Economics and Statistics, annually.

countries remained stable (Argentina, Peru, Venezuela).[12] Meanwhile the few greatest importing countries in Asia appear stable. Evidence of much greater increases in this area are the talked about ties of northern pulp mill production with the Japanese market.[13] Australia offers a small growth market, no doubt a result of the establishment of a pulp industry in this region which includes New Zealand. When all the world trends are summed, other things remaining equal, justification is evident for continued expansion at present rates, and at accelerated rates through developments in Europe and Asia.[14]

Another force would accelerate planned pulp mill expansion. Sales of pulp at American dollar prices improve the economic position of Canadian mills following the devaluing of the Canadian dollar since 1960 (since pegged in 1963). This result, although it may accelerate expansion plans, has

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[12] Expansion of exports will probably be to those areas which have reached a reasonable standard of living (p. 32).... A new pulp mill in Chile will supply the free trade area of Latin America (p. 46). Canadian Pulp and Paper Industry, 17 (April, 1964).

[13] Exports of kraft to Japan through 1961-63 were 20,000, 50,000 amd 160,000 tons. More might have been shipped during 1963 if the supply was available. Ibid., p. 30.

[14] Note the Food and Agricultural Organization found that time series data had a lower response than cross-sectional data for population growth and income elasticity. Op. cit., p. 3.

been somewhat discounted as discussed earlier under the timing of pulp mill additions and tree farm license applications.

Finally the world demand indicates requirements for pulp in which market British Columbia shares. A summary of information is presented in Table VII from various sources indicating the situation with regard to the large demand areas. Current world exports of wood pulp are roughly one-half Scandinavian, one-quarter Canadian, and one-quarter split between the United States and other countries. Although regions of smaller requirements are expected to decrease imports relative to their total requirements, the trend of large demand areas shown in Table VII is expected to increase world pulp and paper imports relative to world demand. British Columbia, as indicated in the table, increased its share of pulp exports in world markets from 1955 to 1960 although this rate of increase was lessened in 1961 and 1962. Nevertheless, the opportunities for growth exist, although such things as Chinese demand and Communist block supply are unknown. North American, European, and Japanese demand will increase nearly 20,000,000 tons between 1965 and 1975 or approximately 2,000,000 tons per year according to the Food and Agricultural Organization of the United Nations.

The expansion of the kraft pulp market from 1,242,000 tons in 1962 to 2,775,000 tons in 1970 is the major component

TABLE VII

WORLD SUPPLY OF & DEMAND FOR PULP & PAPER, 1955, 1960, WITH ESTIMATES FOR 1965, 1975.

in thousands of tons

YEAR	NEWSPRINT				PULP & PAPER				WORLD TOTAL PULP		BRITISH COLUMBIA	
	F.A.O. DEMAND[a] N. Am.	W.Eur.	Japan	China	F.A.O. DEMAND[a] N. Am.	W. Eur.	Japan	China	Prod.[b]	Export[b]	EXPORT[c] Thru B.C.	%
1955	6,250	2,600	446	139	24,700	10,330	1,665	715	51,370	8,370	363	4.3
1960									65,222	10,706	629	5.9
1965	8,160	4,130	935	490	34,800	15,250	3,540	2,360				
1975	10,120	5,900	1,570	1,570	46,200	20,850	6,300	7,080				

Sources:

[a] _Pulp and Paper Demand, Supply and Trade_, Final Report of the World Consultation, Rome: Food Agricultural Organization of the United Nations, Sept., 1959.

[b] _Reference Tables,_ Montreal: Canadian Pulp and Paper Association, Aug. 1963, Tables 36, 37.

[c] _Preliminary Statement of External Trade_, Victoria: Bureau of Economics and Statistics, annually.

of chemical pulp growth to be assumed. Each new mill in northern British Columbia adds about 250,000 tons per year. This seems like rapid growth until it is realized many pulp producing areas in the world are reaching full forest utilization whereas British Columbia is achieving this step in many local areas for the first time. This growth is also not that striking when the world pulp production figures are observed for the 1950's when the Scandinavian and other countries' growth was roughly 100 per cent while North American growth was correspondingly roughly 50 per cent.[15] British Columbia is thus estimated to be sharing in 1/8 of the increasing North American, European, and Japanese pulp demand noted in the late 1960's.

With sustained growth in chemical pulp markets justifying pulp mill expansion, the market for pulping and bleaching chemicals is assured. The increased heavy chemical requirements which are an extension of Table III are then estimated as before and are shown in Table VIII.

Plywood

The growth trend of plywood production previously indicated by Figure 1 (p. 27) was very close to a straight line

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[15] Reference Tables, op. cit., Table 36, p. 17.

TABLE VIII

NEAR FUTURE CHEMICAL REQUIREMENTS OF BRITISH COLUMBIA PULP MILLS

in thousands of tons

Year	Salt Cake	Caustic Soda	Chlorine	Sodium Chlorate	Sulphuric Acid
1966	94.0	118.0	105.0	22.3	17.2
1967	94.0	126.5	107.0	22.4	17.3
1968	104.5	134.0	117.0	25.4	19.5
1969	115.0	141.5	127.0	28.4	21.7
1970	125.5	149.0	137.0	31.4	23.9

Source: As calculated. See typical details in Appendix A-2.

increasing 100 million sq. ft. per year.[16] The Plywood Association felt that increased production was 8 to 10 per cent per year which would be true at 1250 to 1000 million sq. ft. (presently 1600 million). The promotion program of the association may have increased demand in the 1950's, but the effect is now decreasing by the per capita consumption figures.[17] However, increased promotion efforts in Europe may make up for the difference required to support a continued straight line trend. The exports of plywood have increased from 120 million to 270 million sq. ft. from 1960 to 1962, an average of 50 million sq. ft, per year or half the straight line trend. Construction activity and new uses in packing and shipping, flooring, prefabricated beams, and wall panels will also sustain demand. If per capita consumption increases from 70 sq. ft. to 80 sq. ft. in the seven years from 1963 to 1970 (it increased from 60 to 70 in the four years from 1959 to 1963),[18] domestic demand

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[16]All figures on 5/16 in. basis. Use direct ratio conversion for other thicknesses.

[17]Submission to the Tariff Board, Plywood Manufacturers Association of British Columbia, January, 1963, Graph No. 1.

[18]The Canadian per capita consumption was smoothed and plotted on a semi-log scale which yielded a straight line.

should increase one-third,[19] that is, over 400 million sq. ft. for the seven year period or approximately 57 million sq. ft. per year. Thus, assuming the straight line growth trend of 100 million sq. ft. per year is justified (about 50 million domestic: 50 million export), production would be 2300 million sq. ft. by 1970. An increase of 100 million per year which is 6¼ per cent of 1600 sq. ft. nominal for 1963 is 4-1/3 per cent of 2300 sq. ft. The Canadian-American committee for softwood plywood in Canada have published data on industrial raw materials in North America, and on a basis of 4¼ per cent growth per year they estimated Canadian production[20] of 2760 million sq. ft. in 1980 which would compare to 3300 million British Columbia production by the straight line trend. Estimates beyond 1970, therefore, would be subject to revision (4¼ per cent growth until 1970 may be low), but the present trend until 1970 appears to be justified.

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[19] For a population estimated to increase from 19 to 22.1 million. Final Report of the Royal Commission on Canada's Economic Prospects, p. 107, for immigration at 100,000 per year, 1960, 1965, and 1970, estimates of 17.65, 19.82, and 21.13 million; but "Population Information for 127 countries," Population Bulletin, 19 (Oct., 1963) 164, Table I, mid 1963, 19 million, increasing 2.2 per cent annually since 1958.

[20] The plywood industry in British Columbia makes about seven-eighths of all Canadian Plywood. Annual Report, Plywood Manufacturers Association of British Columbia, 1962. p. 2.

The consumption of phenolic resins besides supplying the requirements for plywood bonding will be increased by two other developments. The first is particle board which may affect plywood sales, but which will increase resin sales (more than three times the resin on a weight basis: 1½ - 2 vs. 6 - 7 per cent). A plant in the Vancouver area began production in 1964, and will consume an estimated 3 million pounds per year of resin.[21] The second development is a phenolic impregnated paper overlay for plywood.[22] A resin weight of 19 pounds per thousand sq. ft. on 10 per cent of current production of 1600 million sq. ft. would be equivalent to another 3 million pounds per year of resin. These requirements would be added to the straight line trend of 4.5 million pounds of resin per year.[23] Phenol and formaldehyde requirements for phenolic plywood resin would thus increase 1.00 and 0.85 million pounds per year plus a new market of 0.67 to 1.33 and 0.57 to 1.13 million pounds respectively for the particle board plus overlay uses.

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[21] Private communication.

[22] An impregnated paper is also used for glueing the plys, but this only takes the place of the present glueing method and does not affect resin consumption.

[23] $\frac{\text{72 million pounds}}{\text{1600 million sq. ft.}}(\text{100 million sq. ft.}) = 4.5$ million pounds.

Miscellaneous uses of manufactured chemicals

Miscellaneous small uses of chemicals at present are summarized as follows:

1. Caustic soda--6700 tons per year is used for oil refining, plywood, bottle washing, bleach, and miscellaneous. Consumption should increase 250 tons per year for plywood, oil refining, and bleach.

2. Chlorine--700 tons per year is used for bleach which will increase 25 tons per year. Water works consume about 100 tons per year,[24] and mining also consumes a small amount.

3. Sodium chlorate-- present use as a herbicide and for mining is negligible.

4. Sulphuric acid--6000 tons per year is used for alum, chlorine, and fertilizer in Vancouver and Nanaimo, which will increase possibly 275 tons per year for alum and chlorine.

5. Phenol and formaldehyde--1.8 and 1.5 million pounds per year are used in resin for miscellaneous uses (increase about 2 per cent per year).

Plastics and Resins

Alkyd and polyester resins are currently manufactured

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[24] Canada. Dominion Bureau of Statistics, Waterworks, Provincial, 1958, 1959, Table 2.

in British Columbia though the amounts are small. Canadian manufacturing of these resins is 35 and 9 million pounds per year.[25] Canadian production is approximately 1/20th that of the United States as it is in the chemical industry in general. The current growth rate of coatings is low--about 1½ per cent a year.[26] The growth rate of plastics varies, but also is low currently for most types.[27] Total requirements of organic chemicals for alkyds and polyesters in British Columbia could reach 5 million pounds per year in per capita terms or more, dependent upon the area of the market.

Polystyrene is not manufactured in British Columbia. The Canadian consumption was 52 million pounds in 1962, so that again British Columbia requirements might reach 5 million pounds per year or more with market development.

An idea of the growth of the markets for some organic chemicals which has taken place in the United States can be seen in Table IX. Much of the growth in the 1955 forecast to 1975 has all ready taken place. Present Canadian production

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[25]"Market Data," Canadian Chemical Processing, 47 (July, 1963), p. 41.

[26]Ibid., p. 44.

[27]Taking plastics as a group is misleading. The growth rate of plastics recently has been quite large which is accounted for by the growth of polyethylene.

TABLE IX

A FORECAST & PRODUCTION OF SELECTED ORGANIC CHEMICALS IN THE UNITED STATES

in millions of pounds

CHEMICAL	FORECAST[a] 1960	FORECAST[a] 1975	PRODUCTION[b] 1962 est.	CAPACITY[b] 1963
Benzene	3,630	6,651	3,850	6,800
Toluene		1,060	2,000	3,400
O-Xylene		686	2,500[d]	2,800[d]
P-Xylene		756		
Phenol		1,250	800	850
Styrene		2,635	1,800	2,400
Polystyrene		1,365	1,245[c]	

[d]Total of the 3 Xylenes (O.M.& P.)

Sources:

[a]W. Isard & E.W. Schooler, Location Factors in the Petrochemical Industry, (Washington, D.C.: Office of Technical Services, United States Dept. of Commerce, July, 1955), p. 5.

[b]R. Katzen, "Petrochemical '63," Petroleum Refiner, 41 (Dec. 1962), 120.

[c]Western Plastics, 10 (Nov. 1963), 20.

capacity for benzene, toluene, and xylene in Ontario and Quebec is about 600 million pounds per year. The greatest demand in Canada has been for benzene, the use figures for the three chemicals in 1960 being 149, 18, and 19 million pounds respectively. In 1956, there was only one Canadian producer in Ontario of these primary organic chemicals, but during the early 1960's large capacity additions have occurred at major eastern Canadian refineries. The growth of organic intermediates was about 500 per cent and of resins about 600 per cent in the past decade.[28]

The development of a market for organic chemicals in British Columbia will probably depend upon the development of end use industries. The development of such end use industries may not occur rapidly,[29] but to the extent that technical service is justified to develop the markets as new industry becomes established, future manufacturing of the intermediate chemicals for these end uses is more likely.

Agriculture

The opportunities for the manufacture in volume of

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[28] "Market Data," op. cit., pp. 39, 41.

[29] For instance, as stated earlier, the plastics industry appears confined to construction (in a lumbering province) and consumer items, without development of component parts or packaging.

fertilizer or pesticide on the British Columbia coast are believed to be negligible. Trail overwhelms the fertilizer business, supplying the Prairies, the Pacific Northwest, and some Asian countries. This market is not studied further here. The pesticides are small markets. Although some agricultural products are used in the Fraser Valley, the large market area would appear to be the Prairies where even in the late 1950's little was used.[30] Conditions have changed in the 1960's such that manufacturing has begun of urea both at Calgary and near Edmonton, of 2-4-D near Edmonton, and of mercurial seed treatment at Calgary. Facilities for manufacturing other agricultural products may be established in that area. The likelihood of ammonia manufacture in British Columbia in addition to Trail facilities would seem to depend upon another metallurgy market occurring rather than the satisfaction of the agriculture market.

Soap

The growth of synthetic detergents consumption depends primarily upon two things. The first is the displacement of hard soaps, and the second is population. The combined effect resulted in rapid growth in the past, but

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[30] Canadian Chemical Journey, (London: Canadian Section, Society of Chemical Industry, 1958), p. 54.

the first factor now has a low impact. Hard soap shipments in Canada declined from 92 to 88 to 86 million pounds for 1961, 1962, and 1963 while dry and liquid synthetic detergent shipments increased from 231 to 252 to 269 million pounds.[31] Population alone would increase dry detergents from 182 million pounds in 1962 to 210 million pounds by 1970. Displacement and other uses could boost this figure to 220 million pounds. Factory shipments of dry detergents were 197 million pounds in 1963, and production increased 5 million pounds over 1962.

Oil and gas

The oil and gas industry has shown good growth in the production sector in the northern interior of British Columbia for some years. The manufacture of chemicals for this market, however, not unlike the market for agricultural chemicals, appears to be established in Alberta near Edmonton close to raw materials and markets.

II. ENTRY

The previous discussion of industrial consumption of heavy chemicals in British Columbia discloses two possibilities.

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[31]"Market Data," op. cit., 46; Canada. Dominion Bureau of Statistics, Synthetic Detergents, Dec. 1963, Table 3.

The need for increased supply of chemicals for the pulp and plywood industries is evident. The supply of chemicals for plastics and detergents is an added possibility. Further development of these possibilities will follow in Chapters IV and V. The possibility of chemicals manufactured for the agriculture and oil and gas industries will not be considered further. The large captive market for chemicals at Trail in the metallurgy and fertilizer industry is of little use in the development of this study because of their consolidated expense figures, so that further reference to this case will be limited.

CHAPTER IV

ECONOMIC REQUIREMENTS

The economic feasibility of establishing manufacturing facilities will depend primarily upon return on investment and a consideration of intangible factors. One of the essentials of a return on investment calculation is revenue, which can be estimated when market data, which has been discussed in Chapters II and III are combined with selling price information, which will be discussed in Chapter V. Expense, another essential of a return calculation, results from a combination of economic resources, principally, an efficient combination of raw materials, labor, capital, and technology. A discussion of these resources with the exception of capital which is also postponed until Chapter V forms the substance of this chapter. A blend of literature and local information is again employed to present these data. A note on intangibles is discussed under timing and a note on government action is discussed under tariffs to complete the chapter. All this information forms the basis for the determination of manufacturing expense which are estimated when rate of return is calculated for individual plant examples.

I. RAW MATERIALS

Inorganic Raw Materials

Most raw materials are currently supplied from outside the province.

Salt. The raw material for the manufacture of caustic-chlorine and sodium chlorate is common salt. No commercial deposits are available in British Columbia, the present supply to Vancouver being shipped by ocean freighter or barge from San Francisco or Mexico. The closest commercial land deposits of salt are the Great Salt Lake area in Utah, and the deposits northeast of Edmonton. The Alberta salt beds supply brine for the caustic-chlorine plant north of Two Hills, and this plant also supplies salt for railroad shipment to the Trail plant. The cost of salt from these sources is summarized in Table X with transportation shown separately. The estimates for transportation rates would be for large volume shipments in large units (90 ton cars) similar to the rates for other chemical materials over similar distances (some typical rates are shown in Appendix B-1). Mexican salt is the most economic material on the coast. The price of this salt has increased slightly at the source, but the transportation cost has been reduced by the use of large 30,000 ton self unloading carriers. For inland locations,

TABLE X

SALT COST FROM VARIOUS SOURCES TO BRITISH COLUMBIA SITES

in dollars per ton

SOURCE	COST	TRANSFER TO DESTINATION			
		VANCOUVER	PRINCE RUPERT	PRINCE GEORGE	TRAIL
MEXICO	$1.25[a]	6.00est.	7.50est.		
SAN FRANCISCO	5.10[a]	4.25-6.25[c]			
ALBERTA	2.00[b]	9.25est.		12.50est.	22.00[d]
SALT LAKE	1.50est.	10.75est.			

Sources:

[a]<u>Preliminary Statement of External Trade</u>, Victoria: Burbeau of Economics and Statistics, 1962.

[b]Canada. Dominion Bureau of Statistics, <u>Chemical Products</u>, Materials Used, 1960.

[c]Private Communication.

[d]Tariff (36,000#) commodity rate.

volume and other considerations are involved. Alberta salt has been purified before shipment to Trail which reduces investment for brine facilities at Trail. Electric Reduction Co. in Vancouver similarly limits its investment in brine facilities by purchase of purified brine "over the fence" from Hooker.

Sulphur and sulphides. Sulphur from the Peace River area of British Columbia or Alberta, which has been recovered from natural gas, may be available on the coast for as low as $17 per ton. Such a price allows the sulphur plant $8 and $9 for freight. Sulphide may be available from Brittania for $5 per ton, or $10 per ton of sulphur at 50 per cent sulphur content, with an iron oxide credit possible of $1 per ton.[1] Sulphur from these two sources is one of the few commercial raw materials available within the province.

Alumina. Bauxite for alum manufacture is shipped from Jamaica or British Guiana. A current domestic price for bauxite is $30.50 per ton (plus freight). A plant in Alberta uses purified alumina hydrate from Quebec which reduces investment for alum manufacture.

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[1]Private communication.

Phosphate. Phosphate rock is imported from the United States deposits in Montana and Florida. Phosphate rock from the Montana deposits is currently shipped to Trail (Consolidated Mining & Smelting has an interest in the Montana venture), and a small amount is shipped to the coast costing $7.74 per ton plus $8.26 freight or $16 per ton.[2] Large shipments of 10,000 tons would be necessary for Florida material to compete on the coast. Small shipment freight is estimated to be $13 to $14 per ton.[3] A small amount of material of the right quality for animal feed is imported from Japan and Europe. The cost is $77 and $53 per ton respectively plus $34 freight or $111 and $87 per ton.

Potash. Fertilizer requirements for potash have been imported in the past from the United States (price $28.20 plus freight), but Saskatchewan is now a major supplier since deposits were developed there in 1963.

Sodium Sulphate. Salt cake, a major requirement for the British Columbia kraft pulp mills, is available as a natural material from Saskatchewan deposits or from California. The posted price is $16.50 per ton. The competitive price

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[2] External Trade, plus railroad tariff.

[3] Private communication.

would allow freight which is a minimum of $10.60 per ton in 90 ton cars from Saskatchewan to Vancouver. The ocean freight rates from California, similar to salt, would be $4.25 to $6.25 per ton. A large proportion of the British Columbia requirements have been imported from California in the past (20,600 tons in 1962 of an estimated 59,000 tons consumed). Duty would be subject to 99 per cent drawback on this material because most of the pulp utilizing this material is exported.[4]

Organic Raw Materials

Organic raw materials may be derived from coal, oil and gas, or agricultural products. Raw materials for chemicals derived from oil and gas are not generally held as cheap, because they have a high value as various alternate types of fuels. A small amount relatively of the oil stream (about 2 per cent), however, is all that is required as petrochemical raw material. Currently, British Columbia requirements are derived from oil in Alberta and California.[5] Without a steel industry there does not appear to be a likelihood

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[4]Canada. Department of National Revenue, Memorandum D 17-4, Jan. 2, 1958.

[5]The products from the production and refining of British Columbia oil are not used at present as organic chemical raw materials.

of organic raw materials from a coal source, although this source is generally recognized to be cheaper than oil. Even if a steel manufacturer starts refining ore in British Columbia the volume of organic oils would be small.[6] Agricultural sources have been developed for specific purposes, none of which are a concern to this study. Chemicals from wood or wood pulp operations have not been developed in British Columbia, and this source likewise is not a concern of this study.[7]

Various location possibilities are involved with oil and gas as raw materials. One is location at the source; in this case examples exist in Alberta. A second is location along a pipeline, but there is no market opportunity in this case between Alberta or northern British Columbia and Vancouver. A third is location at the end of a natural gas pipeline near a market, of which there is no example at the British Columbia coast terminus. A fourth is location near

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[6] Current estimates assume a minimum 300,000 ton refinery, from which production of 6 million pounds of organic oil is estimated based upon Eastern Canadian steel figures.

[7] Some of the chemicals derived from wood pulp operations include alcohols, acids, terpenes, and lignin. Markets are small for these materials. Alcohols and acids from oil and gas at Edmonton are in good supply. Terpenes would have a market similar to oil xylenes. Lignosulphonates (from lignin) are a future possibility with market development. Over 4 million pounds of this material was imported fhrough British Columbia during 1962.

a refinery, of which there are no cases in British Columbia.

A multitude of products is possible when gas and oil are used as raw materials. Clarity for the purposes of this study would not be aided with an enumeration. Two broad situations are noted at this point. Firstly, gas and oil may be further subdivided into gas, light hydrocarbon liquids, refinery gases, and refinery liquids. Secondly, the location situation that has occurred in Alberta and British Columbia should be noted. In Alberta, close to the source of raw materials, gas, light hydrocarbon liquids, and refinery gases are used to manufacture polyethylene, alcohols, aldehydes, and acetic acid; and, close to markets as well, these substances are used to manufacture glycols and amines (although material manufactured from refinery gases is shipped from Sarnia, Ontario for part of this process). Formaldehyde is manufactured in Vancouver from methyl alcohol manufactured in Edmonton. The price of methanol in duty free use is 24 to 30 cents per imperial gallon with freight of 1/2 cent per pound (total 3.6 to 4.0 cents per pound).

In British Columbia, no primary organic chemical manufacturing has occurred to date, although the petrochemical toluene may be derived from refinery liquids, which is done in California and imported for use in the manufacturing of phenol. The price landed in Vancouver, duty paid, is estimated to be 4½ cents per pound. The price will not likely increase unless world crude oil prices increase. A decrease in price to about 4 cents might occur with manufacture in British Columbia. Benzene, toluene, ethylbenzene, and mixed xylenes may all be recovered from refinery liquids and used in the manufacture of intermediates, detergents, and many other products. The economics of their recovery will be reviewed in Chapter V.

Materials and Supplies

The cost of chemicals, minerals, and catalyst supplies are expected to be fairly stable and represent about 1 to 7 per cent of manufacturing costs (see table in Appendix B-2). The increase in the cost of maintenance and consumed materials is generally not significant in the short run unless a change in price, or usage, or per cent of manufacturing costs is significant.[8] One journal article about estimating future costs in the chemical industry gives factors of four per cent for maintenance and one per cent for supplies, packaging, taxes, and insurance.[9] This article also suggests a one per

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[8] In a corrosive chemical plant maintenance costs may be quite high especially after new equipment has gone through the break-in period.

[9] W. Copulsky and R. Cziner, "Estimating Future Costs," Chemical Engineering Progress, 56 (Feb., 1960), 46. These United States factors should apply in Canada.

cent inflation factor. Graphite costs are significant for electrolytic industries such as caustic-chlorine and chlorates. Price increases have averaged about one cent per pound per year or about two per cent and are assumed to continue in the future.

II. OTHER RESOURCES

Labor

The supply of labor is assumed to be adequate for any plant locations which are possible in British Columbia. The demand from the chemical industry is typically small. Skills and price are the two prime considerations. Four basic chemical plants in the Vancouver area employ 155 total personnel, a new plant in Nanaimo employs 35. The 1958 and 1959 Dominion Bureau of Statistics chemical and allied products, summary of personnel, indicated 728 and 755 employees in British Columbia with roughly one-third office and supervisory staff. The oil refineries (1400 employees approximately in 1959-1960) and pulp mills (9496 employees in 1961) would have demands for many skills similar to the chemical industry and are also a potential source of supply.[10] Contract maintenance and

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[10] The pulp mills will undoubtedly be the large demand area in the near future as a result of the many new mills. This may tend to bid up price. Oil refining is practically stagnant in requirements and employees actually declined in 1960 over 1959.

operation is available from one company in British Columbia which is an additional source of supply.

Some of the skills required in the chemical industry would be provided by the current chemical engineering graduating classes in Vancouver which number approximately 25,[11] and which are more than adequate for current British Columbia requirements. A like number graduate in chemistry each year. In two years, technologists trained in British Columbia will also be available to the chemical process industries. Job functions of technically trained people vary. One survey resulted in the figures given in Table XI. As some individuals serve in more than one function, the total is greater than 100 per cent. A heavy chemical plant in British Columbia might have 10 per cent university graduates, distributed to management, design and construction, operations, and sales--technical service. Little independent research and development has been done in British Columbia up to the present time.

The wages and salaries in the industry are relatively high in comparison with manufacturing generally. The wages paid in the oil refining industry lead in British Columbia

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[11] "Chemical Scientists and Chemical Engineering Students," Chemistry in Canada, 14 (Dec., 1962), 48.

TABLE XI

TECHNICAL JOB FUNCTIONS

percentage distribution

JOB FUNCTIONS	ENGINEERS	CHEMISTS
Operations	32.5	15.1
Design and Construction	25.0	2.2
Research	25.0	75.7
Development	50.0	43.0
Sales	3.3	5.7
Purchasing	0.8	---
Other	7.5	1.4
No Answer	---	1.6
	144.4[a]	144.7[a]

[a]Individuals reporting more than one classification bring the total over 100 per cent.

Source: Administration of the Chemical Enterprise (C. Berenson Ed., New York: Interscience Publishers, 1963), p. 174.

followed about four per cent less by pulp and paper and the large chemical plants. Smaller plants and allied products follow about five to twelve per cent less than this, while manufacturing generally is 15 per cent less. Basic wage increases were three per cent in 1958, have recently been greater than 3½ per cent, and will be assumed to be about 3½ per cent or 10 cents per hour per year in the near future.

To calculate labor costs, the basic rates must be increased about five per cent to arrive at earnings because of shift premiums, overtime work, and other allowances, plus as much as 29 per cent for legal, contract, and non-contract fringe benefits. A typical structure for a large chemical plant in selected years is shown in Table XII. An average basic wage currently of $2.80 per hour thus becomes a labor cost of $3.75 per hour which when multiplied by 52 weeks of 40 hours is equivalent to $7800 per year per employee. Some plants will have lower costs as noted above. Contract wage rates are generally higher (in 1964, $2.47 to $3.47 per hour), and fringe benefits lower. A contract for labor also involves a percentage contractor's fee (from 15 per cent to 5½ per cent depending upon the amount of the contract).

Utilities

Chemical processing requires process heat, cooling, and

TABLE XII

WAGE STRUCTURE IN THE BASIC CHEMICAL INDUSTRY
OF BRITISH COLUMBIA

average in dollars per hour

YEAR	BASIC	EARNINGS	FRINGE ADDED
1964	2.79	2.94	3.74
1962	2.59	2.72	3.33
1958	2.30	2.33	2.80 est.

Source: Private communication.

mechanical energy. Normal requirements are currently provided as follows: heat with oil, gas, steam, or electricity; cooling with air or water from domestic supply, the ocean, or a river, or wells; mechanical energy with steam or electricity. An additional extremely important consideration is the chemical reaction energy required for the electrolytic industries such as caustic-chlorine, and chlorates. Utilities supply is not generally a problem. Effluent water must be controlled properly. Some cost considerations will be briefly discussed.

Fuel gas used directly for process heat or indirectly through steam generation is available on an interruptable basis for four cents per hundred thousand BTU (therm) or approximately 40 cents per thousand cu. ft. (MCF). The cost of steam from gas value is thus 42 to 43 cents per thousand pounds. Oil is required as standby fuel. In the smaller plants, at low consumption, gas rates will increase to nine cents per therm.

Process water cost depends upon the capital cost involved with inlet, outlet, and distribution systems which may be extensive. Domestic water in the Vancouver area is available for 15 to 25 cents per thousand Imperial gallons. Additional service costs may be included in municipal tax structures. Gas and water rates are assumed to be stable in the near term although Vancouver city increased its water rates in 1965.

Electricity rates depend upon total consumption, power factor, and load factor. Electrolytic rates averaged 3.5 mills in 1958, 4.2 mills from 1959 and will most likely approach 5 mills in 1966. Present motor load rates are assumed to be 5 to 8.5 mills (including 5 per cent sales tax) for maximum load factor and loads greater than 200 H.P.

Transportation

Chemical prices are often f.o.b. factory. When freight is equalized, it is a transportation cost, but it is recognized here as a decreased price for revenue. Manufacturers in British Columbia have not incurred any appreciable transportation costs through ownership of barges, tank trucks, and containers, but tank car leasing is often an expense. The current cost to lease tank cars on long term contracts is approximately $2100 per year each. The cost to lease tank cars in the future is assumed to increase approximately 15 per cent in 1966. Maintenance costs associated with tank cars may also be incurred by the manufacturer.

Radical changes in transportation are not expected in the short run, but costs can be reduced. The cost for chlorate cars may be reduced 10 per cent by a change from tank cars to hopper cars. "Over the fence" plants incur no tank car expense to the extent of the adjacent market. Captive use also obviates tank car expense. The customer may reduce costs, even if the chemical plant is not adjacent, by the use of changed unloading facilities to accept larger shipments such as barge loads instead of tank cars.

Technology

There is often more than one process route or method available to manufacture a chemical. Each manufacturer may or may not have developed his own process although typically the local manufacturers have developed their own processes. Minor refinements in technique may also be developed by individuals who license another's process. Brief comments on local manufacturers' processes are pertinent.

Caustic-chlorine. Two basic types of electrolytic cells are employed for caustic-chlorine manufacture--the mercury cell, and the diaphragm cell. The mercury cell has a high mercury cost, but produces a pure caustic directly which is desirable for viscose rayon, and transparent cellulose film manufacture. The diaphragm cell produces a weak caustic which is concentrated for sale and which contains salt impurity although this is of no consequence for a majority of uses including pulp. The Hooker cell is most commonly used as a diaphragm cell, and this cell is employed exclusively in British Columbia including license at Trail, and Two Hills, Alberta.

Chlorate. Various techniques are employed by the few manufacturers of chlorate. Method may be slanted towards power costs or graphite costs in a given situation. In Vancouver, the present situation encourages reducing graphite costs.

Phenol. Five processes are available to manufacture phenol. Plant scale and byproducts are a concern with the various processes. A tie-in with caustic-chlorine operation and large scale is required with one. Disposal of salt cake is required with another (not a disadvantage locally, but a byproduct of low value). A third requires disposal of polyphenols and also some integration. A fourth and newer process requires disposal of acetone. The fifth and latest commercial process does not involve byproduct disposal directly. A cheaper starting material, toluene, is required with the fifth process developed and used locally by Dow.[12]

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[12]The price of benzene is now less than toluene in eastern Canada with the supply situation recently developed there. See p.106.

Formaldehyde. Three processes are licensed to manufacture formaldehyde.

Petrochemical Processes. Many major oil companies have developed their own processes. Research corporations such as Universal Oil Products (U.O.P.) have also developed processes which are available for license. The economic feasibility of a U.O.P. Udex extraction unit for the manufacture of benzene, toluene, and xylene will be considered in Chapter V. A further review of petrochemical processes is not pertinent to this study.

Technical service

Technology does not end at the factory gate. The detail requirements of an industrial market have been described as dollars to the purchasing agent, methods to the production manager, and technology to the scientists.[13] The importance of supplying proper technical service to maintain markets is stressed everywhere. Technical service developed during the 1930's,[14] and is a recognized approach for the direct

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[13] Chemical Marketing in the Competitive Sixties (Advances in Chemistry Series No. 24, Washington: American Chemical Society, 1959), p. 59.

[14] E.H. Hempel, The Economics of Chemical Industries (New York: John Wiley & Sons, Inc., 1939), p. 36.

selling of industrial chemicals.[15] The direct channel of distribution is employed by the basic chemical manufacturers in British Columbia utilizing local or home office personnel. Pulp bleaching methods, techniques, materials handling, and equipment are part of the service to the pulp industry.

Timing

One of the major considerations regarding an investment may be timing. Many things may be forecasted, but reliability for some of the factors will be poor. The intangibles that must be considered include economic conditions, inflation, costs, prices, market share, plant safety, and plant morale.[16] Even with reliable market data and production forecasts one cannot be certain of how the competition will react. Some of the price and competitive implications will be discussed further in the next chapter. No attempt is made here to

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[15] Direct selling contrasts markedly with the extensive distribution system required for the marketing of chemical consumer products. Heavy inorganic chemicals supplied to a few users in a small area makes direct sales logical. Many users over a large area would require middlemen. Hooker, in this region, are committed to basic inorganic chemicals and direct selling. Dow, in this region, has a separate sales organization to handle its other interests. Long run diversification is involved and the choice may be of vital consequence--an early omission in vertical integration may be a costly oversight. Ibid., p. 196.

[16] H.A. Quigley and J.B. Weaver, "Economic Considerations in Postponing Investment," Industrial and Enginerring Chemistry, 52 (Nov. 1960), 57A.

review economic conditions in several countries or areas of the world where much of the product of the British Columbia forest industry is marketed; the product which has consumed basic chemicals in its manufacture. The pulp and paper industry should be familiar with these foreign conditions as should a chemical manufacturer if his market is largely export.

Tariffs

The current meeting of the General Agreement on Tariffs and Trade (GATT) may result in freer trade. This was the general purpose of the "Kennedy round" after President Kennedy was given authority to reduce existing United States tariffs. In Canada, the recommendations of the Tariff Board Reference 120--Chemicals, which has held hearings over several years, have not been released. Notwithstanding the outcome from the foregoing, the situation is probably clear--tariffs offer little protection for domestic producers of heavy chemicals. The following chemicals are duty free for British Preferential or Most Favoured Nation: phenol for plywood glue (item 922), maleic anhydride (item 923), formaldehyde (item 2196), and detergent alkylate (item 2696). Benzene, toluene, and xylene have a tariff of approximately one per cent (tariff item 269 - 1/3 cent per gallon). Salt cake, chlorine, caustic soda, sodium chlorate, sulphuric acid, and alum are subject to various duties under different tariff items, but when these chemicals are consumed in pulp which is exported there is a 99 per cent drawback (Memorandum D17-4). The Canadian government is not likely to grant tariff protection when the nation is a world trader. Tariff protection is probably not wanted in any case if an export market for chemicals is desired, although foreign tariffs may prohibit export entry even with a free domestic policy.

CHAPTER V

ECONOMIC FEASIBILITY

Economic feasibility is used here in the sense of return on investment. Profitability is also measured by turnover and margin when fixed investment is not as significant as it is in the chemical industry. There are also other factors to consider for decision making such as reliability of data, market trend, risk factors, technical features, and availability of capital. The previous chapters have outlined market trends, and technical features. Of course, all data are subject to question. This chapter will review the issue of supply of capital, and then give the results of rate of return calculations. Either subject could be considered first, but capital is here looked upon as another resource to be considered before all resources are combined to show feasibility.

The amount of capital required for investment in the heavy chemical industry of the province will be indicated by referring to local plants. Of course these investments are only a part of the total picture in approved or rejected projects which the parent corporations will have considered. How these investments fit in the total scheme of things can be deduced from a review of the financial statements of parent corporations. Thus, total corporate capital requirements for a given period are reviewed, and their source identified.

Continuing, the rate of return on investment for local examples is calculated by bringing together investments, revenues, and expenses. Included in this section is a discussion of the composition of assets provided from investment capital, though finite examples are not given; a review of chemical prices to use with market data; and an explanation of additional items of "fixed" expense including depreciation, taxes, insurance, and debt charges. The net profit results are used to show payout or simple rate of return, and discounted rate of return, to incorporate interest. Other return methods, and differences between methods are not reviewed here. Finally, whether the calculated rates of return deduced from the above meet any required standard is considered.

I. FINANCING

Requirements

Problems in financing are not indicated until firm size is considered. The extent of some recent local investment decisions involves some small amounts below a million dollars, and assuming construction approximately the year before operation, items such as Hooker Chemicals caustic-chlorine plants --$12 million invested when assets were $134 million, an additional $8 million invested when assets were $209 million, Electric Reduction Company's chlorate plant--$4 million invested when assets were approximately $90 million (est.£ 33 million at $2.70), and Dow Chemical's phenol plant--$5 million invested when assets were $1,021 million. The decisions regarding these investments and their financing would have been made some time before construction. These situations will now be examined in turn.

The funds flow statements for Hooker Electrochemical Corporation indicate two periods which resulted in large flows in recent history during 1955 to 1956 and 1959.[1] The first was the result of equity through merger: the second was the result of an issue of debt. The first does not indicate financing in the ordinary sense, but rather a growth which as a result provided a broader equity base (and also horizontal integration). Debt was 29 per cent of debt plus equity in 1955, and 37 per cent in 1960 a year after the debt issue of $21 million. The significance of the debt issue thus refers to events later than the expenditure of approximately $12 million during 1957 for operations commencing in 1958. The

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[1]See Appendix C-1 for funds flow statements referred to in the example companies.

funds flow during the 1957 period indicates operations and minor debt provided the funds for plant and working capital. Although debt dollars cannot be shown fo flow specifically to working capital dollars, the balance of the "typical" situation is apparent when operations provides the fixed asset funds. A minor source of funds would have resulted from reduction of slightly high inventories during 1956 to 1957.

The funds flow statements for Dow Chemical also indicate two periods which resulted in heavy flow in recent history. Financing, which had provided a supply before 1955 (princiapply convertible debentures in 1952), was invested during 1955 and 1956. Investment in plant of $162 million and $189 million during 1957 and 1958 resulted in a large amount of debt in 1958 (net inflow $142 million).[2] In the next three years investment in plant assets was $58, 99, and 151 million. Notes payable provided funds in 1961. Working capital requirements were large during 1963 (net $84 million), and this combined with a refunding operation of the $60 million 1961 notes, resulted in a substantial debt issue of $100

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[2] Dow had obtained favorable terms in the bond market as well as making private placements with insurance companies. C. Berenson (Ed.) Administration of the Chemical Enterprise (New York: Interscience Publishers, John Wiley & Sons, 1963), p. 379.

million. Debt, as a percentage of debt plus equity has swung through a wide range during this period: 1954--50 per cent, 1956--30 per cent, 1958--40 per cent, 1960--21 per cent, 1962--15 per cent, and 1963--19 per cent. The size of the Vancouver investment and the concommitant investments near Edmonton are practically lost in the total scheme of things. A different analysis would be possible if statements for the Canadian operations were available.

The funds flow statements of Albright and Wilson the parent of Electric Reduction Company of Canada Limited, also show two periods which resulted in large flows in recent history, although a little further apart than the two previous cases. Equity and operations provided funds during 1955 and 1960 to 1961 respectively for large investments in plant. The over-all picture here clouds the fact that subsidiaries have loans and borrowings attested by notes to the statements. The debt as a percentage of debt plus equity for 1962 is thus 14.5 per cent for the parent and 24.4 per cent for the consolidated structure, which results in an average of about 45 per cent in the subsidiaries.

In each of the cases above the need for substantial amounts of funds has occurred in periods of from four to six years. Details are not reviewed, but it would appear that these moves occurred favorably in relation to the market averages. The equity base has been broadened in each case by merger, convertible debentures, and stock issue. The major financing has not been influenced in any perceptible way by requirements in British Columbia.

Source

The financial requirements of the chemical industry in British Columbia are not substantial. In one case fairly normal activity provided the funds to place a subsidiary in Canada: in the second and third case apparently operations or borrowings by Canadian subsidiaries extended the subsidiaries' operations to British Columbia. Funds flow for growth will be discussed further in the second section of this chapter.

II. RETURN ON INVESTMENT

Investment

Investments are total amounts; that is, the investment includes the assets of working capital as well as plant capital. During the initial construction, amounts of cash are required for inventories of equipment, spare parts, and supplies as well as start-up expenses capitalized. Operations further require the build-up of process inventories, cash, and a net balance of accounts. Funds had already been committed before plant construction to expand sales in British Columbia so that the only new requirements at the time of plant construction would be the result of expanded operations as they developed, other things remaining equal (that is, funds decisions previous to manufacturing decisions had expanded sales in British Columbia.) The amounts of investment to be used upon which estimated returns will be based are:

Caustic-chlorine

1957 - $12 million (private communication)
1962 - 0.6 million (private communication)
1963 - 8 million (private communication)
1967 - 10 million (news release)

Sodium chlorate

1957 - $4 million (private communication)

Alum

1957 - $0.5 million (estimated)

Phenol

1962 - $5 million (private communication)

Formaldehyde

1963 - $0.3 million (estimated)

No data on the capital structure of British Columbia firms are available, but an example of the average capital structure for Canadian Fertilizer and Industrial Chemicals is presented in Table XIII. Of interest in the table is the newness of the "loss firms" evidenced by their lower

TABLE XIII

TOTAL ASSETS & LIABILITIES
CANADIAN FERTILIZER & INDUSTRIAL CHEMICAL COMPANIES

expressed as percentages

ASSETS	Profit	Loss	LIABILITIES	Profit	Loss
Cash	5.4	2.6	Loans	2.1	2.2
Securities	10.0	1.0	Accounts Payable	6.0	2.6
Accounts Receivable	9.7	8.6	Tax Liabilities	1.9	-
Inventory	13.9	6.7	Other current	.6	.3
Land	1.8	0.6	Debt	7.9	35.7
Building & Equipment	47.2	68.6	Other Liabilities[a]	18.9	19.4
Investment in Affiliates	10.0	9.6	Preferred Stock	2.7	2.2
Other	2.0	2.3	Common Stock	24.8	29.9
	100.0	100.0			
			Surplus	35.1	7.7
Depreciation & Depletion (Percent Plant)	(52.5)	(30.5)		100.0	100.0

[a]Includes wages and commissions payable, dividends and employees tax deductions payable, loans from affiliated companies, reserve for liabilities such as, guarantees, pensions, fire or marine insurance, or Tax Equalization Reserve.

Source: Adapted from money figures in Canada. Department of National Revenue, Taxation Statistics, 1963, p. 137.

accumulated depreciation. In addition the debt as a percentage of debt plus equity is 58 per cent in these firms compared with 30 per cent in the profit firms.[3]

Revenue

The market data have been developed for the chemicals under consideration. This must now be adapted to manufacturing and market considerations, and price incorporated so that estimates of revenue may be derived. Price changes for chemicals in recent years have been much lower than for other commodities generally.[4]

The two products caustic-chlorine from salt decomposition are produced in a fixed ratio which may not be so balanced in the market. The market in British Columbia in the past required additional caustic which has been imported as well as caustic-chlorine imported over and above this imbalance. The rapid growth in bleached kraft pulp has brought about a near balance in the market at present, and in the

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[3]A review of over 30 United States and Canadian chemical companies for 1960 indicated net income as a per cent of net worth ranging from 0 to 7 for 50 per cent debt/capital structure trending upwards to 4 to 11 per cent for 25 per cent debt/capital structure. Details are in Appendix D.

[4]The industrial price index for acids, alkalis, and salts given in the Bank of Canada, Statistical Summary, 1963, with 1956 = 100 was 1959 - 105.2 and 1962 = 103.9.

near future expansion of the dissolving pulp market will help to prevent an imbalance in the opposite direction. The actual operations of the British Columbia plants must then be phased in with total requirements and imports provided from plants of a parent and a competitor in Tacoma and possibly a very small amount from Alberta. The price received for local production has remained firm since operations began in 1958 (chlorine $60. caustic $54 bulk--$55 tank cars per ton).[5] The last time price increases occurred in the western provinces was in 1957, although increases have occurred since in the eastern provinces. Any shipments to Castlegar or Hinton, Alberta are also freight equalized with Trail and Two Hills, Alberta. The competitive situation will likely prevent price increases in the near future. "Over the fence" plants will save pulp producers transportation costs as well ($0.50 to $2.00 per ton plus insurance on the coast).

The market for sodium chlorate in the pulp industry is growing to meet the supply which can be manufactured locally. Originally, plant capacity was required to supply a uranium mining and a herbicide market. The loss of the

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[5]Private communication.

uranium market, competition from chlorine bleaching, and potential competition from pulp mills making their own chlorate in solution brought about a price cut of 6 per cent in 1960 ($160 to 150 per ton.)[6] The price has been firm since that time, and no increases are expected in the future with potential competition from pulp mills or other chemical manufacturers. Operations above local nominal capacity and shipments from parent plants in eastern Canada will maintain supply until about 1967. Beyond this immediate period, the market growth for bleached kraft pulp and increased chlorate bleaching may justify increased manufacturing capacity.

Alum capacity is probably sufficient for the near future (7000 tons per year market and 14,000 ton capacity), and competition without raw material price increases will prevent alum price increases (price is about $10 per ton less in the east). The last increases occurred in 1961 when bauxite list price increased 30 per cent which as 25 per cent of operating costs represents 7.5 per cent of total cost, and alum price increased 4 per cent within 6 months ($50 to $52 per ton), or about one-half the cost increase.

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[6] Private communication and also the list price, which when quoted is from the quarterly price reports of Canadian Chemical Processing.

Benzene-Toluene-Xylene 2000 BPD				Detergent
250 T	267 B-T	307 B-T-EB	410 B-T-X	25MM#/yr
440	470	540	720	2000
64(8)	64	64	64	160
125	145	170	170	115
50	50	50	50	15
36	38	40	40	5
12	13	15	20	400
111	118	125	125	33
44	47	50	50	20
-	-	-	-	20
862	945	1054	1239	2768
1250	1350	1580	2100	4250
388	405	526	931	1482
194	203	263	465	741
304	321	388	590	774
13.7	13.6	15.5	23.6	117

C of GS % Sales	Sell. Gen. % Sales	Dividend Payout %
71.9	11.0	59
63.6	16.2	33
77.3	9.2	55
65	16.8	31 + stock
74	7.4	57 + stock
----86----		67.5
71.5	17	55.5
----85----		25
-----84----		42
72.25	17.4	39
75.8	8.3	46.5 + stock
60.6	21.8	50 + stock
78	11.6	45
70.5	10.9	43 + stock
71.5	13.8	40
65.0	26	--
76	14	41.3
67	13.8	16 + stock
91	7.9	125
62	26	stock
66	13.6	29.4
75	20	71
65	26	61
61	8.9	--
70	15	55

	Albright & Wilson[b]								Allied
	55	56	57	58	59	60	61	62	62
	2.2	3.0	3.3	3.7	4.5	4.7	5.5	5.6	133
	-	-	0.2	0.2	0.9	1.0	(0.3)	-	1
	2.4	1.1	0.3	0.5	(0.4)	0.3	2.0	(0.7)	18
	4.1	(0.2)	-	0.1	0.1	2.5	5.3	(0.5)	1
	8.7	1.7	3.8	4.5	5.1	8.5	12.5	4.4	153
	0.2	0.3	1.3	(0.9)	0.2	1.9	2.9	1.1	(1)
	2.2	0.6	-	1.7	1.6	0.1	(1.9)	(0.3)	10
	6.0	0.3	2.0	3.1	2.5	5.5	10.4	2.5	92
	0.3	0.5	0.5	0.6	0.8	1.0	1.1	1.1	47
									5

2/3 Nam.	1	1Pr.R.	4/7Kit.
300[f]	447[f]	447[f]	245[f]
231	244	333	284
382	567	561	307
75	120	125	70
40	40	50	40
15	25	25	-
400	400	525	400
200	200	260	200
-	400	-	-
1645	2447	2326	1516
3012	4445	4445	2438
1367	1803	1924	922
683	901	962	461
684	902	962	461
1084	1302	1487	861

Salt cake list price declined 3 per cent in 1960 and has remained firm ($17 to 16.50 per ton).

Formaldehyde list price has increased a little, 7 per cent in 1960 over 1958, and 4 per cent in 1964 over 1960 (3.50 to 3.75 to 3.90 cents per pound, 37 per cent uninhibited). The increased supply of natural gas and light hydrocarbon liquids will help maintain the price of raw materials and primary chemicals such as methanol, constant. The increases in formaldhyde price are less likely to be repeated in the near future. The increase in formaldehyde capacity on the coast will help maintain the present price situation which aided the justification for this capacity in the first place.[7]

Most markets and prices of immediate concern have now been reviewed with the exception of phenol. This product and other primary organic chemicals will be looked at generally. A heavy chemical does not usually entail great risk because the market is known, assured, and readily forecast. This is the result of the consumption of these chemicals by basic industries which have been established within a region.

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[7]The price situation for formaldehyde is beyond the scope of this study. The major supplier in the recent past in Edmonton prefers to upgrade this material to pentarythritol. Rail shipments of methanol or formaldehyde from Edmonton are also subject to competition from imports by ocean transport.

Petrochemicals after their introduction may move into this area, price declines occur, and overcapacity may accelerate the process, which apparently happened with phenol. The supply has had a drastic effect on the price of phenol recently, the price declining two cents per pound in 1962 and another two cents in 1963 to settle at 12 cents per pound. Petrochemical capacity has greatly expanded the supply of benzene, toluene, and xylene in recent years and prices have declined in eastern Canada 25 per cent, 10 per cent and 7½ per cent respectively to 29½, 32, and 37 cents per imperial gallon delivered (3.4, 3.7 and 4.25 cents per pound). These prices are likely now at a stable level, because where they were at one time greater than coal derived material, they are now approximately equivalent (30 to 35 cents per imperial gallon). The supply and price effect is not so severe in the west, and price will likely remain stable with transportation the barrier. Duty for these materials at 1/3 cents per gallon is approximately one per cent. A decline in price for detergent alkylate occurred, as an earlier example, from 20 cents per pound to 12½ cents from 1948 to 1951, and since has gradually declined to 10.2 cents. The decline in the price of styrene has been less pronounced declining from 13 to 11¼ cents per pound since 1958.[8] Such declines in chemical prices have had an adverse effect upon the earnings of Dow Chemical Company who are large manufacturers of phenol and styrene, but these price levels will probably be maintained in the future settling in the 10 to 12 cents per pound range, and manufacturing costs sufficiently below these prices will be required to realize a profit.[9] Whether there is any elasticity of demand or whether a possible shift of demand could occur for some basic chemicals with this declining price situation is not known, but some substitution in end use may occur through time.

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[8]The price of styrene dropped 4 cents per pound in the planning stage of facilities for the Cosden styrene plant in the United States. E.V. Anderson "Styrene-Crude Oil to Polymer," Industrial and Engineering Chemistry, 52 (July 1960), 550.

[9]A large world supply exists from overcapacity in the United States and Europe. Low quotations for phenol, styrene, and detergent alkylate were 10.5, 10.2, and 6.4 cents per pound in Belgium, Italy, and Belgium last year. P.W. Sherwood, "Use This Correlation for Forecasting Petrochemical Markets," Petroleum Refiner, 42 (Jan., 1963), 140. If 1.7 cents freight is added, and these items are duty free, landed price would be 12.2, 11.0 and 8.1 cents per pound. This would supply phenol competitively with and detergent alkylate cheaper than domestic sources. Large reductions in price for new synthetic chemicals are not unusual, but phenol is not that new. The price for this chemical in the United States was 10 cents per pound in 1936, before demands increased and new petrochemical sources began producing. W.L. Faith, D.B. Keyes, and R.L. Clarke, Industrial Chemicals (New York: John Wiley & Sons, Inc., 1957), p. 588.

The revenue to be derived for chemical plants may now be summarized utilizing market data and price information. This is portrayed in Table XIV.

Fixed Expense

Depreciation. A straight line depreciation policy is followed by the Canadian organizations with local plants.[10] The capital cost allowance permitted by tax regulations is actually a declining balance method, but on a modest basis (barring some recent special regional allowances) so that small plant additions would maintain actual depreciation charges relatively constant. Rather than involve the details of capital cost allowance of each case, a uniform figure of five per cent will be assumed for profitability estimates and purposes of comparison (Hooker recently has been 4½ to 5½ per cent, Dow 7 to 10 per cent, Albright and Wilson 6 per cent, Consolidated Mining & Smelting 6½ per cent).

Overhead. Overhead costs over and above local expenses include general, administrative, and selling expense.

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[10]From their annual reports, Dow Chemical in the United States follows a declining balance depreciation policy, and Allied in the United States uses the sum of the digits method. Albright and Wilson follow a standard high book depreciation policy for interdivisional comparison, which is not allowed here for estimates of profitability which are to be compared to other firms. Private communication.

TABLE XIV

REVENUE FROM BASIC CHEMICAL MARKETING IN BRITISH COLUMBIA

in thousands of tons and thousands of dollars

YEAR	CAUSTIC	REVENUE	CHLORINE	REVENUE	SODIUM CHLORATE	REVENUE	PHENOL	REVENUE
	thousand tons	thousand dollars	thousand tons	thousand dollars	thousand tons	thousand dollars	thousand tons	thousand dollars
1958	22.5 at $55	$1238	20.0 at $60	$1200	20 at $160	$3200	-	
1959	28.0 at $55	1512	25.0 at $60	1500	20 at $160	3200	-	
1960	34.0 at $55	1870	30.0 at $60	1800	15 at $150	2250	-	
1961	39.5 at $55	2172	35.0 (capacity)	2100	16 at $150	2400	-	
1962	41.0 at $55	2255	36.5 (capacity)	2190	17.5 $150	2625	-	
1963	68.0 at $55	3740	60.0 (capacity)	3600	18 at $150	2700	12 at $223.4[a]	$2680
1964	68.0 at $55	3740	60.0 (Nanaimo)	3600	19 at $150	2850	12 at $225.0	2700
1965	68.0 at $55	3740	60.0	3600	20 (capacity)	3000	12 at $226.6	2720
1966	68.0 at $55	3740	60.0 (capacity)	3600	20	3000	12 at $228.4	2740
1967	68.0 at $55	3740	60.0	3600			12 at $230.0	2760
1968	68.0 at $55	3740	60.0	3600			12 at $231.6	2780
1969	68.0 at $55	3740	60.0	3600			12 at $233.4	2800
1970	68.0 at $55	3740	60.0	3600			12 at $235.0	2820
1971	68.0 at $55	3740	60.0	3600			12 at $235.0	2820
1972	68.0 at $55	3740	60.0	3600			12 at $235.0	2820
1973	68.0 at $55	3740	60.0	3600			12 at $235.0	2820

[a]Effective price increases with greater local demand for plywood and lower resultant transportation costs (list price $240/ton).

Source: estimated from market data and list price.

This figure varies between chemical companies as a percentage of sales from about 6 to 25 per cent.[11] Precise classification of overhead items is not known so that possible differences might be explained. In many of the local cases selling expense is primarily a local expense which has been included in the return calculations. Engineering is a usual general expense which may be allocated in different ways. Research and development may be handled similarly. In any event, expenses of this type must be "reasonable" when they are allocated for tax purposes. The allocation may be accomplished through subdivision by manhour or manpower, investment, or products. All allocation is considered arbitrary. For purposes of this study some allocation by a factor percentage of sales is utilized in place of more specific information. Howeve, such allocation is not applied arbitrarily through time. Initially, the extent of parent overhead is perhaps irrelevant to an investment decision in the British Columbia area, and this attitude is also applied here.[12] Then when an

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[11]Review of over 30 United States and Canadian Chemical companies expenses in Moody's Industrials, 1961. See Appendix D.

[12]J. Ross *et al*. in their article "Guidelines for Estimating Profitability," for instance, say certain areas of administrative, selling, and general expense are relatively unaffected--executive management, corporate sales, engineering, operations administration, comptroller and treasurer administration, legal and tax administration, public relations, and donations and endowments. Chemical Engineering, 70 (Aug. 19, 1963), p. 145.

expansion is evaluated locally, incremental costs again apply to the additional investment, but the original investment is then viewed as part of the parent's whole and thus allocated some overhead expense. Such an approach considers the pitfall of evaluating facilities incrementally as if overhead were never a factor for long run profitability.[13]

Taxes. Property tax varies from municipality to municipality through assessment and mill rate differences. Assessment value is reasonably established by the newness of the investments in the case of the plants which are studied here. Tax is then calculated on approximately 50 per cent of this value depreciated. Depreciation allowed by municipalities is not the same as federal capital cost allowance. An average figure for total facilities of five per cent is again assumed though such a value may be slightly high. This allowance is made for five years only, from which time a depreciated value of 75 per cent original investment is assumed following municipal policy. Actual general and school mill rates are then applied as they would be to the municipal assessment rolls. Additional rates for services may apply to these specific

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[13]Incremental evaluations by an industry can result in over supply and depressed prices, and this recently has been claimed of the oil industry.

rates. The taxes thus calculated are approximately 1.6 to 1.7 per cent of investment value in the cases calculated. In unincorporated areas, provincial tax assessment for general and school purposes similarly establishes a value and uses 50 per cent to which tax is applied though the general rate is 10 mills. If additional assessments for services are not great, provincial property tax may be approximately 1.3 per cent of investment value.

Insurance. Insurance expense depends upon coverage attempted. The types of coverage include fire, extended coverage, business interruption, boiler and machinery, public liability, automobile and fidelity. Generalizations in this field are practically impossible, but some are attempted for evaluation.

Fire, extended coverage, and business interruption insurance apply basically to the complete plant. A review of the Superintendent of Insurance Report Abstracts for recent years indicates that fire premiums are about 0.7 per cent of coverage for oil refiners and miscellaneous manufacturers. The relative premium rate for extended coverage and business interruption from other sources is about 0.1 per cent and 0.06 per cent. These rates could not be applied without consideration of risk, experience, and detailed construction.

The risk for the above premiums is equivalent to either hazardous materials (refiners), or average construction (manufacturers). The risk might be three times as high in sawmills for instance. Premiums may vary similarly with construction over a four or five times range for construction varying from fire resistant to wood frame. In the chemical examples considered here investment value in new plants is reasonable for coverage, and the total premium rate of 0.86 per cent of coverage for insurance expense is reasonable for inflammable materials. Chemical plants of "all-steel" construction which do not process inflammable materials, such as caustic-chlorine and acids, are assumed to have a premium rate much less of 0.4 per cent.

Other types of insurance coverage are important, but the premium expense is much less. Boiler and machinery, and automobile coverage depend upon specific cases. Public liability depends upon experience and product sales, or size (by employees or other). Additional liability coverage is available for small additional premiums, similar to extended coverage. Bonding of employees depends upon employee classification and might cost $25 per supervisor per year. An arbitrary premium is assumed of 0.05 per cent assets and 0.025 per cent sales to allow for the expense of these last types of coverage (weighted to assets--consumer products would be weighted more to sales).

Debt. Interest expense is not included in the calculation of returns. This is not done because capital structure varies between organizations, and furthermore any total capital structure bears no relation to the investment in individual projects (see discussion under requirements p. 95ff.) It would be possible to show the effect of leverage in the return calculations if this were desired by assuming some interest expense and then adding back this expense after tax to derive funds flow related to total capital.

Profits

Details of revenue and expense may now be brought together so that estimated profits may be utilized to evaluate investments by return methods. The actual results are shown in the appendices C-2 to C-5, and are referred to here.

The income tax rates are generally applied to the profit from expansions or extended operations in Canada at the current rate of 50 per cent. For the initial investment in Canada, the stepped tax rate is used, currently 21 per cent of the first $35,000, then 50 per cent.

Example revenues have been considered in Table XIV on page 109. The typical expense items which have been discussed in Chapter IV and the previous section of this Chapter and which are used in the appendices are summarized under raw materials, labor, utilities, supplies, maintenance material, transportation, depreciation, taxes and insurance, debt, and general and administration. The total of these items subtracted from revenue provides gross income. After suitable income tax deduction to obtain net income to the shareholders, depreciation is added back and funds from operations is the result. The funds can be accumulated from year to year until an amount equivalent to investment is reached. This is the payback period in years. To incorporate interest, present values are applied to the funds figures. A trial and error process results. When the discount percentage utilized and the years to accumulate investment are equivalent (e.g. 10 per cent and 10 years, or five per cent and 20 years) a solution is found. A few trial solutions are shown in the appendices, and the final present value has been extrapolated for caustic-chlorine and phenol and the per cent discount figure interpolated, which is adequate considering the accuracy of the figures. Annual present values were used, and slightly lower rates of return would result with the use of other present values approaching infinite tables.

<u>Caustic-chlorine</u>. Return on the intial investment for

the Hooker investment in Vancouver as calculated (see Appendix C-2) shows a payout of about 8 years and a discounted rate of return from 1958 of approximately 8 per cent. Such returns are minimally above return to shareholders during the existence of the investment. With inflation or any increased share value (negligible in this case) the return would barely improve the position of the common shareholder. If heavy chemicals are considered to be low risk, one source indicated target returns of 10 to 20 per cent would justify the investment.[14] Additional investment and increased scale would improve the initial Hooker picture. Two factors account for the improvement. One is the decreased investment in an "over the fence" plant at Nanaimo. The other is continued rapid market growth which will utilize additional capacity more rapidly barring imports or premature construction. Improved return is indicated for the rapid utilization of capacity at Nanaimo (for the 2/3 capacity assumed 1964 to 1965 and full capacity by 1966--simple returns are 7½ and 6 years respectively). A careful expansion program in northern British Columbia would not disrupt this picture. Also, the funds generated by Vancouver in its first 6 years of operation were not quite

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[14] J. Happel, Chemical Process Economics (New York: John Wiley & Sons, Inc., 1958), p. 127.

sufficient to build Nanaimo, but the present combination could generate $10 million for a northern plant in just over 4 years. Thus the present earnings should sustain further growth without funds commitment by the parent in the United States.

The return from investments in the heavy chemical industry are well known as long run ventures. As increasing increments of capacity are added, a smaller percentage of idle capacity exists, so that returns should improve in the long run if other things do not change drastically. The rate of return and capacity utilization also depends upon market share and customer preferences. Initial buying habits from more than one supplier can be changed. Longer term contracts can also be negotiated although preferences and provisions are not reviewed here. Other items of competition have been discussed under technology, price, transportation, and service.

A logical competitor to Hooker Chemicals is Pennsalt Chemicals Corporation which held a greater share in the market when both were supplying British Columbia from Tacoma before Hooker built their plant in Vancouver. The profitability of Pennsalt was less than Hooker in 1958, but Pennsalt has apparently chosen to reinvest in diversification and not long run expansion in this area. Recent actions by this company include acquisitions of Delco and Sharples in 1957 and 1962 (machinery lines), additional investment (the remaining 20 per cent) in a Texas company in 1959 (sulphur compounds), participation in a Netherlands firm in 1960 and since increased, and a joint venture with Olin-Mathieson in 1960 (chlorate chemicals in Kentucky). The short run growth of the firm's assets and sales has been low, but the earnings per share increase has been favorable: 1956--\$0.97, 1957--\$0.80, 1958--\$0.95, (3 for 1 split), 1959--\$1.18, 1960--\$1.26, 1961--\$1.40, 1962--\$1.61. Thus in the short run this firm's policy has had successful results.

Other announced competitors of Hooker in the caustic-chlorine business are Food Machinery Corporation, and Western Chemicals of Two Hills, Alberta (most recently associated with Pennsalt). Because Food Machinery Corporation have interests in an Alaska pulp mill, Hooker will have to protect the northern British Columbia market which they are doing with an announced plant project in Prince Rupert. Although competition has announced projects for the lower mainland, a Prince George location in the future would be more logical.[15]

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[15] A news release in July, 1964 states that Food Machinery Corporation will build a \$10 million plant immediately at Squamish. They must capture some of the lower mainland market to achieve success in this location. Woodfibre is the announced customer (News item, The Province, July 14, 1964, p. 6.)

The market will start there in 1966 and grow.[16] A volume freight rate for Alberta salt would supply raw material at this location competitively with the supply of Mexican salt.

The small plant of Consolidated Mining & Smelting at Trail is a special case. Salt is expensive, but labor is lower by 10 per cent; specific power rates are unknown but are undoubtedly lower; and many other charges are lower as a result of co-ordination of these operations with the other large operations. In addition, market balance can be achieved producing caustic potash as well as caustic soda. Thus, their statement that scale is not important must be reviewed in the light of the circumstances.[17] Hooker returns appear to become satisfactory at 170 tons per day (the expanded Vancouver plant). Faith, Keyes, and Clark state that 200 tons per day is the economic size, which appears reasonable.[18]

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[16]The pulp mill of Canadian Forest Products is proceeding at Prince George. Other mill sites planned in the area include Bulkley Valley, Prince George, and the Peace River.

[17]Submission to the Tariff Board Reference 120, June 10, 1963.

[18]W.L. Faith, D.B. Keyes, and R.L. Clark, op. cit., p. 263. Note that about three Kraft pulp mills of the 500 to 750 tons per day capacity which are being constructed these days could be supplied by a 100 tons per day caustic-chlorine plant (disregarding caustic-chlorine market balance).

Chlorate. The return on the initial investment for Erco chlorate manufacture shows a payout of about 5 years and a discounted rate of return from 1958 of approximately 12.5 per cent (see appendix C-3). These returns are reasonable considering the remarks made under caustic-chlorine though increased stock value is not known. The return was increased by low investment (less fixed cost), and decreased by reduced selling price and lost markets. The returns on future major additional investment will likely be less initially as a result of lower initial capacity utilization. Funds generation has been more than adequate for future expansion.

Sulphuric Acid. Returns for the investment in a sulphur feed sulphuric acid plant were calculated for one year at capacities of 25, 50, and 100 tons per day. One year return was 0 per cent, 12.5 per cent and 21.7 per cent respectively without the addition of general and administrative expense (see Appendix C-4). Under the circumstances a demand of approximately 50 tons would not present attractive returns for Allied Chemical to rebuild at Barnet which they have decided not to do for the present (see Table III, p. 25). A 100 ton plant at 70 per cent capacity would have a simple return of 12 per cent. Present growth will reach 70 tons per day by about 1970, so that unless new markets develop, consideration of investment in a local sulphuric plant will be deferred until that time (see Table VIII, p. 61).

Alum. The one year return to a $500,000 investment by Allied Chemical in a 14,000 ton per year alum plant is 29 per cent (see Appendix C-4). However, at the present time competition from Alberta limits the market to 7,000 tons per year which returns 12 per cent. What might be a satisfactory return is thus hindered by excess capacity and competition.

Phenol. The decline in price of phenol from 16 to 12 cents per pound reduced one year returns from 22.6 per cent to 13 per cent for the Dow plant in Vancouver. The payout is 8 years, and the discounted rate of return 7.9 per cent (see Appendix C-5). No selling expense or overhead has been shown. This would be allocated from the total expense of the Dow sales organization which handles all Dow products. The return to the total investment in British Columbia and Alberta is no doubt better, but details are not available for the Edmonton operation (and this is also beyond the scope of this study). Maximum production of benzoic acid (limited to the Canadian market) improves the position slightly because this material would realize approximately 25 cents per pound or 13 cents per pound incrementally for phenol displaced in the first stage of the process.

Formaldehyde. An investment less than normal (no product purification), captive use, operation at full capacity, and no allowance for overhead, yields a one year return of 18 per cent to Reichhold Chemicals (see Appendix C-4). The availability of a process, plus the right price structure of raw material and finished product enables a profitable backwards integration in this case. No selling expense is involved in the captive use of this product.

Benzene-Toluene-Ethyl Benzene-Xylene. A petroleum refiner would require a 2,000 barrel per day extraction unit to recover enough toluene for Dow demand. No cost is assumed for excess liquid feed subsequently returned to the refinery pool. When markets exist for the other products besides toluene which may be separated from the extracted organic chemical stream then for slight differences in investment the returns are increased. One year returns for toluene, or limited benzene-toluene, or benzene-toluene-ethyl benzene are thus estimated to be 13 per cent, 13 per cent, and 15 per cent respectively (see Appendix C-4). Markets for any xylenes would improve this picture still further. The market for these basic chemicals (BTX) may be summarized as shown in Table XV. The total amount of each chemical is an estimate of the supply from a 2,000 barrel per day Udex unit. The returns for the

TABLE XV

REQUIREMENTS OF BTX FOR MISCELLANEOUS CHEMICALS

barrels per day

MARKET million lbs. per year	BENZENE	TOLUENE	ETHYL BENZENE	XYLENES
15 Alkyl Aryl Sulphonate	17	-	-	-
5 Maleic Anhydride	73	-	-	-
24 Phenol	-	233	-	-
4.5 Styrene	-	-	40	-
Solvents	-	-	-	10
Total Supply[a]	120	270	40	200
Excess	30	37	-	190

[a]2000 BPD Udex, Canadian crude oil.

Source: calculated for given markets.

investment in an extraction unit become attractive only when markets for most of the chemicals exist. This is different from the situation in Eastern Canada where the production capacity is large, but the market predominantly benzene (see p. 68).

Plastics and Soap. The minimum plant size for maleic anhydride and styrene which are manufactured from benzene and ethyl benzene respectively would be at least 5 million pounds per year (barring any new technological developments). As indicated earlier in Chapter III, no feasibility exists until a market of this size or greater is developed, which would be a proportion of the present Canadian market for these chemicals equivalent to the population in the area.

The economic size of a synthetic detergent plant is small (as low as 1.5 million pounds per year), but this is not the case with the detergent alkylate and the sodium tripolyphosphate primary chemicals needed to produce the product. The phosphate requirements for a plant supplying western Canadian requirements of syndet is not large enough to justify a phosphorus plant by itself,[19] so that phosphoric acid from

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[19]A polyphosphate requirement of 10 million pounds per year in 25 million pounds per year of detergent is 5000 tons per year. Phosphate plant size is in the range of 35,000 to 80,000 tons per year according to W.L. Faith, D.B. Keyes, and R.L. Clark, op. cit., p. 65.

Trail might be contemplated. The limited use of benzene for alkylate manufacture would offer practically no increase in return to a benzene-toluunene producer, so that a raw material advantage to an alkylate producer must again wait upon an increased market for plastics. Thus, purchase of the primary chemical phosphoric acid, and the intermediate chemical detergent alkylate, would enable finished product manufacture, but would involve little investment for primary chemicals. The return to a detergent manufacturer appears to be attractive (see Appendix C-4). Distribution of product to the outlets now supplied from Eastern Canada would be required.

CHAPTER VI

CONCLUSIONS

The large consumers of basic chemicals in British Columbia are currently the pulp and paper, and plywood industries. These industries whose present growth pattern started in the 1950's will continue to grow substantially in the near future. The basic chemicals which are manufactured in the province for these industries include caustic soda, chlorine, sodium chlorate, alum, phenol, and formaldehyde. The plants which manufacture these chemicals have been established in the recent past from 1957 until 1963.

Growth of the pulp and paper market depends primarily upon British Columbia's share in foreign markets. Europe and Asia are the important growth areas for British Columbia kraft pulp, and the important growth area for newsprint and sulphite pulp is the United States. The share in overseas kraft markets will be sustained by international investment, examples of which have occurred in Holland, Great Britain, and are expected to occur in Japan. The share in the United States market at present relies primarily on the rapid growth in the nearby region of California. Familiarity with the growth of foreign economies would aid the pulp and paper industry in their forecasting of foreign markets. The Food and

Agricultural Organization of the United Nations has prepared what are considered the best estimates of the world supply and demand using income techniques. Such downstream market study is important for basic chemical forecasting when the chemicals are consumed in manufactured products rather than being sold as finished products.

The growth of the plywood market depends upon new domestic uses, which in per capita terms are declining, and upon increased exports promoted by the manufacturer's association. A straight line trend appears justified in the near future which is a declining percentage growth. This growth would be above the compound rate assumed until 1970 by the Canadian-American Committee, softwood plywood in Canada, at which time their rate of 4¼ per cent, or some other rate, may apply.

The growth of the Agricultural, Oil and Gas, and Mining and Metallurgy industries is not likely to result in basic chemical manufacture in British Columbia in the near future. The Agriculture and Oil and Gas industry are generally supplied from Alberta. A new development in metallurgy could change that market's demand. The plastics plus the synthetic detergent market may result in basic chemical manufacture in the future. Syndets could be manufactured now from purchased basic chemicals, but this would require entry to existing marketing channels.

Resource requirements for the chemical industry were reviewed. The only raw materials currently of commercial use in British Columbia are sulphur or sulphides, and petroleum liquids and gas. The refining of metal sulphides at Trail provides the byproduct material to manufacture sulphuric acid for metal refining and fertilizer manufacture, but a sulphur or sulphide route to sulphuric acid on the coast is uneconomic in the near future. Petroleum gas is used to manufacture ammonia at Trail, but no utilization of petroleum gas for chemicals manufacture is likely elsewhere in the province at this time. Petroleum liquids are available at oil refineries for manufacture into basic chemicals for plastics and detergents if a sufficient market develops to isolate and separate the various organic chemicals which can be derived from this source. Raw materials are a large percentage of petrochemical costs so that ready supply could be an important consideration in the future (see Appendix B-2 for these percentages).

Generally, the mineral raw materials for the manufacture of existing and potential basic inorganic chemicals are brought from outside the province for manufacture adjacent to the local market. Freight to move the basic chemical to the point of use is thus kept to a minimum. Salt from Mexico and Alberta provides the raw material for caustic soda, chlorine, and sodium chlorate. Similarly bauxite for alum, phosphate rock for phosphoric acid, and potash for caustic potash are brought into the province. The forestry and metallurgy industries of the province consume these chemicals. The basic chemicals do not progress further to finished products or consumer items as refinery liquids could--phenol and formaldehyde are thus exceptional at present in that they are market and not raw material oriented.

The technology used by the example companies studied was in each case the organization's own. This knowledge has been undoubtedly an important factor in the determination of the entrants.

Requirements of labor, utilities, supplies, and transportation are generally in good supply and would not seem to be a deterrent to chemicals manufacture. Cost of resources is important when an item assumes a large percentage of the total cost. Labor is thus important to inorganic chemicals in this province and necessitates larger plant scale to justify investment (e.g. sulphuric acid). Increasing costs also reduce return on investment through time. The firm or decreasing trend in chemical prices necessitates an expanded scale in a growth market to maintain returns.

The capital requirements of the industry in British

Columbia are not large and have been provided out of parent organization routine operations. A fairly normal capital budgeting procedure should suffice for basic chemical investment opportunities in British Columbia based upon the size of the parent corporations of the examples considered in this thesis. Funds flow in the branch plants which are profitable can likely sustain expansion.

The profitability appears modest in the cases explored. Profit performance for a variety of reasons has been satisfactory though limited, but perhaps it is to be expected in long run ventures of this type. Slow growth (held back by imports from the United States plant) limited return on a large incremental investment in caustic-chlorine. A drastic change in chlorate market structure affected short run returns for chlorate manufacture. A price reduction brought on by world supply reduced profit in phenol manufacture. These are all risks to which any investment is subject and of three discounted rates of return estimated for an intermediate run in Appendices C-2, C-3, and C-5, only one achieved a target of 10 to 20 per cent. World implications when they affect profitability do not make the decision process any easier. For protection the investment or expenses must be reduced. This may be done through purchase when scale is small, or improved technology, or alternate products to reduce the scale factor, or by large scale.

Although this study indicates the possibility of basic organic chemicals manufacture for plastics, etc., further study would be required to indicate how this might come about. The growth of sales and service organization which brings in chemicals and aids in the development of consumer products would be required. The commitment of funds prior to plant decisions, which was mentioned in Chapter V, must also be profitable. Other products such as synthetic latex for coatings or size might also be manufactured in the future and broaden the base for basic organic chemicals. No studies of the technology for alternate products to reduce the scale factor was attempted.

Manufacture primarily for export was not considered in this study. Ammonia could readily be manufactured from petroleum gas at tidewater, but the market, which must be developed, would be offshore. With potash from Saskatchewan likely to become a large export item, ammonia might be added as part of a fertilizer package.

Generally, basic chemical manufacture does not employ raw material resources of the province, employs few people, requires relatively small amounts of investment, and realizes modest returns. The Canadian tariff position of world trade and no protection leaves manufacturers open to world competition. A study was not attempted of tariff policy in other countries where manufacturing of petrochemicals is practiced, thus limiting the possibilities of export chemicals. However, export of basic organic chemicals is practiced from eastern Canada which has just expanded into organic chemicals from petroleum on a large scale. Similar developments might occur in the west in the future.

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APPENDIX

APPENDIX A-1

MARKET END USE PATTERNS

as percentage of market

Market	Caustic			Chlorine				Sulphuric a		Phenol		Maleic Anh.
	B.C.[d]	Can.[b]	U.S.[c]	B.C.[d]	Can.'48[a]	Can.'61[b]	U.S.[c]	B.C.[d]	Can.[b]	B.C.[d]	U.S.[c]	U.S.[c]
Pulp & Paper	93.7	42.0	7.7	99	75	54.6	11.0	69	2.3			7
Chemicals	0.6	39.6	54.5	1	17	42.0	63.5	23.2	54.4		35	
Resins										100	48	32 (alkyd)
Metallurgy		2.4	2.5		3	1.4			26.0			
Water works					2	0.9						
Soap		5.4	5.0			1.1			1.0			
Fertilizer								7.8	7.4			
Polyesters												16
Drying oils												15
Other	5.7	10.6	30.3				25.5		8.9		17	30
	100.0	100.0	100.0	100	100	100.0	100.0	100.0	100.0	100	100	100

Note: as discussed on p. 34.

Source:

[a]C.J.S. Warrington and R.V.V. Nicholls, A History of Chemistry in Canada (Toronto: Sir Isaac Pitman and Sons (Canada) Limited, 1949), p. 210.

[b]Canada. Dominion Bureau of Statistics. Industrial Chemicals, 1961, Tables 11, 12, 13.

[c]W.C. Faith, D.B. Keyes, R.L. Clark, Industrial Chemicals (New York: John Wiley & Sons, Inc., 1958), pp. 261, 500, 588, 691.

[d]Estimate for British Columbia in 1963. Sulphuric acid excludes Consolidated Mining and Smelting at Trail.

APPENDIX B-1

TYPICAL FREIGHT RATES

COMMODITY	POINTS	RATE (min. carload)
Ammonia & Ammonium Nitrate	Calgary - Vancouver (offshore fertilizer)	$18.60/T (50,000#) 7.80/T (80,000#)
	Warfield - Van.(offshore)	6.40/T (80,000#)
Formaldehyde	Edmonton - Vancouver	11.00/T (agreed chrg. 180,000#)
Ethlyene Glycol	Edmonton - Vancouver	15.00/T (60,000#) 17.00/T (50,000#) 18.00/T (40,000#) 20.00/T (30,000#)
Sulphur	Taylor - Pr. George	5.00/T
Sulphuric Acid	Edmonton - Vancouver	28.40/T
Soaps	Ontario - Vancouver (agreed charge 101)	66.60/T (40,000#) 58.80/T (50,000#) 54.40/T (60,000#) 52.00/T (80,000#)
Caustic Soda	Vancouver - Castelgar	31.80/T (80,000#)
	Two Hills - Castelgar	36.60/T (80,000#)
	Trail - Castelgar	5.40/T (80,000#)
Chlorine	Vancouver - Castelgar	38.60/T (110,000#)
	Two Hills - Castelgar	44.80/T (110,000#)
	Trail - Castelgar	6.60/T (110,000#)
Phenol	Vancouver - Ontario	40.00/T
Alumina	Jamaica - Vancouver	15.00/T (Free in & out, F.I.O.) 7.00/T (10,000 Tons F.I.O.)
Phosphate	Florida - Japan	8.00/T (12,000 Tons)
	Montana - Vancouver	8.26/T (80,000#)

Source: Railroad tariffs, and prive communications.

APPENDIX B-2

EXAMPLE RELATIONSHIPS OF CHEMICAL PROCESS EXPENSES

as percentages

Item	Caustic Chlorine 195 & 170 T/D	Sodium Chlorate 57 T/D	Phenol 24MM#/yr	Sulphuric Acid 100 T/D	Alum 50 T/D	Udex BTX 2000 BPD	Detergent 25MM#/yr	Formaldehyde 12MM#/yr 37%
Raw Materials	17.8	8.3	52.5	35.1	64.4	53.8	74.6	71.6
Labor	14.9	13.5	15.8	25.6	12.5	4.8	11.9	4.7
Utilities	19.5	32.9	0.9	2.7	2.8	12.7	7.9	3.7
Supplies	4.6	9.6	-	-	3.8	3.7	1.1	3.4
Maint. Mat'l	1.5	5.6	3.8	6.8	3.8	3.0	0.4	3.4
Transportation	4.9	3.3	1.3	8.5	-	1.5	-	-
Depreciation	15.6	11.1	11.8	8.5	4.7	9.3	1.1	5.1
Tax & Ins.	5.6	3.5	6.8	5.1	3.4	3.7	0.4	3.0
Debt	15.6	11.1	7.1	7.7	4.7	7.5	1.1	5.1
Gen. & Admin.	-	1.1	-	-	-	-	1.5	-
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: derived from expenses utilized in appendices C-2 to C-5.

APPENDIX A-2

MARKET FOR BRITISH COLUMBIA PULP & PAPER CHEMICALS
1962 to 1966

in thousands of tons

Chemical		Salt Cake		Caustic		Chlorine		Sod. Chlorate		Sulphuric a	
1962	Capacity								(45#/T B)		(35#/T B)
Kraft	1242	59(95#/T UB)		43.3(105#/T B)		55(140#/T B)		13.7(23#/T SB)		10.7(18#/TSB)	
Dissolving	260	-		45 (345#/T)		11.3(87#/T)		0.8(6#/T)		0.4(3#/T)	
Sulphite	130	-		5.5(85#/T)		8.4(130#/T)		-		-	
Total			59		94		75		14.5		11.1
'63 Kraft	155(120B)	8.3	67	6.6	101	8.4	83	2.7	17.2	2.2	13.3
'64 Kraft	330(70B,150SB)	15.7	83	12.1	113	15.4	99	3.3	20.5	2.5	15.8
'66 Kraft	220(80B,40SB)	12.0	95	4.3	117	5.6	104	1.8	22.3	1.4	17.2

Source: Private communications for consumption, announced expansions for increased requirements.

APPENDIX C-1

FUNDS FLOW

in millions of dollars

Company	Hooker								Dow								
Year	55	56	57	58	59	60	61	62	55	56	57	58	59	60	61	62	63[a]
<u>Source</u>																	
Operations	17	19	17	19	22	21	21	26	110	134	134	128	146	161	154	157	180
Liabilities	3	4	5	2	4	-	-	5	(4)	(8)	(60)	(36)	34	(9)	82	(15)	(20)
Debt	6	5	4	6	21	(2)	(3)	(2)	(5)	(82)	(27)	142	(103)	(18)	(9)	1	41
Stock	21	9	-	4	1	1	-	8	(32)	23	28	22	21	23	41	14	(7)
Total	47	37	26	31	48	20	18	37	69	67	195	256	98	157	268	157	194
<u>Use</u>																	
Acc. Rec.	10	4	3	4	32	(5)	(14)	8	1	(42)	(34)	15	22	7	20	18	62
Invent.	7	5	2	1	1	3	(1)	3	(6)	28	34	21	(13)	10	16	(10)	2
Plant	24	22	15	19	8	15	26	18	48	57	162	189	58	99	151	90	80
Dividend	6	6	6	7	7	7	7	8	23	24	30	31	31	37	40	47	47
Other									3	-	3	-		4	41	12	3

[a] Annual report. Fiscal year changed

[b] Millions of pounds

Source: adapted from <u>Moody's Industrials</u>

APPENDIX C-2

RETURNS CAUSTIC-CHLORINE

in thousand dollars per year

Item	1958	59	60	61	62	63	64	65	66	67	68	69	70	
Raw Mat'l	264[d]	330	396	432	450	720	720	720	720	720	720	720	720	
Labor (82)	500[c]	500	525	560	575	605	635	665	695	725	755	785	815	
Utilities	240	334	400	463	487	791	791	791	928	928	928	928	928	
Supplies	60	74	90	107	114	185	189	193	197	201	205	209	213	
Maint. Mat.	50	40	40	50	50	90	50	50	60	60	80	60	60	
Transp.	190	190	190	195	195	200	200	200	200	175	175	175	175	
Depr. 5%	600	600	600	600	600	630	630	630	630	630	630	630	630	
Tax & Ins.	260	260	260	245	220	225	235	235	235	235	235	235	255	
Gen. & Adm.	(Res. 200. Ge. - 10% Sales)					900	900	900	900	900	900	900	900	
Total	2164	2328	2501	2652	2691	4376	4380	4414	4595	4604	4658	4762	4706	
Revenue[b]	2438	3012	3670	4272	4445	7340	7340	7340	7340	7340	7340	7340	7340	
Gross	(274)	684	1169	1620	1754	2964	2960	2926	2745	2736	2682	2668	2634	
I. Tax[a]	122	335	577	800	866	1472	1470	1454	1362	1358	1330	1324	1306	
Net	152	349	592	820	888	1492	1490	1472	1383	1378	1352	1344	1328	
Funds[e]	752	949	1193	1420	1488	2122	2120	2102	2013	2008	1982	1974	1958	
6% Disc. (Sum)	710	845	1000	1125	1110	1495	1410	1320	1190	1120	1045	982	918	(14270)
8% Disc. (Sum)	697	813	945	1043	1012	1335	1235	1135	1005	930	850	785	720	(12605)
10% Disc.(Sum)	684	785	895	970	925	1195	1085	980	850	775	695	630	568	(11137)

[a]Prescribed rates for Vancouver, 50% on new plants. [b]Table XIV p. 109. [c](87) in 1958

[d]Salt price from 1958, $8 per ton, 8, 7.50, 7.50 and 7.25 in 1963 and thereafter.

[e]Funds of 12,146 in 8 years, discount to 13 years sums as shown ( ), 12,605 at about 8 percent for an investment of 12,600.

[f]Estimated for proportion of capacity shown. Nanaimo 2/3 - 1964-65, 1 - 1966; Pr. Rupert - 1967; Kitimat - 1970.

APPENDIX C-3

RETURNS SODIUM CHLORATE

in thousand dollars per year

	1958	59	60	61	62	63	64	65	66
Raw Mat'l $15/T	165	165	99	132	144	149	157	165	165
Labor (33)	200	200	210	224	228	243	256	268	280
Utilities	560	660	495	527	577	593	625	660	775
Supplies	180	183	139	151	168	174	186	199	202
Maint. Mat.	50	50	100	100	100	100	100	100	100
Transp.	60	60	60	60	60	60	60	55	55
Depr. 5%	200	200	200	200	200	200	200	200	200
Tax & Ins.[a]	76	76	76	72	63	64	65	66	67
Gen. & Adm.[b]	20	20	20	20	20	20	20	20	20
Total	1511	1614	1399	1486	1558	1601	1667	1731	1864
Revenue	3200	3200	2250	2400	2625	2700	2850	3000	3000
Gross	1689	1586	851	914	1067	1099	1187	1269	1036
I. Tax.	844	793	425	457	533	549	593	634	568
Net	845	793	426	457	534	550	594	635	568
Funds[c]	1045	993	626	657	734	750	794	835	768
10% Disc. (Sum)	950	820	470	449	455	422	407	390	4363
12% Disc. (Sum)	933	790	446	418	415	380	359	337	4078
14% Disc. (Sun)	916	763	423	389	380	342	320	293	3826

[a] Insurance about 1/2 of expected.

[b] Est. for engineering only, technical service also involved.

[c] Funds of 4055 in 5 years, discounted sum as shown (   ), 4000 investment interpolated at 12.5 percent.

APPENDIX C-4

VARIOUS CHEMICAL RETURNS - ONE YEAR BASIS

in thousand dollars per year

Product	Sulphuric Acid			Alum		Formaldehyde
Plant Cap.	25T/D	50	100	7000T/yr	14000	12MM#/yr 37%
Raw Mat'l	52	103	206	170	340	212
Labor	150(20)	150	150	66(10)	66	14(2)
Utilities	4	8	16	10	15	11
Supplies	-	-	-	10	20	10
Maint.	10	20	40	18	20	10
Transp.	12	25	50	-	-	-
Depr.	18	30	50	25	25	15
Tax & Ins.	7	12	30	18	18	9
Gen. & Adm.	-	-	-	-	-	-
Total	243	348	542	317	504	281
Revenue	219	438	876	364	728	360
Gross	(24)	90	334	47	224	79
Net		45	167	34	122	40
Funds		75	217	59	147	55
100 Funds / Investment		12.5	21.7	11.8	29.4	18.3

Source: Local information where available from private communication, and technical journal figures adapted to time and place.

APPENDIX C-5

RETURNS PHENOL

in thousand dollars per year

Item	1963	64	65	66	67	68	69	70	71				
Raw Mat'l 4.5¢/lb.	1100	1100	1100	1100	1100	1100	1100	1100	1100				
Labor (30)	234	246	258	270	282	294	306	318	330				
Utilities	20	20	20	21	21	21	21	21	21				
Supplies	-	-	-	-	-	-	-	-	-				
Maint. Mat.[a]	182	194	206	218	230	242	254	266	278				
Transp.	28	26	24	22	21	19	17	15	15				
Depr. 5%	250	250	250	250	250	250	250	250	250				
Tax & Ins.	144	142	138	136	132	128	126	126	126				
Gen. & Adm.	-	-	-	-	-	-	-	-	-				
Total	1958	1978	1996	2017	2036	2054	2074	2096	2120				
Revenue[b]	2758	2778	2798	2818	2838	2858	2878	2898	2898				
Gross	800	800	802	801	802	804	804	802	778				
Inc. Tax	400	400	401	401	401	402	402	401	389				
Net	400	400	401	400	401	402	402	401	389				
Funds[c]	650	650	651	650	651	652	652	651	639	627	615	603	
6% Disc. (Sum)	612	602	547	515	486	460	434	408	378	350	324	300	(5416)
8% Disc. (Sum)	579	557	516	478	444	410	380	352	319	290	264	240	(4829)

[a] Includes 17 contract maintenance crew.

[b] Includes 600,000 lb. Benzoic Acid at 13¢/lb. incremental revenue.

[c] Funds of 5207 in 8 years; discount extrapolated to 12 years sums as shown ( ), investment of 5000 interpolated at 7.9 percent.

APPENDIX D

MISCELLANEOUS DATA FOR AMERICAN & CANADIAN CHEMICAL COMPANIES

Company	Sales $ MM	Returns % Assets	Returns % Net Worth	Returns % Sales	Deprecia- tion - %	Owners' Equity %
Hooker Chemicals	150	6.8	12.7	8.5	57	60
Wyandotte	97	5.1	7.2	5.0	41	84
American Potash	50	7.1	8.2	10.0	53	95
Spencer	74	6.7	7.1	9.0	60	75
Stauffer	220	10.9	11.8	9.1	49	88
I.C.I.		4.6	6.0		83	86
C.I.L.	170	4.4	7.5	3.8	53	66
Pennsalt	90	5.5	8.0	5.4	44	80
Matheson		12.2	26.5			82
Dom Tar	215	2.8	4.7	4.6	58	61
Olin Mathieson	690	4.0	8.7	5.0	58	55
Diamond Alkali	138	8.2	12.0	8.5	49	80
Grace	469	2.7	6.4	2.9	58	55
F.M.C.	353	6.9	11.2	5.8	50	76
Dow	781	9.1	14.1	10.6	49	79
Monsanto	890	6.2	11.3	7.6	68	82
Gen. Aniline	160	4.0	5.3	4.4		84
Mallinckrodt	35	2.7	3.8	2.9	48	74
Rohm & Haas	218	11.5	13.4	9.6	50	100
Catalin	19	0.4	0.8	0.2	59	63
Polymer	8	6.3	10.6	6.2	68	63
Comm. Solvents	62	6.8	11.2	8.1	41	73
Reichhold	99	4.8	6.5	3.3	70	69
Atlas	71	6.2	7.1	4.2	48	89.5
Can. Chemical	28	3.3	7.1	9.7	75	50
American Marietta.						95
Koppers	302	4.8	6.1	2.8		
Dupont	2,142				41	
Union Carbide	1,548	12.3	16.5	11.3		
Hercules	337	10.4	14.4	8.1	47	
Cyanamide	578	7.3	10.8	8.1	49.5	
Can. Oils (av. of 3)		8.0	10.9	11.1		
4 Can. Pulps (average)	148	7.5	9.7	7.9	51	

Source: Moody's Industrials. 1961.