INDUSTRIAL BENEFITS

OF

BEAUFORT SEA OIL TRANSPORTATION ALTERNATIVES

INDUSTRY, TRADE AND COMMERCE/
REGIONAL ECONOMIC EXPANSION

FINANCIAL AND COST
BENEFIT ANALYSIS UNIT

AUGUST, 1983

INDUSTRIAL BENEFITS OF BEAUFORT SEA OIL TRANSPORTATION ALTERNATIVES

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TABLE OF CONTENTS

LIST OF TABLES

Page

Chapter 4 (cont'd)

Chapter 5

Page

Chapter 8

Special Annex

EXECUTIVE SUMMARY

The study assesses the industrial benefits of alternative Beaufort Sea Oil development and transportation scenarios, including: i) a national and regional economic impact of Beaufort development and transportation up to the year 2000, ii) an initial assessment of manufacturing capabilities and opportunities with respect to icebreaker tankers and pipelines, and iii) an economic and financial tariff comparison of alternative transportation modes up to the year 2010.

No sufficient commercial oil reserves have yet been proven in the Beaufort region, and therefore all the scenarios considered in this study are hypothetical.

Eight transportation scenarios are considered, including four pipeline and four marine alternatives:

High Oil Throughput - Up to 1 Million BOPD

Scenario 1 : 36" Mackenzie route to Edmonton; uses Interprovincial Pipeline to Chicago and Sarnia.

Scenario 2A: Tanker route through the Northwest Passage to Point Tupper (Nova Scotia); oil transshipped on shuttle tankers; split at Portland between Montreal-Sarnia and Philadelphia; icebreaking tankers produced in the Halifax/Canso and foreign yards.

Scenario 2B: Same route as Scenario 2A except that all icebreaking tankers are imported.

Medium Oil Throughput - Up to 500,000 BOPD

Scenario 4 : 36" Dempster route pipeline to Whitehorse and down to Skagway (USA); regular tanker to Tokyo.

Scenario 5A: Same route as Scenarios 2A and 2B except that the entire oil production is exported to Philadelphia; icebreaking tankers produced in the Halifax/Canso and foreign yards.

Scenario 5B: Same route as Scenario 5A except that all icebreaking tankers are imported.

Scenario 7 : 30" Mackenzie route pipeline to Edmonton; uses Interprovincial Pipeline to Chicago.

Low Oil Throughput - Up to 200,000 BOPD

Two variants of a 20" pipeline scenario are considered.

Scenario 8 : a) Short Pipeline: 20" Mackenzie route pipeline to Zama (Alberta); uses Rainbow Pipeline to Edmonton and Interprovincial Pipeline to Chicago.

b) Extended Pipeline: 20" Mackenzie pipeline to Edmonton; oil is then transported to Chicago via the Interprovincial Pipeline.

The design and cost assumptions underlying this study are subject to a considerable range of error, which will be narrowed as further research and experience modifies the industries' conception of this major project. Therefore, the study results should be viewed as merely providing a possible order of magnitude of the relative merits of alternative transportation scenarios.

Table 1 summarizes the findings of the study.

Financial Transportation Tariffs

The low volume 20" (Short Pipeline) exhibits the lowest constant dollar tariff or cost of service together with the high volume 36" Mackenzie pipeline, closely followed by the 20" (Extended Pipeline). The Joint Industry Task Force now think the 36" pipeline would be a no go situation and the pipeline would be built as multiples of smaller pipe size. The high volume marine cases lag behind, followed by the medium volume Dempster pipeline and marine scenarios. The elevated 30" Mackenzie pipeline ranks last. Current thinking is that this 30" elevated line is very conservatively designed and as a result costs are very high. The extent to which this line could be buried is now under study. Little difference is observed between the domestic and foreign marine cases and both are considered to be conservatively designed, the major area of difficulty being the costs loading and storage facilities.

Economic Transportation Unit Costs

Economic efficiency analysis translates private transportation costs into social or economic costs per barrel of oil transported (unit cost) to account for the presence of distortions or externalities, including subsidies, taxes, duties, labour benefits and foreign exchange effects.

Economic adjustments do not markedly disturb the ranking or differential observed in the tariff comparisons, except that among medium volume scenarios, the Dempster is 10 per cent more efficient than either marine cases, or the 30" Mackenzie pipeline. The benefits of building a domestic VLCC yard arising from job creation, taxes and foreign exchange savings of not importing tankers are not sufficient to provide a distinct economic cost advantage to the Canadian marine option relative to the corresponding foreign marine or pipeline scenario.

Economic Impacts

An economic impact analysis was carried out for all scenarios, except for the 20" and 30" buried Mackenzie pipelines.

National Impacts

Despite an earlier oil production start-up for the high marine cases (1986 vs 1990 for the pipeline), the high volume pipeline shows essentially the same cumulated impacts on key variables relative to the domestic marine case (percentage difference in bracket): GNP - $47.5 vs $45.8 billion[1] (3.7%); RDP[2] - $61.1 vs $57.4 billion (6%) and employment - 3.3 vs 3.2 million person-years (2.9%). If a marine mode were to be selected, the benefits of replacing tanker imports by building a new domestic yard would create about 190,000 additional person-years (6.3%).

The medium volume cases, which assume a common start-up for oil production by 1990, indicate that a Dempster pipeline (which is not necessarily the best comparison since the modes deliver to different markets) would have a stronger impact relative to a domestically-built tanker mode (percentage difference in bracket): GNP - $31.1 vs $28.5 billion (8.3%); RDP - $41.3 vs $37.2 billion (10.9%) and employment - 2.5 vs 2.3 million person-years (10%). The proposed Halifax/Canso yard would create about 170,000 additional person-years (7.9%) relative to a foreign marine scenario.

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[1] 1971 dollars; as a rough estimate, multiply 1971 values by 2.5 to obtain 1981 dollars

[2] Real Domestic Product or Gross Domestic Product at Factor Cost (GDP) includes interest and dividend payments paid to non-residents, while GNP excludes these payments

Manufacturing Capabilities and Opportunities

The Canadian material content, based on the existing manufacturing capabilities, would be of the order of 80 to 90 per cent for a pipeline compared to approximately 25 to 40 per cent for the proposed Canadian-built icebreaker tanker. There is potential to increase the Canadian material content of a pipeline to a little more than 90 per cent and to approximately 80 per cent for the tanker. Thus, there is potentially greater scope to expand manufacturing facilities for the tankers, in the event domestic capacity to build the required type of tankers is available. Manufacturing capabilities with respect to the pipeline are well established in the country and potential for new capabilities is not great. The potential for domestic suppliers of marine equipment (propulsion system, steering, electrical system) would require further study.

In the unlikely event of a clustering of pipeline projects in the late 80s, there could be insufficient Canadian pipelaying and even pipemaking steel capacity in 1987 and 1988 to meet the requirements of a Mackenzie pipeline route. Barring unforeseen events, the shorter Dempster pipeline should not encounter any capacity problems.

Due to resource constraints, the 20" and 30" buried Mackenzie pipelines were not assessed. Likewise no attempt was made to refine any of the marine scenarios.

Conclusion

In terms of financial tariff or cost of service and economic efficiency, the Mackenzie pipeline scenarios #8 (20" Short), #1 (36") and #8 (20" Extended) show the best performance of all the options. In view of the smaller oil reserves required by a low volume pipeline, relative to a high or medium volume option, the 20" pipeline scenario (Short or Extended) appears quite attractive.

In the high volume case, the pipeline appears superior to the domestic marine scenario, in terms of financial tariff, economic efficiency and Canadian material content, but on national economic impacts, the pipeline edge is not significant. The distribution of economic impacts varies by mode, the domestic marine mode is definitely advantageous to Nova Scotia.

In the medium volume case, the relative merits of a pipeline are not as clear cut. The Dempster pipeline is slightly more attractive than the domestic marine or 30" Mackenzie pipeline scenario on economic efficiency, Canadian material content and, except for Nova Scotia, on national and provincial economic impacts. However this system is oriented to a totally different market and consequently is not completely comparable. Given the great uncertainties associated with the study's assumptions, one cannot dismiss at this time the relative merits of a medium volume domestic marine nor a 30" Mackenzie pipeline scenario. This would be particularly so given the current possibility that a 30" pipeline could essentially be buried with a substantially lower cost.

Irrespective of the throughput, domestic marine scenarios show a clear advantage relative to foreign marine scenarios in terms of national and provincial economic impacts.

TABLE 1

STUDY SUMMARY - FINDINGS

	HIGH VOLUME			MEDIUM VOLUME				LOW VOLUME	
	PIPELINE MACKENZIE #1 (36")	MARINE FOREIGN #2B	MARINE CANADIAN #2A	PIPELINE DEMPSTER #4 (36")	MARINE FOREIGN #5B	MARINE CANADIAN #5A	PIPELINE MACKENZIE #7 (30")	PIPELINE MACKENZIE #8 (20")	
								SHORT	EXTENDED
FINANCIAL TRANSPORTATION TARIFF* ($/BARREL)	5.46	9.34	9.38	10.43	10.44	10.56	11.44	5.28	6.41
ECONOMIC TRANSPORTATION COST*									
- CONSERVATIVE:	5.24	9.83	9.78	10.08	11.18	11.08	11.07	4.91	6.17
- OPTIMISTIC:	5.08	9.75	9.66	9.73	11.06	10.88	10.73	4.77	5.98
GNP (MILLION $ 1971)	47,558	44,239	45,854	31,129	27,334	28,548	N/A	N/A	N/A
GDP (MILLION $ 1971)	61,104	55,090	57,428	41,316	35,381	37,240	N/A	N/A	N/A
EMPLOYMENT (THOUSANDS - MY)	3,309	3,025	3,215	2,576	2,170	2,341	N/A	N/A	N/A
FEDERAL BALANCE (BILLION $ CURRENT)	161.40	167.20	169.40	64.10	50.60	51.80	N/A	N/A	N/A
GDP (MILLION $ 1971) (ATLANTIC + QUEBEC + MANITOBA)	19,272	17,254	19,630	13,089	11,177	13,060	N/A	N/A	N/A
EMPLOYMENT (THOUSANDS - MY) (ATLANTIC + QUEBEC + MANITOBA)	1,118	1,040	1,260	870	731	915	N/A	N/A	N/A
DOMESTIC MATERIAL TRANSPORTATION CONTENT(%)									
- EXISTING:	80 - 90	N/A	25 - 40	80 - 90	N/A	25 - 40	80 - 90	N/A	N/A
- POTENTIAL	APPROX. 90	N/A	UP TO 80	90+	N/A	UP TO 65	APPROX. 90	N/A	N/A

* TO MARKETS

1. OBJECTIVES OF DREE STUDY

The purpose of the study is to assess the industrial benefits of alternative Beaufort Sea oil development and transportation scenarios at the national and regional levels. The analysis focusses on the following aspects:

i) a national and regional economic impact analysis of alternative Beaufort oil development and transportation scenarios, with the emphasis on the differential impact of alternative transportation modes;

ii) an initial assessment of Canadian manufacturing capabilities and development opportunities with respect to icebreaker tankers and pipeline;

iii) an economic cost comparison of alternative transportation modes; and

iv) computation of financial transportation tariffs.

2. THE CARIN TRANSPORTATION STUDY[1]

The purpose of the Carin study was to analyze the relative merits of pipeline vs icebreaker tanker. The assignment was accomplished in a very short period of time and was not intended to be definitive. Relative merits of the alternative transportation modes were described in terms of economic or resource unit cost, financial transportation tariff (incorporating cost of debt and equity and taxes), taxation implications, environmental and socio-economic impacts. The objective of the analysis was to obtain a preliminary indication

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[1] Beaufort Sea Oil Transportation Alternatives, Energy, Mines and Resources, and Indian and Northern Affairs, July 1982. Referred as the Carin Study in this report.

of the nature of the crucial elements of each transportation system. Due to a tight deadline, the assessment of industrial benefits was restricted to a brief overview of the factors involved. However, Carin identified potential areas for further study, including the economic impact of alternative transportation modes, the relative merits and efficiency of a domestic VLCC yard over VLCC imports, supply capabilities and Canadian content. It is these issues, among others, that our study has addressed.

There is an inherent advantage in accepting the Carin study as the basis for this analysis, namely, a data set which has already been subjected to some review by the interested groups. The Carin work group asked Dome Petroleum Limited, Gulf Canada Resources Inc. and Esso Resources Canada Limited for submission with respect to the costs of alternative transportation systems in the Beaufort.

This report supplements the Carin study with regards to the national and regional impact analysis, manufacturing capabilities and opportunities, and an assessment of the merits of a new VLCC yard. It further complements that study in the area of economic transportation costs through additional benefit/cost adjustments. New financial tariffs are also calculated because of different assumptions relative to vessel prices and oil throughput.

Our study should be viewed as an extension of the Carin study. Therefore, reading of that study would facilitate understanding of our report. Nevertheless, the key technical and cost assumptions including the caveats of the Carin study have been reproduced to render this report as self-contained as possible.

The design and cost assumptions underlying this study are subject to a considerable range of error, which will be narrowed with further research and experience. Therefore, the study results should be viewed as merely providing an order of magnitude of the relative merits of alternative transportation scenarios.

<u>Note</u>: As a result of studies underway that suggest up to 30" pipelines down the Mackenzie might be buried, Esso and Gulf, requested that the 20" Mackenzie pipeline scenario 8, with a peak throughput of 200,000 BOPD, be added to the seven original scenarios. A similar request to rework the 30" pipeline scenario at the lower buried costs was not analysed. The additional analysis was restricted to the calculation of the financial tariff and economic unit cost and is presented in a special annex at the end of the report (see Special Annex). However the executive summary and conclusions of the study incorporate the findings on scenario 8.

3. BEAUFORT OIL SCENARIOS

No sufficient commercial oil reserves have yet been proven in the Beaufort region and therefore all the scenarios considered in this study are hypothetical.

Seven scenarios are considered.[1] They include:

i) two alternative transportation modes: tanker and pipeline;

ii) two oil throughput levels: high vs medium volume; and

iii) two levels of Canadian content for each marine scenario: domestic production vs import of tankers.

Overall, three pipeline and four marine scenarios are analyzed.

The route, mode, market and Canadian content are described on Table 3-1. The specific route is shown on map 1.

Unlike Carin,[2] the proportion of oil delivered to domestic and export markets is identical between the two alternative modes, for a given volume of oil production. The high volume scenarios export three-quarters of their throughput while the medium volume scenarios export their entire throughput. While this assumption does not necessarily reflect federal policy on oil exports, it ensures minimal bias with respect to markets between competing transportation modes.

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[1] Due to the already large number of scenarios considered by this study, selected Carin's scenarios were dropped e.g. - scenario 3(subsea pipeline to Prudhoe Bay-Alyeska pipeline-Tokyo); scenario 6(low volume 24" pipeline to Edmonton) and scenario 7 (36" medium volume pipeline to Edmonton).

[2] Carin Study, p.2.6

Carin's production profiles were altered, particularly in the early years of production. In addition, the medium throughput scenarios have been equalized between the two modes. These profiles needed to be adjusted to conform to the production profile of the Beaufort Planning Model because reservoir profiles and typical growth patterns suggested a divergence from Carin's rules (see Annex 7-1 for a description of that model). The Beaufort model assumptions were also adjusted to approximate Carin's throughput. The model was used for providing data to assess the macro and regional economic impacts. This study's production profiles together with Carin's throughput are indicated in Table 3-2.

Table 3-1

SCENARIO DESCRIPTION

Scenario 1 - Mackenzie Pipeline - High Volume

36" pipeline runs from Richards Island (Beaufort Sea) to Inuvik, along Mackenzie Highway route to Norman Wells (Northwest Territories) and Zama (Northern Alberta), then follows the Rainbow Pipeline route to Edmonton; uses the existing Interprovincial Pipeline system with a split at Superior (Wisconsin) for oil delivery at Chicago and Sarnia.

Scenario 2A - Tanker - High Volume and High Canadian Content

Tanker route through the Northwest Passage (Prince of Wales Strait - Viscount Melville Sound, Barrow Strait - Lancaster Sound - Baffin Bay - Davis Strait - Labrador Sea - Strait of Belle Isle) to Point Tupper (Nova Scotia); oil transshipped on shuttle tankers; split at Portland between Montreal/Sarnia and Philadelphia; icebreaking tankers produced in the Halifax/Canso and foreign yards.

Scenario 2B - Tanker - High Volume and Low Canadian Content

Same route as Scenario 2A except that all icebreaking tankers are imported.

Scenario 4 - Dempster Pipeline - Medium Volume

36" pipeline runs from Richards Island to Inuvik, follows Dempster Highway until just east of Dawson, follows the Klondike Highway to Carmacks; goes southward to the Alaska Highway at Takhini, until Whitehorse; goes south to Carcross then along the White Pass and Yukon railway right of way to the port of Skagway (USA). Oil is transported by regular tankers to Tokyo.

Scenario 5A - Tanker - Medium Volume and High Canadian Content

Same route as Scenarios 2A and 2B except that oil transshipped on shuttle tankers to Philadelphia; icebreaking tankers produced in the Halifax/Canso and foreign yards.

Scenario 5B

Same route as Scenario 5A except that all icebreaking tankers are imported.

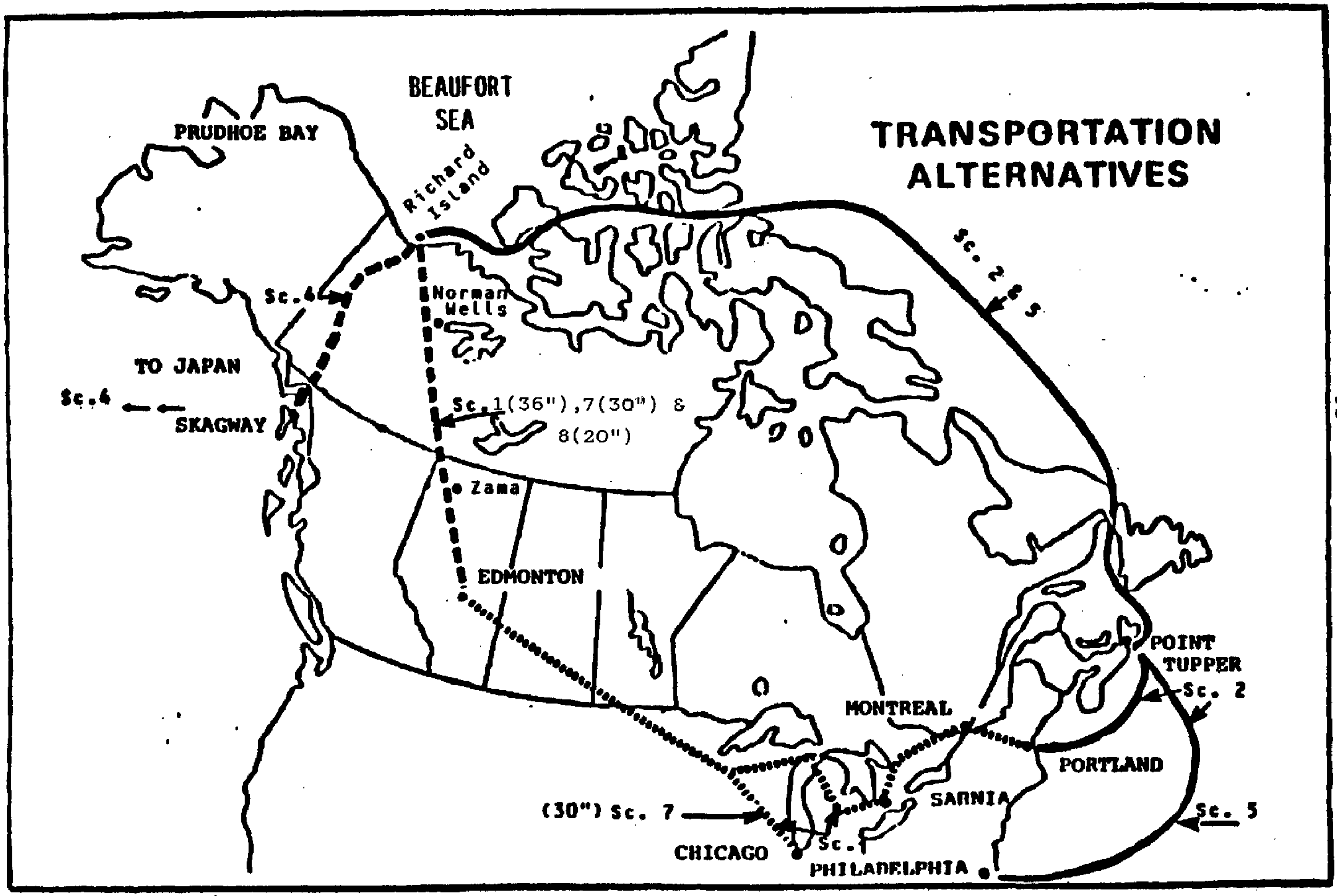
Scenario 7 (30") - Mackenzie Pipeline - Medium Volume

30" pipeline following the same route as Scenario 1 except that the entire throughput is exported to Chicago.

Scenario 8 (20" Buried) - Mackenzie Pipeline - Low Volume

This scenario was added as an annex just as the study was being completed and is essentially a low volume variation of Scenario 7. The justification for adding this scenario is that industry studies underway suggest that up to 30" pipelines might be buried down the Mackenzie route at substantially reduced capital costs.

MAP 1



TRANSPORTATION ALTERNATIVES
BEAUFORT SEA
PRUDHOE BAY
Richard Island
Norman Wells
Sc. 4
TO JAPAN
Sc. 4
SKAGWAY
Sc. 1(36"), 7(30") & 8(20")
Zama
EDMONTON
Sc. 2 & 5
POINT TUPPER
Sc. 2
MONTREAL
PORTLAND
SARNIA
Sc. 5
(30") Sc. 7
CHICAGO
Sc. 1
PHILADELPHIA

TABLE 3-2

BEAUFORT OIL THROUGHPUT

High Production Profiles

(000's BOPD)

	Scenario 1 Pipeline		Scenarios 2A and 2B Marine	
	Carin[1]	DREE	Carin[1]	DREE
1986	-	-	90	12
1987	-	-	90	36
1988	-	-	90	97
1989	-	-	90	247
1990	400	116	360	361
1991	470	332	450	471
1992	540	541	540	544
1993	610	651	585	637
1994	680	756	675	669
1995	750	803	720	717
1996	800	882	765	744
1997	850	922	810	812
1998	900	968	900	930
1999	950	976	945	965
2000	1000	993	990	965
2001	1000	1000	990	990
2002	1000	1000	990	990
2003	1000	1000	990	990
2004	1000	1000	990	990
2005	1000	1000	990	990
2006	1000	1000	990	990
2007	1000	1000	990	990
2008	1000	1000	990	990
2009	1000	1000	990	990
2010	1000	1000	990	990
Total Throughput (MMB)[2]	6553	6547	6566	6605

1 Carin Study, Table 2.1.
2 Million barrels

TABLE 3-2 (cont'd)

BEAUFORT OIL THROUGHPUT

Medium Production Profiles

(000's BOPD)

	Scenarios 4 and 7(30") Pipeline		Scenarios 5A and 5B Marine	
	Carin[1]	DREE	Carin[1]	DREE
1990	150	44	135	44
1991	170	116	135	116
1992	180	169	180	169
1993	200	207	180	207
1994	230	225	180	225
1995	255	246	225	246
1996	255	252	225	252
1997	255	253	225	253
1998	285	300	270	300
1999	305	337	270	337
2000	320	350	270	350
2001	320	360	315	360
2002	340	360	315	360
2003	360	360	360	360
2004	380	380	360	380
2005	400	400	405	400
2006	420	420	405	420
2007	440	440	405	440
2008	460	460	450	460
2009	480	480	450	480
2010	500	495	495	495
Total Throughput (MMB)[2]	2448	2429	2284	2429

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1 Carin Study, Table 2.1
2 Million barrels

4. TRANSPORTATION ASSUMPTIONS/TECHNICAL SPECIFICATIONS

Introduction

There is considerable variation in the design and cost estimates of the transportation systems. The general assumptions and technical specifications together with the caveats associated with the cost estimates are essentially similar to those of the Carin study.[1] Where assumptions differ, they are specifically identified. All costs are expressed in 1981 dollars.

4.1 Pipeline Transportation System

Pipeline Gathering System

Unlike Carin, the pipeline sub-sea gathering system has been excluded from the transportation costs but included in the production costs. Gathering costs are reflected in the macro and regional impacts of Beaufort development associated with pipeline systems. The question of whether the gathering system should be a part of or excluded from pipeline transportation costs remains an unresolved issue.

Mainland Pipeline

Pipeline specifications and capital costs are similar to Carin's except for slight modifications in pipeline operating costs to account for changes in the oil throughput. The confidence level of the cost data is high for the large volume pipeline scenario #1 because it was based on detailed engineering consultant studies but low for the 36" Dempster and 30" Mackenzie pipeline scenarios as engineering studies are still underway.

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1 Carin Study, Chapter 3. Only Carin's base cases were selected. Optimistic and Conservative scenarios were ignored.

TABLE 4-1 - PIPELINE SPECIFICATIONS AND COSTS

($MM 1981)

		Mackenzie Scenario 1	Dempster Scenario 4	Mackenzie Scenario 7
SPECIFICATIONS	- Length (km (mi) Total	2,250 (1,400)	1,320 (820)	2,250 (1,400
	- above ground	725 (450)	755 (470)	725 (450)
	- buried	1,530 (950)	560 (350)	1,530 (950)
	- Line size (mm (in))	914 (36)	914 (36)	762 (30)
	- No. of pump stations	24	12	16
	- Construction time (yrs)	4	4	4
CAPITAL COST	- Land	10	10	10
	- Pipeline	3,700	3,000	2,860
	- Stations	800	260	360
	- Terminal(s)	70	260	70
	- O&M Facilities	180	110	160
	- Logistics & Support	860	640	560
	- Construction camps	350	210	350
	- Freight	240	260	170
	TOTAL DIRECT	6,210	4,750	4,540
	- Pre-permit Costs	50	40	40
	- Engineering	430	320	390
	- O&M Prior to Service	60	50	55
	- Regulatory Costs	80	70	85
	- Owner Costs	190	140	175
	- Contingency	1,055	770	940
	TOTAL INDIRECT	1,865	1,390	1,685
	- Total (Ex. AFUDC)	8,075	6,140	6,225
	(Inc. AFUDC)	9,672	7,333	7,492
OPERATING COST @ Peak Rate	- Energy	190	99	140
	- Maintenance	34	18	31
	- Admin., Insur., Indir. Taxes	142	88	144
	TOTAL ANNUAL	366	205	315

Source: Esso; Carin Study.

4.2 Marine Transportation System

General marine specifications (Table 4-2) and costs (Table 4-3) are similar to Carin's except for vessel prices and construction time.

Tanker

The study assumes that arctic tankers are driven by a diesel propulsion system. Tanker specifications, which are similar to Carin's for diesel tankers, are shown in Table 4-4, while tanker transit performance is listed in Table 4-5.

Individual tanker prices are shown in Table 4-6. The price of domestically produced and foreign tankers was obtained from the DREE Halifax/Canso study.[1] The foreign price is a guesstimate and somewhat lower than Carin's (10% to 20%) because it reflects the lower cost of a diesel vs an electric driven system.[2] At a steady state, the foreign and the domestic price before SIAP[3] are close to about $320 million (Table 4-6). However, the first Canadian produced tanker costs $468 million (before SIAP) vs. $350 million for its foreign equivalent. Further investigation is required to firm up foreign tanker prices.

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1 Dome Greenfield Shipyard, Nova Scotia, Draft, December 1982, DREE.

2 It is unclear whether Carin's study estimate of foreign tanker price applies to an electric or diesel system. It was assumed that Carin's study estimate referred to an electric system. The percentage difference is a guesstimate as no independent study was undertaken to assess the cost of an electric driven tanker.

3 Shipbuilding Industry Assistance Program.

Table 4-2

MARINE SPECIFICATIONS

Number of Tankers:	
Scenario 2B	22
Scenario 2A	22 (10 domestic, 12 foreign)
Scenario 5B	11
Scenario 5A	11 (7 domestic, 4 foreign)
Number of Icebreakers:	
Scenarios 2A and 2B	2
Scenarios 5A and 5B	1
Number of Northern Terminals (ASPM)	
Scenarios 2A and 2B	2
Scenarios 5A and 5B	1
Construction Time	
Tanker	2 years (1 year at steady state)
Icebreaker	2 years
Northern Terminal	4 years

Table 4-3

MARINE COSTS

($MM 1981)

Tanker Capital Cost ($MM):	
First	468 (domestic before SIAP); 350 (foreign before duty)
Steady State	320 (domestic before SIAP or foreign before duty)
Operating Cost ($MM/year)	55
Icebreaker Capital Cost ($MM)	250 (domestic before SIAP)
Operating Cost ($MM/year)	30
Northern Terminal Capital Cost ($MM)	1530
Operating Cost ($MM/year)	100
Navigational Aids Capital Cost ($MM)	15
Operating Cost ($MM/year)	1

Table 4-4

TANKER SPECIFICATIONS

Class	10
Dimensions	370 m x 50 m
Power	150,000 hp
Propulsion System	Geared Diesel
Steel Weight	80,000 tonnes
Deadweight	203,000 tonnes
Shafting	Twin shafts - 3 engines per shaft

Table 4-5

TANKER TRANSIT PERFORMANCE

Return Trips Per Year	11.5
Loading/Unloading Time (days)	4
Drydocking (days/year)	35
Annual Tanker Delivery Capacity (barrels)	1,500,000
Average Delivery per Day (BOPD)	45,000

Table 4-6

TANKER PRICES*

($MM, 1981)

Tanker Number	International Price	Domestic Cost Before SIAP
1	350	468
2	346	417
3	341	379
4	337	359
5	332	345
6	328	336
7	324	326
8	320	324
9	320	322
10	320	322
11	320	322
12	320	322
13	320	322
14	320	322
15	320	322
16	320	322
17	320	322
18	320	322
19	320	322
20	320	322
21	320	322
22	320	322

* Excludes Interest During Construction and 25% tariff duty.

Source: Dome Greenfield Shipyard, op.cit. p.6.

At the time of drafting, a new government policy was announced regarding shipbuilding, coasting trade and customs jurisdiction over the Canadian continental shelf. This policy, when enacted, would remove the 9 per cent SIAP subsidy by 1985 and impose a tariff duty of 25 per cent on "non-Canadian built ship's engaging in (Canadian) coasting trade". According to that policy, a 25 per cent duty would be applied on foreign-built icebreaking tankers moving oil from Beaufort to Point Tupper. However, it may not be applied if oil is delivered directly to a foreign port for foreign use. In that regard, our study would underestimate the financial cost, <u>but not the economic cost</u>[1], of foreign-built tankers by 25 per cent.

The number of tankers required is the same as Carin's, i.e., 22 in the high marine case and 11 in the medium marine cases. Tables 4-7 and 4-8 show the tanker requirement schedule for the high and medium volume scenarios respectively. In the Canadian-built tanker cases, the number of domestically produced tankers is a function of the domestic capacity of the Halifax/Canso yard[2] to meet tanker and other vessel requirements.

It takes two years to build a tanker before the shipyard, domestic or foreign, reaches steady state. At steady state, it takes only one year[3] rather than the two years assumed by Carin.

The mix of domestic and foreign tankers delivered, in the Canadian-built tanker cases, is indicated in Table 4-9 for Scenario 2A and Table 4-10 for Scenario 5A. Scenarios 2A and 5A allow a domestic production of 10 and 7 tankers, respectively. Canadian-built tankers tend to be produced towards the end of the study period, relative to the foreign-built tankers. Domestic tanker production could potentially increase to higher levels for Scenarios 2A and 5A respectively, by adjusting the oil throughput profile and the yard manpower requirements in order to maximize Canadian content.

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1 Refer to section 6.
2 Dome Greenfield Shipyard, op. cit., p.6.
3 This is a rough approximation of the Halifax/Canso construction schedule estimates.

Table 4-7

TANKER REQUIREMENT SCHEDULE

HIGH VOLUME SCENARIOS 2A AND 2B

	Oil Throughput MBOPD[3]	Total No. of Tankers Required	No. of Tankers Delivered[1] Incremental	Total
1986	12	0.26[2]	1	1
1987	36	0.80	0	1
1988	97	2.15	2	3
1989	247	5.48	3	6
1990	361	8.02	3	9
1991	471	10.46	2	11
1992	544	12.08	2	13
1993	637	14.15	2	15
1994	669	14.86	0	15
1995	717	15.93	1	16
1996	744	16.53	1	17
1997	812	18.04	2	19
1998	930	20.66	2	21
1999	965	21.44	1	22
2000	965	21.44	0	22
2001	990	22.00	0	22
2002	990	22.00	0	22
2003	990	22.00	0	22
2004	990	22.00	0	22
2005	990	22.00	0	22
2006	990	22.00	0	22
2007	990	22.00	0	22
2008	990	22.00	0	22
2009	990	22.00	0	22
2010	990	22.00	0	22

1 Tankers are delivered on January 1 of the year of operation.

2 0.26 means that the tanker is fully operating 26% of the year (12,000/45,000) i.e., the tanker starts to operate on the 268th day of the year, or 365(1-.26).

3 Thousand BOPD

Table 4-8

TANKER REQUIREMENT SCHEDULE

MEDIUM VOLUME SCENARIOS 5A AND 5B

	Oil Throughput MBOPD	Total No. of Tankers Required	No. of Tankers Delivered	
			Incremental	Total
1990	44	0.97	1	1
1991	116	2.57	2	3
1992	169	3.75	1	4
1993	207	4.60	1	5
1994	225	5.00	0	5
1995	246	5.46	1	6
1996	252	5.60	0	6
1997	253	5.62	0	6
1998	300	6.66	1	7
1999	337	7.48	1	8
2000	350	7.77	0	8
2001	360	8.00	0	8
2002	360	8.00	0	8
2003	360	8.00	0	8
2004	380	8.44	1	9
2005	400	8.88	0	9
2006	420	9.33	1	10
2007	440	9.77	0	10
2008	460	10.22	1	11
2009	480	10.66	0	11
2010	495	11.00	0	11

Table 4-9

DOMESTIC AND FOREIGN TANKER DELIVERY SCHEDULE

AND HALIFAX/CANSO CAPACITY

HIGH VOLUME SCENARIO 2A

Year	Halifax/Canso Schedule By Type of Vessel[1]	Tanker Incremental Requirement	Tanker Incremental Requirement: Domestic[2]	Tanker Incremental Requirement: Foreign
1986		1		1
1987		0		
1988		2		2
1989	1 Tanker (Sept.)[3]	3		3
1990		3	1	2
1991	1 Tanker (Mar.)	2		2
1992	1 Tanker (May)	2	1	1
1993	1 Tanker (May)	2	1	1
1994	1 Tanker (Mar.)	0		
1995	2 Tankers, (Jan. & Sept.)	1	1	
1996	1 Tanker (May)	1	1	
1997	2 Tankers, (Jan. & Sept.)	2	2	
1998	1 Tanker, (May)	2	2	
1999	1 Tanker (Jan.) 1 Small Drill Barge (April)	1	1	
2000	1 Tanker (Mar.) 1 Small Drill Barge (April)			
2001	1 Tanker (Dec.) 1 Small Drill Barge (Dec.)			
TOTAL[4]	14 Tankers 3 Small Drill Barges	22	10	12

1 Based on original Carin Scenario - high volume.

2 A tanker is purchased domestically whenever there is tanker production capacity available in the Halifax/Canso shipyard to satisfy Beaufort tanker requirements.

3 Tanker delivered in September.

4 Where tanker demand was insufficient, shipyard was worked to capacity supplying other appropriate equipment for Beaufort Sea developments.

Table 4-10

DOMESTIC AND FOREIGN TANKER DELIVERY SCHEDULE AND HALIFAX/CANSO CAPACITY MEDIUM VOLUME SCENARIO 5A

Year	Halifax/Canso Schedule By Type of Vessel[1]	Tanker Incremental Requirement	Tanker Incremental Requirement Domestic[2]	Foreign
1989	1 Tanker (Sept.)			
	1 Small Process Barge			
1990	1 Small Process Barge			
	1 Storage Barge	1	1	
1991		2		2
1992		1		1
1993	1 Tanker (Mar.)	1		1
	1 Small Process Barge			
1994	1 Storage Barge	0		
1995		1	1	
1996	1 Tanker (Feb.)	0		
	1 Shuttle Tanker			
1997		0		
1998	1 Tanker (Feb.)	1	1	
	1 Small Drill Barge			
1999	1 Storage Barge	1	1	
2000	1 Tanker (Nov.)	0		
2001	1 Small Process Barge	0		
2002		0		
2003		0		
2004		1	1	
2005		0		
2006		1	1	
2007		0		
2008		1	1	
2009		0		
2010		0		
TOTAL[3]	5 Tankers	11	7	4
	4 Small Process Barges			
	3 Storage Barges			
	1 Small Drill Barge			
	1 Shuttle Tanker			

1 Based on original Carin Scenario - Medium Volume.

2 A tanker is purchased domestically whenever there is tanker production capacity available in the Halifax/Canso shipyard to satisfy Beaufort tanker requirements.

3 Where tanker demand was insufficient, shipyard was worked to capacity supplying other appropriate equipment for Beaufort Sea developments.

Northern Storage and Loading Terminal

The Arctic Single Point Mooring (ASPM) loading and storage terminal design was selected to maintain consistency with the Carin study base case. The cost and number of northern terminals including storage are similar to Carin's[1] (Table 4-2 and 4-3).

Marine Gathering System

As in the Carin study, no allowance has been made for including the cost of a sub-sea pipeline in the event that oil from the onshore fields[2] is delivered through a sub-sea pipeline to the loading terminal. The Beaufort proponents identify that possibility for the marine system in their Environmental Impact Statement.[3] To that extent, the marine transportation cost may be underestimated as in the pipeline case.

Icebreaker

It takes two years to build domestically a Class 10 icebreaker and costs $250 million (before SIAP) compared to $200 million according to Carin.

Tariffs - Existing Facilities

Pipeline tariffs on existing facilities and tanker tariffs on non-Arctic routes are similar to Carin's (see Annex 6-3).

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1 For a description of the ASPM and APLA systems, see Carin Study, Chapter 3.

2 Our economic impact study assumes production from offshore fields only (see Section 7.2).

3 Hydrocarbon Development in the Beaufort Sea - Mackenzie Delta Region, Environmental Impact Statement, 1982, Volume 2, paragraph 4.6.2.

4.3 Transportation Costs - Capital and Operating Costs

A summary of transportation costs, for the period 1981-2010, is shown in Table 4-11, while annual capital and operating costs for each scenario is indicated in Tables 4-12 to 4-18. These costs exclude transportation corporate taxes, return on equity, and long-term debt charges but include indirect taxes, duties and subsidies.

These data do not provide for a real price increase of oil. However, calculations of the financial and economic costs assume a 2 per cent real rate of increase after 1984. Based on current expectations, crude oil prices may have been overestimated. Given the energy intensive nature of the marine scenarios, lower crude oil prices would reduce their unit transportation cost relative to the pipeline scenarios.

Table 4-11

PRIVATE TRANSPORTATION COSTS[1]

SUMMARY

(Undiscounted 1981 $MM)

Scenarios	New Facilities		Existing Facilities	Total Cost	
	Capital[2]	Operating[3]	Operating[3]	Excl. AFUDC	Incl. AFUDC
High Pipeline - 36" Mackenzie (#1)	8,075	6,763	3,929	18,767	20,364
High Marine - High Content (#2A)	10,764	27,696	3,137	41,597	42,798
High Marine - Low Content (#2B)	10,689	27,696	3,137	41,522	42,576
Medium Pipeline - 36" Dempster (#4)	6,140	3,017	2,429	11,586	12,779
Medium Marine - High Content (#5A)	5,541	10,886	729	17,156	17,827
Medium Marine - Low Content (#5B)	5,411	10,886	729	17,026	17,611
Medium Pipeline - 30" Mackenzie (#7) (Partly Elevated)	6,225	5,190	1,457	12,872	14,139

(1) Exclude corporate taxes, return on equity, long-term debt charges. Include shipyard subsidies, indirect taxes, duties (except recent 25% duty on vessels)

(2) Excludes AFUDC (Interest During Construction)

(3) Excludes 2% real increase in fuel

Table 4-12

BEAUFORT SEA PIPELINE TRANSPORTATION - CAPITAL & OPERATING COST

HIGH PIPELINE SCENARIO #1 ($ x 10^6 1981)

	Total	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Capital Expenditure (New Facility)																										
Mainline Pipeline (Beaufort/Edmonton P/L)	7205	410	1340	2590	2030	700	55		40		40															
Pump Stations	800		50	100	150	200	100	100		100																
Onshore Storage - Beaufort	70		30	40																						
Total Capital Expenditure (excl. AFUDC)	8075	410	1420	2730	2180	900	155	100	40	100	40															
AFUDC	1597	30	168	470	843	58	10	6	3	6	3															
Total Capital Expenditure (incl. AFUDC)	9672	440	1588	3200	3023	958	165	106	43	106	43															
Operating Cost (New Facility)	6763					149	175	208	246	285	304	324	341	352	358	361	366	366	366	366	366	366	366	366	366	366
Tariff - Edm./Chicago/Sarnia/P/L	3929					25	73	118	143	166	176	193	202	212	214	217	219	219	219	219	219	219	219	219	219	219
Total Annual Cost																										
Including AFUDC	20364	440	1588	3200	3023	1132	413	432	432	557	523	517	543	564	572	578	585	585	585	585	585	585	585	585	585	585
Excluding AFUDC	18767	410	1420	2730	2180	1074	403	426	429	551	520	517	543	564	572	578	585	585	585	585	585	585	585	585	585	585
Throughput (M BOPD)						116	332	541	651	756	803	882	922	968	976	993	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
(MM BPY)	6547					42	121	197	238	276	293	322	337	353	356	362	365	365	365	365	365	365	365	365	365	365

Table 4-13

BEAUFORT SEA TANKER TRANSPORTATION - CAPITAL & OPERATING COST

HIGH MARINE SCENARIO #2A (Canadian Built Tankers) ($ x 10^6 1981)

Capital Expenditure (New Facility)	Total	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Northern Terminal	3060	140	140	1200				50	140	140	1200				50
Tanker	7233		175	175	344	842	873	695	830	682	492	164	320	310	450
Icebreaker	456		114	114					114	114					
Navigational Aids	15		5	10											
Total Capital Expenditure (excl. AFUDC)	10764	140	434	1499	344	842	873	745	1084	936	1692	164	320	310	500
AFUDC	1201	10	53	202	25	116	134	98	69	120	171	10	43	41	53
Total Capital Expenditure (incl. AFUDC)	11965	150	487	1701	369	958	1007	843	1153	1056	1863	174	363	351	553
Operating Cost (New Facility)	27696				124	186	250	433	572	707	826	940	1079	1137	1170
Tariff-Pt.Tupper/Phil.	1486				1	3	8	21	30	39	45	53	55	59	61
Pt.Tupper/Sarnia	1651				1	3	9	23	33	43	50	59	61	66	68
Total Tariff	3137				2	6	17	44	63	82	95	112	116	125	129
Total Annual Cost Including AFUDC	42798	150	487	1701	495	1150	1274	1320	1788	1845	2784	1226	1558	1613	1852
Excluding AFUDC	41597	140	434	1499	470	1034	1140	1222	1719	1725	2613	1216	1515	1572	1799
Throughput (M BOPD)					12	36	97	247	361	471	544	637	669	717	744
(MM BPY)	6605				4	13	35	90	132	172	199	233	244	262	272

Capital Expenditure (New Facility)	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Northern Terminal														
Tanker	588	293												
Icebreaker														
Navigational Aids														
Total Capital Expenditure (excl. AFUDC)	588	293												
AFUDC	37	19												
Total Capital Expenditure (incl. AFUDC)	625	312												
Operating Cost (New Facility)	1253	1398	1440	1471	1471	1471	1471	1471	1471	1471	1471	1471	1471	1471
Tariff-Pt.Tupper/Phil.	67	76	79	79	81	81	81	81	81	81	81	81	81	81
Pt.Tupper/Sarnia	74	85	88	88	90	90	90	90	90	90	90	90	90	90
Total Tariff	141	161	167	167	171	171	171	171	171	171	171	171	171	171
Total Annual Cost Including AFUDC	2019	1871	1607	1638	1642	1642	1642	1642	1642	1642	1642	1642	1642	1642
Excluding AFUDC	1982	1852	1607	1638	1642	1642	1642	1642	1642	1642	1642	1642	1642	1642
Throughput (M BOPD)	812	930	965	965	990	990	990	990	990	990	990	990	990	990
(MM BPY)	296	339	352	352	361	361	361	361	361	361	361	361	361	361

Table 4-14

BEAUFORT SEA TANKER TRANSPORTATION - CAPITAL & OPERATING COST

HIGH MARINE SCENARIO # 28 (Foreign Built Tankers) **($ x 10^6 1981)**

Capital Expenditure (New Facility)	Total	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Northern Terminal	3060	140	140	1200				50	140	140	1200				50														
Tanker	7158		175	175	344	842	660	802	640	640	640		320	320	640	640	320												
Icebreaker	456		114	114					114	114																			
Nav. Aids	15		5	10																									
Total Capital Expenditure (excl.AFUDC)	10689	140	434	1499	344	842	660	852	894	894	1840		320	320	690	640	320												
AFUDC	1054	10	53	202	25	116	120	76	57	92	158		20	20	44	41	20												
Total Capital Investment (Incl. AFUDC)	11743	150	487	1701	369	958	780	928	951	986	1998		340	340	734	681	340												
Operating Cost (New Facility)	27696				124	186	250	433	572	707	826	940	1079	1137	1170	1253	1398	1440	1471	1471	1471	1471	1471	1471	1471	1471	1471	1471	1471
Tariff-Pt.Tupper/Phil.	1486				1	3	8	21	30	39	45	53	55	59	61	67	76	79	79	8(	81	81	81	8(	81	81	81	81	81
Pt.Tupper/Sarnia	1651				1	3	9	23	33	43	50	59	61	66	68	74	85	88	88	90	90	90	90	90	90	90	90	90	90
Total Tariff	3137				2	6	17	44	63	82	95	112	116	125	129	141	161	167	167	171	171	171	171	171	171	171	171	171	171
Total Annual Cost																													
Including AFUDC	42576	150	487	1701	495	1150	1047	1405	1586	1775	2919	1052	1535	1602	2033	2075	1899	1607	1638	1642	1642	1642	1642	1642	1642	1642	1642	1642	1642
Excluding AFUDC	41522	140	434	1499	470	1034	927	1329	1529	1683	2761	1052	1515	1582	1989	2034	1879	1607	1638	1642	1642	1642	1642	1642	1642	1642	1642	1642	1642
Throughout (M BOPD)					12	36	97	247	361	471	544	637	669	717	744	812	930	965	965	990	990	990	990	990	990	990	990	990	990
(MM BPY)	6605				4	13	35	90	132	172	199	233	244	262	272	296	339	352	352	361	361	361	361	361	361	361	361	361	361

Table 4-15

BEAUFORT SEA PIPELINE TRANSPORTATION - CAPITAL & OPERATING COST

MEDIUM PIPELINE SCENARIO #4 ($ x 10^6 1981)

	Total	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Capital Expenditure (New Facility)																										
Mainline Pipeline (Beaufort/Skagway P/L)	5620	300	900	2100	1700	550								40	30											
Pump Stations	260		40	50	50									60	60											
Onshore Storage - Beaufort	60		30	30																						
- Skagway	200			60	60										40	40										
Total Capital Expenditure (excl. AFUDC)	6140	300	970	2240	1810	550								100	130	40										
AFUDC	1193	22	118	349	652	35								6	8	3										
Total Capital Expenditure (Incl. AFUDC)	7333	322	1088	2589	2462	585								106	138	43										
Operating Cost (New Facility)	3017					73	89	100	107	111	113	121	125	130	137	147	156	156	156	164	171	178	185	193	200	205
Tariff - Skagway/Tokyo	2429					16	42	62	76	82	90	92	92	110	123	128	131	131	131	139	146	153	161	168	175	181
Total Annual Cost																										
Including AFUDC	12779	322	1088	2589	2462	674	131	162	183	193	203	213	217	346	398	318	287	287	287	303	317	331	346	361	375	386
Excluding AFUDC	11586	300	970	2240	1810	639	131	162	183	193	203	213	217	340	390	315	287	287	287	303	317	331	346	361	375	386
Throughput (M BOPD)						44	116	169	207	225	246	252	253	300	337	350	360	360	360	380	400	420	440	460	480	495
(MM BPY)	2429					16	42	62	76	82	90	92	92	110	123	128	131	131	131	139	146	153	161	168	175	181

Table 4-16

BEAUFORT SEA TANKER TRANSPORTATION - CAPITAL & OPERATING COST

MEDIUM MARINE SCENARIO # 5A (Canadian Built Tankers) **($ x 10^6 1981)**

Capital Expenditure (New Facility)	Total	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Northern Terminal	1530					140	140	1200											50										
Tanker	3768						213	561	519	339	168	190	189		173	336	163				157	157	153	153	149	148			
Icebreaker	228						114	114																					
Navigational Aids	15						5	10																					
Total Capital Expenditure (excl. AFUDC)	5541					140	472	1885	519	339	168	190	189		173	336	163		50		157	157	153	153	149	148			
AFUDC	671					10	52	208	69	34	34	12	38		11	45	33		3		10	31	10	31	10	30			
Total Capital Investment (incl. AFUDC)	6212					150	524	2093	588	373	202	202	227		184	381	196		53		167	188	163	184	159	178			
Operating Cost (New Facility)	10886								186	273	338	384	406	432	439	440	498	543	559	571	571	571	595	620	644	669	693	718	736
Tariff-Pt.Tupper/Phil.	729								5	13	19	23	25	27	28	28	33	37	38	39	39	39	42	44	46	48	50	52	54
Total Annual Cost																													
Including AFUDC	17827					150	524	2093	779	659	559	609	658	459	651	849	727	580	650	610	777	798	800	848	849	895	743	770	790
Excluding AFUDC	17156					140	472	1885	710	625	525	597	620	459	640	804	694	580	647	610	767	767	790	817	839	865	743	770	790
Throughput (M BOPD)									44	116	169	207	225	246	252	253	300	337	350	360	360	360	380	400	420	440	460	480	495
(MM BPY)	2429								16	42	62	76	82	90	92	92	110	123	128	131	131	131	139	146	153	161	168	175	181

Table 4-17

BEAUFORT SEA TANKER TRANSPORTATION - CAPITAL & OPERATING COST

MEDIUM MARINE SCENARIO #5B (Foreign Built Tankers) **($ x 10^6 1981)**

Capital Expenditure (New Facility)	Total	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Northern Terminal	1530					140	140	1200											50										
Tanker	3638						175	519	512	334	166	164	164		162	162	320					320		320		320			
Icebreaker	228						114	114																					
Nav. Aids	15						5	10																					
Total Capital Expenditure (excl. AFUDC)	5411					140	434	1843	512	334	166	164	164		162	162	320		50			320		320		320			
AFUDC	585					10	49	201	79	44	33	11	33		10	32	20		3			20		20		20			
Total Capital Investment (incl. AFUDC)	5996					150	483	2044	591	378	199	175	197		172	194	340		53			340		340		340			
Operating Costs	10886								186	273	338	384	406	432	439	440	498	543	559	571	571	571	595	620	644	669	693	718	736
Tariff-Pt. Tupper/Phil.	729								5	13	19	23	25	27	28	28	33	37	38	39	39	39	42	44	46	48	50	52	54
Total Annual Cost																													
Including AFUDC	17611					150	483	2044	782	664	556	582	628	459	639	662	871	580	650	610	610	950	637	1004	690	1057	743	770	790
Excluding AFUDC	17026					140	434	1843	703	620	523	571	595	459	629	630	851	580	647	610	610	930	637	984	690	1037	743	770	790
Throughput (M BOPD)									44	116	169	207	225	246	252	253	300	337	350	360	360	360	380	400	420	440	460	480	495
(MM BPY)	2429								16	42	62	76	82	90	92	92	110	123	128	131	131	131	139	146	153	161	168	175	181

Table 4-18

BEAUFORT SEA PIPELINE TRANSPORTATION - CAPITAL & OPERATING COST

MEDIUM PIPELINE SCENARIO #7 (30") ($ x 10^6 1981)

	Total	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Capital Expenditure (New Facility)																										
Mainline Pipeline (excl. AFUDC)																										
Pipeline (Beaufort/Edm. P/L)	6225	257	1211	2310	1755	543								75	74											
AFUDC	1267	19	129	383	691	35								5	5											
Total Capital Expenditure (Incl. AFUDC)	7492	276	1340	2693	2446	578								80	79											
Operating Cost (New Facility)	5190					150	170	187	199	207	220	220	230	245	257	266	253	260	267	274	280	287	294	301	308	315
Tariff - Edm./Chicago/P/L	1457					10	25	37	46	49	54	55	55	66	74	77	78	78	78	83	88	92	97	101	105	109
Total Annual Cost																										
Including AFUDC	14139	276	1340	2693	2446	738	195	224	245	256	274	275	285	391	410	343	331	338	345	357	368	379	391	402	413	424
Excluding AFUDC	12872	257	1211	2310	1755	703	195	224	245	256	274	275	285	386	405	343	331	338	345	356	368	379	391	402	413	424
Throughput (M BOPD)						44	116	169	207	225	246	252	253	300	337	350	360	360	360	380	400	420	440	460	480	495
(MM BPY)	2429					16	42	62	76	82	90	92	92	110	123	128	131	131	131	139	146	153	161	168	175	181

5. FINANCIAL TRANSPORTATION TARIFFS

Introduction

Calculations were made of the cost of service per barrel, or financial tariff, required to recover the financial costs of moving oil to market over the life of the project. The traditional method of tariff calculation allows recovery of depreciation, operating and maintenance expenses, corporate and indirect taxes, interest charges and an approved rate of return on equity. These tariffs are required for assessing the macro and regional economic impacts. The methodology used followed Carin's approach which employed the National Energy Board cost of service model. "Traditional" annual and levelled tariffs (average discounted tariffs) were calculated. For a discussion on the issue of reprofiling and deferring charges (taxes, debt, interest, etc.) resulting from the front-end loading problem, refer to Carin study.[1]

5.1 Assumptions

The financial assumptions shown in Table 5-1 are similar to Carin's, except for the following:

- i) a higher CCA rate is applied on domestic tankers and icebreakers, compared to imported vessels;
- ii) CCA is also applied to the AFUDC of the respective capital cost items;
- iii) a 9% SIAP subsidy is assumed on domestically-built tankers and icebreakers.
- iv) real fuel prices increase by 2 per cent after 1984 rather than after 1981.

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[1] Carin Study, Chapter 4, Part I.

Table 5-1
FINANCIAL TARIFF ASSUMPTIONS

General

(Flow-through method)	
Inflation rate	8%
Real discount rate	10%
Real price increase of fuel after 1984	2%
Depreciation - straight line	4%
Depreciation life	25 years
Income tax rate	47%
Ad valorem tax on undepreciated capital cost	0.8%
Debt repayment period	25 years
Debt/Equity ratio	75/25
Long-term debt rate	12%
Interest during construction (AFUDC)	
1981-1987	14.625%
1988-2010	12.75%
After tax rate return on equity	18%
Salvage value	0
Cost overrun	0

Capital Cost Allowances	CCA Rates (Declining Balance)
Marine Terminal	10%
Pipelines, onshore storage, pump stations	6%
Tankers: foreign	15%
domestic	33-1/3%
Icebreaker	33-1/3%
Navigational Aids	15%

CCA applied to capital cost items, including AFUDC.

Marine

Investment tax credit on tankers, icebreakers and navigational aids	None
SIAP Subsidy	9%

Caveats

The following caveats should be considered in addition to those already discussed in the Carin study which are reproduced in Annex 5-1. The direction of the bias on the financial tariff for each scenario is identified in brackets below:

Marine:

a 25 per cent tariff duty should have been applied on imported tankers (underestimate - low and high Canadian content);

no sub-sea gathering system built (potential underestimate - low and high Canadian content);

the 9 per cent SIAP subsidy should be removed from domestically-built tankers and icebreakers (underestimate - high Canadian content);

a shorter life for tankers, say 15 to 20 years would be more reasonable and therefore require more tankers than estimated (underestimate-low and high Canadian content;

tanker and icebreaker salvage values should have been allowed (overestimate - low and high Canadian content);

a straight line rather than a declining balance CCA rate should be applied on domestically-built vessels; (overestimate - high Canadian content);

an investment tax credit should have been allowed on vessels and navigational aids (overestimate - low and high Canadian content);

Pipeline:

no sub-sea gathering system built (potential underestimate);

no salvage value allowed (potential overestimate).

the 0.8 per cent ad valorem tax may have already been included in operating costs (potential overestimate).

The study's assumptions would tend to underestimate the tariff of both the low and high Canadian content marine scenarios though the latter would be affected to a lesser extent. The direction of the bias on the pipeline tariffs appears to over estimate the tariff. Additional computations would be required to test alternative assumptions.

5.2 Unit Financial Tariffs

Average discounted financial tariffs for new facilities, as well as new and existing facilities are shown in Table 5-2. Annual "traditional" tariffs to move oil to markets are indicated in Table 5-3.

As expected, the high volume scenarios exhibit lower tariffs than the medium volume scenarios.

Among the high volume scenarios, the pipeline ranks first; the low and high Canadian content marine scenarios lag far behind but remain very close to one another.

The medium volume scenario tariffs, for new and existing facilities, tend to be of similar magnitude except for pipeline scenario 7 (30") which lags behind by about 10 per cent.

The pipeline tariff is more sensitive to variations in the oil throughput than the marine tariff. For example, as we move from the high to the medium volume scenario, the pipeline tariff almost doubles (Scenario 1 vs. Scenario 7), whereas the marine tariff increases by about 13 per cent (Scenarios 2A and 2B vs. Scenarios 5A and 5B).

The "traditional" early years tariff are very high, leaving little money for oil producers and the federal government. In those years, the wellhead price or new oil reference price net of transportation cost is either negative or too small to cover production costs (Table 5.4).

Table 5-2

UNIT FINANCIAL TARIFFS TO MOVE OIL TO MARKET

(discounted* 1981 dollars per barrel)

Scenario	New Facilities Only	New and Existing Facilities
High Pipeline (#1)	4.86	5.46
High Marine - Low Canadian Content (#2B)	8.86	9.34
High Marine - High Canadian Content (#2A)	8.90	9.38
Medium Pipeline (#4)	9.43	10.43
Medium Marine - Low Canadian Content (#5B)	10.14	10.44
Medium Marine - High Canadian Content (#5A)	10.26	10.56
Medium Pipeline - 30" (#7)	10.84	11.44

* Discounted at a real rate of 10%.

Table 5-3

ANNUAL "TRADITIONAL" TARIFF TO MOVE OIL TO MARKET

(constant 1981 dollars per barrel)

	Scenario						
	#1	#2A	#2B	#4	#5A	#5B	#7(30")
1986		128.00	128.00				
1987		41.70	41.70				
1988		20.42	20.42				
1989		12.02	12.02				
1990	38.72	10.64	10.48	76.76	36.94	36.24	84.40
1991	14.46	9.49	9.38	30.43	18.75	18.41	33.06
1992	8.76	9.48	9.33	19.45	14.25	14.03	21.14
1993	7.08	9.99	9.85	14.87	12.56	12.39	16.22
1994	5.95	9.78	9.66	12.83	11.41	11.26	14.07
1995	5.41	9.32	9.21	10.92	11.21	10.99	12.11
1996	4.76	9.05	8.95	9.99	10.64	10.44	11.03
1997	4.36	8.83	8.77	9.31	10.25	10.07	10.39
1998	3.98	8.38	8.36	7.44	9.53	9.37	8.35
1999	3.76	8.16	8.16	6.54	9.22	10.06	7.31
2000	3.53	8.06	8.06	6.20	8.81	8.68	6.82
2001	3.35	7.70	7.70	5.84	8.49	8.37	6.18
2002	3.19	7.55	7.55	5.49	8.27	8.16	6.90
2003	3.05	7.43	7.54	5.17	8.10	8.00	5.66
2004	2.93	7.33	7.58	4.73	8.15	8.07	5.17
2005	2.82	7.24	7.49	4.38	7.86	7.89	4.79
2006	2.72	7.42	7.41	4.08	7.97	7.99	4.46
2007	2.63	7.42	7.35	3.82	7.67	7.75	4.17
2008	2.55	7.35	7.29	3.61	7.79	7.82	3.94
2009	2.48	6.98	6.93	3.44	7.58	7.68	3.76
2010	2.42	7.26	7.22	3.30	7.41	7.54	3.61

Table 5-4

WELLHEAD PRICE NET OF TRANSPORTATION(1)

(constant 1981 dollars per barrel)

	New Oil Reference Price(2)	Scenario						
		1	2A	2B	4	5A	5B	7(30")
1986	36.23		-91.77	-91.77				
1987	36.96		-4.74	-4.74				
1988	37.70		17.28	17.28				
1989	38.45		26.43	26.43				
1990	39.22	0.50	28.58	28.74	-37.54	2.28	2.98	-45.18
1991	40.00	25.54	30.51	30.62	9.57	21.25	21.59	6.94
1992	40.80	32.04	31.32	31.47	21.35	26.55	26.77	19.66
1993	41.62	34.54	31.63	31.77	26.75	29.06	29.23	25.40
1994	42.45	36.50	32.67	32.79	29.62	31.04	31.19	28.38
1995	43.30	37.89	33.98	34.09	32.38	32.09	32.31	31.19
2000	47.81	44.28	38.98	39.75	41.61	39.00	39.13	40.99
2005	52.78	49.96	45.54	45.29	48.40	44.92	44.89	47.99
2010	58.28	55.86	51.02	51.06	54.98	50.87	50.74	54.67

(1) The wellhead price, before taxes and royalties are paid, is the oil price at point of destination less transportation cost to markets. For simplicity sake, Montreal is selected as the point of destination, except for Scenario 4 in which case the destination is Japan.

(2) Carin Study New Oil Reference Price adjusted for a real increase of 2% after 1984 rather than after 1981.

6. Economic Transportation Costs

The economic efficiency analysis below attempts to calculate the resource cost of transporting Beaufort Sea oil under alternative production levels and transportation modes, for the period 1981-2010. The resource cost is expressed in terms of unit economic cost (i.e., economic cost per barrel of oil). The unit economic cost is a similar concept to that of the financial tariff discussed in Section 5, except that costs are now viewed from the society's rather than from the private sector's point of view.

Generally, a private transportation company is authorized to charge tariffs to recover operating and maintenance expenses, indirect taxes and duty, depreciation, interest charges, and a certain rate of return on its equity.

From society's point of view, however, not all private costs represent a resource cost, neither are all social costs reflected in private costs. Thus, for example, taxes are a private cost but not a resource cost; the reverse is true for subsidies.

Economic costs were calculated by, first, adjusting private costs for the presence of unaccounted social benefits and costs. Then economic unit costs were calculated by essentially seeking to determine the notional tariff that would generate enough revenues to cover the real resource costs involved.

Section 6.1 discusses the various adjustments necessary to convert private costs into economic costs; Section 6.2 presents the findings; and Section 6.3 displays results from sensitivity analyses. Annex 6.1 outlines the main assumptions underlying the calculation of economic costs; Annex 6.2 discusses the calculation of the employment benefits associated with the job creation of various scenarios; and Annex 6.3 presents the main data inputs used in the economic analysis.

6.1 Economic Adjustments

6.1.1 Discount Rate

In economic analysis, present values are calculated by employing the social discount rate. While the private discount rate generally reflects the private cost of funds, the social discount rate represents the rate of return that would be obtained if the resources used in a project were instead utilized elsewhere in the economy. It is calculated as the weighted average economic opportunity cost of capital, where the weights reflect the extent to which the required funds are likely to be drawn from alternative domestic investment projects, consumption, and foreign sources. The social discount rate for Canada has been estimated in real terms at 10 per cent.[1] This rate has been customarily employed by our Department. However, its level is subject to debate. The Department of Energy, Mines and Resources, for example, is employing a 7 per cent real discount rate. It may also be argued that risky projects, such as Beaufort, should use a risk adjusted discount rate - say 10 per cent plus a risk premium.

6.1.2 Taxes, Subsidies and Interest Charges

From the economic point of view, taxes are generally not treated as a resource cost but simply as a transfer. Thus, duty and excise taxes on imported materials were subtracted from costs.

Indirect taxes on domestic materials should also have been subtracted. However, because the information was often not available, they were left as part of the economic costs.

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[1] Glenn P. Jenkins, "Capital in Canada: Its Social and Private Performance in 1965-1974" Discussion Paper No. 98, (Ottawa, Economic Council of Canada, 1977).

Corporate taxes were not part of private costs except mainly in two cases: (a) on the profits of construction sub-contractors; and (b) on the profits of Dome's proposed Halifax/Canso shipyard. Thus, costs were reduced by the corporate taxes corresponding to these two cases.

Subsidies on the other hand do not constitute a social benefit and therefore should be added back to costs. Subsidies are involved only in the case of the construction of the Dome proposed shipyard and the construction of vessels (SIAP). These subsidies were added back as costs.

Interest during construction (AFUDC) is not considered an economic cost. From the economic point of view, interest charges - as well as profits before taxes - reflect the return to capital in a particular use, rather than its foregone economic opportunity. Thus interest charges were excluded from costs.

6.1.3 Cost of Imports

Although to a private company the cost of imports includes duty and excise taxes, from the economic point of view these levies do not normally represent a resource cost; therefore, both duty and excise taxes on imports were excluded from the calculation of economic costs.

However, at the same time, it is generally recognized that the exchange rate tends to underestimate the true resource cost of imports. Canadian import restrictions and export promotion policies generally have the effect of appreciating the Canadian dollar. Thus, tariffs on imported goods make the social value of these goods higher than their foreign exchange cost. Similarly, the existence of export subsidies may make the social cost of exports higher than their foreign exchange earnings.

Recent empirical work on the subject shows that "... because of tariffs, non-tariff barriers, other commodity taxes, as well as production and capital subsidies, we find that there is at least a 7 per cent differential between the market price and the social value of foreign exchange".[2]

Consequently, to the cost of imported materials and services, a 7 per cent premium was added. This type of adjustment tends to favour those transportation modes that rely relatively more on domestic, rather than imported materials.

6.1.4 Resource Cost of Existing Facilities

In the case of existing facilities - such as existing pipelines and non-arctic tankers - it was assumed that private tariffs exceed incremental costs and that only 70 per cent of the transportation charges of existing facilities represent incremental operating costs.

6.1.5 Cost of Public Infrastructure

To the extent that additional public infrastructure and services -- e.g., highways, river dredging, health and other government services -- are required, the corresponding costs should be added to private costs. Although such costs could be significant, they were ignored because of lack of data. Only in the case of the Dome proposed shipyard was the cost of infrastructure included.

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2 Jenkins, G.P. and C.Y. Kuo, "On Measuring the Social Opportunity Cost of Foreign Exchange for Canada", paper presented at the Canadian Economics Association Annual Meeting, Ottawa, June 4, 1982.

6.1.6 Cost of Labour

The wage bill often does not reflect properly the true economic opportunity cost of labour. For example, when permanent jobs are created, one should credit private costs by the improvement in the welfare of the individuals employed, as well as the savings to society in terms of lower unemployment insurance payments and higher personal income taxes.

The calculation of the economic cost of labour involves two difficult issues: first, the assignment of a dollar value to the improvement of the employment prospects of the individuals affected; and second, the net increase in job opportunities associated with each particular transportation scenario.

With respect to the first issue, part of the benefit of job creation accrues to society at large, in the form of lower unemployment insurance payments and higher personal income taxes. The rest accrues directly to individuals employed, in the form of higher disposable income. It is generally recognized, however, that non-working time is not worthless. Therefore, the benefit of additional work to previously unemployed individuals would be less than the increase in their disposable income. The calculation of the value of non-working time to the individual is a difficult empirical topic. As a result, the measurement of the benefits of job creation is a controversial issue.

With respect to the second issue, one has to recognize that employment opportunities would not be limited to those directly created by the construction and operation of the transportation facilities. Additional jobs will be created indirectly in other industries for the production of materials required, such as steel and equipment.

The extent of indirect job creation is a controversial issue. It depends crucially on the state of the economy. The traditional approach in the Project Assessment and Evaluation Branch, DREE, has been to assume that pockets of regional unemployment will persist in the future, but the rest of the economy will tend to operate near its full capacity. According to this approach, as long as a project takes place in a high unemployment area, it is considered realistic to assume that most jobs created locally will be filled by individuals that are not holding full-time jobs, while jobs created elsewhere in the economy will involve mostly the reallocation of already fully employed resources. We refer to this as a conservative approach.

However, given long-term macro-economic forecasts of high unemployment in Canada, at least to the end of this decade, we felt that a more liberal calculation of the job creation impact may be relevant.[3] Consequently, all indirect jobs created across Canada were taken into account, in what is referred to here as an optimistic approach.[4,5]

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3 See base case forecast in section 7.2.1

4 Indirect jobs refer here to the employment necessary to produce the domestic materials required for the construction of pipelines, vessels, and ASPMs. The further job creation through the respending of incomes and the production of more consumer goods was not included.

5 For further details on the economic adjustment of labour costs see Annex 6.2.

6.1.7 Integration of Results of Proposed Dome Shipyard

In the case of domestic marine scenarios a new shipyard would be required. The proposed yard has already been evaluated by the Project Assessment and Evaluation Branch, DREE.[1]

In calculating economic transportation costs, the entire production of the proposed shipyard was taken into account - rather than simply the part of the activity directly related to Beaufort Sea oil transportation. The rationale is that, in the absence of Beaufort domestic marine transportation, there would be no justification for a new shipyard. As a result, not only VLCCs would not be built in Canada, but also other large vessels that existing Canadian shipyards cannot handle.

Thus, the private costs of domestic marine scenarios were adjusted by taking into account the anticipated social costs and benefits of the proposed shipyard, In particular, private costs were adjusted by taking into account the following results of the new shipyard: public infrastructure and subsidies (+), interest charges and corporate taxes (-), the foreign exchange benefit resulting from the replacement of imported vessels by domestic ones (-), the foreign exchange loss due to the imports of materials for building domestic vessels (+), and the benefit of job creation (-).

A further major adjustment that was introduced is to allow for the fact that domestic tankers are costlier than imported. To the extent that the new shipyard would be building VLCCs for Beaufort, the higher domestic cost is already included in private costs. However, to the extent that vessels -- other than VLCCs -- from the new shipyard would not be destined for Beaufort transportation, the cost differential has not already been included and, therefore, should be added on.

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1 "Economic Analysis of the Proposed Dome Shipyard in Halifax/ Canso", Project Assessment and Evaluation Branch, Draft, DREE, 1982.

6.2 Calculation of Unit Economic Costs

Unit economic costs represent the per barrel cost to society of transporting Beaufort Sea oil. Under similar circumstances, the scenario with the lowest unit economic cost is the most desirable one.

The first step in calculating unit economic costs was to adjust annual private costs. The starting point was private costs exclusive of operating interest charges, rate of return on equity and corporate taxes, but inclusive of interest during construction, indirect taxes, duty on imports and subsidies.

Table 6-1 summarizes the adjustments necessary to convert private costs into economic costs. As discussed earlier, private costs were adjusted by: subtracting corporate taxes on the profits of construction sub-contractors, duty on imports and interest charges during construction, and by adding subsidies to the proposed Dome shipyard (column 4); adding a premium on imports (column 5); adding the cost to society of paying higher prices for domestic vessels (other than VLCCs) than imported ones (column 6); and by subtracting the benefit of employment, first with respect to direct on-site jobs (column 7), and second with respect to indirect jobs required to produce materials (column 8). The adjustments are discussed in more detail in Annex 6.1.

The economic adjustments lead to two series of annual economic costs: (a) a conservative one, where labour benefits are limited to those resulting from direct job creation; and (b) an optimistic one, where labour benefits include also those resulting from indirect job creation -- i.e., jobs associated with the production of domestic materials.

Table 6-1

ECONOMIC TRANSPORTATION COSTS

(UNDISCOUNTED $MM 1981)

SCENARIO	PRIVATE TRANSPOR-TATION COSTS (2)	PRIVATE COSTS PLUS 2% ANNUAL ESCALATION OF FUEL PRICES (3)	CORPOR. TAXES MINUS SUBSIDIES, PLUS DUTY, PLUS INTEREST (4)	FOREIGN EXCHANGE PREMIUM (5)	SHIPYARD OUTPUT VALUATION ADJUSTMENT (6)	DIRECT LABOUR BENEFIT (7)	INDIRECT LABOUR BENEFIT (8)	CONSERVATIVE ECONOMIC TRANSPORTA-TION COSTS (3)-(4)+(5)+(6)-(7)	OPTIMISTIC ECONOMIC TRANSPORTATION COSTS (3)-(4)+(5)+(6)-(7)-(8)
HIGH VOLUME									
PIPELINE #1	20,364	21,481	2,512	171	-	430	347	18,710	18,363
MARINE #2B (FOREIGN)	42,576	49,514	1,504	637	-	599	187	48,048	47,861
MARINE #2A (CANADIAN)	42,798	49,736	1,421	399	305	1,497	341	47,522	47,181
MEDIUM VOLUME									
PIPELINE #4	12,779	13,238	1,701	128	-	265	270	11,400	11,130
MARINE #5B (FOREIGN)	17,611	20,405	687	293	-	245	94	19,776	19,672
MARINE #5A (CANADIAN)	17,827	20,621	561	85	321	980	189	19,486	19,196
PIPELINE #7 (30")	14,139	14,781	1,631	103	-	296	257	12,957	12,700

The second step in calculating unit economic costs involves accounting for the element of time. Capital has a social opportunity cost, estimated at about 10 per cent in real terms. Intuitively, unit economic cost is the price at which a unit of transportation services should be sold so that all economic costs, including the economic opportunity cost of capital, are covered. Technically, unit economic costs are calculated as follows:[1]

$$\text{Unit Economic Cost} = \text{Present value of Economic Costs} \div \text{Present Value of Throughput}$$

The unit economic costs, calculated according to the above formula, are summarized in Table 6.2. The lowest unit economic cost occurs when pipeline is used with a high volume of throughout (Scenario #1). The pipeline unit economic cost is about half of the corresponding domestic or foreign marine scenarios (#2A and #2B). In the case of the lower throughput, pipeline scenario #4 unit cost is lower than marine scenarios #5A and #5B, as well as pipeline scenario #7 (30") by a margin of about 10 per cent. It should be noted that in the financial calculations, pipeline scenario #4 tariff was about the same as either marine scenarios #5A and #5B. Because scenario #4 delivers oil to a different destination caution should be used in drawing conclusions. Scenario #4 provides economic access to a ready market - Japan.

The very favourable cost comparisons of scenario #8 are discussed in the Special Annex.

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[1] Carin Study, Annex 3-1.

Table 6-2

PRESENT VALUE OF ECONOMIC TRANSPORTATION COSTS

(Discounted $MM 1981)

Scenario	Present Value of Cumulated Throughput (Millions of Barrels) (1)	Present Value of Conservative Economic Costs ($MM 1981) (2)	Present Value of Optimistic Economic Costs ($MM 1981) (3)	Conservative Economic Transportation Unit Cost ($ 1981) (2)/(1)	Optimistic Economic Transportation Unit cost ($ 1981) (3)/(1)
HIGH VOLUME					
Pipeline #1	1,077	5,643	5,470	5.24	5.08
Marine (Foreign) #2B	1,155	11,358	11,259	9.83	9.75
Marine (Canadian) #2A	1,155	11,297	11,154	9.78	9.66
MEDIUM VOLUME					
Pipeline # 4	372	3,750	3,620	10.08	9.73
Marine (Foreign) # 5B	372	4,158	4,113	11.18	11.06
Marine (Canadian # 5A	372	4,120	4,046	11.08	10.88
Pipeline # 7 (30")	372	4,117	3,992	11.07	10.73

6.3 Sensitivity Analysis - Conservative Economic Costs

Additional analysis is performed to assess the sensitivity of economic transportation costs (conservative) to changes in a few key variables including fuel cost, social discount rate, capital and operating costs, and foreign financing. The results are displayed in Table 6-3.

Given that the ranking and cost differential among the high volume scenarios are not much affected by the sensitivity calculations, the following discussion will focus on the medium volume cases.

No Real Escalation in Fuel Price

Absence of a 2 per cent real increase in the fuel price improves the relative efficiency of the energy-intensive marine scenarios, almost closing the cost gap with the Dempster pipeline.

Real Discount Rates: 7% vs 13%

At 7 per cent, the gap between the marine and pipeline scenarios widens and even the higher cost 30" partly elevated Mackenzie pipeline surpasses the marine mode.

At 13 per cent the difference between the Dempster pipeline and marine modes becomes minimal. While no specific analysis has been undertaken to assess the extent of the risk premium associated with particular Beaufort transportation alternatives, we are of the opinion that this particular project is a riskier venture than the average investment project in Canada. Risk factors may include unproven engineering design -- e.g. sub-sea

TABLE 6-3

SENSITIVITY ANALYSIS - CONSERVATIVE ECONOMIC UNIT COST ($1981)
(PER CENT CHANGE)

SCENARIO	BASE CASE–CONSERVATIVE ECONOMIC UNIT COST	NO REAL INCREASE IN FUEL PRICE		REAL DISCOUNT RATE 7%		REAL DISCOUNT RATE 13%		125% OF OPERATING COST		125% OF CAPITAL COST		125% OF DOMESTIC TANKER CAPITAL COST		8-3/4 % FOREIGN FINANCING OF IMPORTED TANKER
	$	$	%	$	%	$	%	$	%	$	%	$	%	$
HIGH VOLUME														
MACKENZIE PIPELINE #1 (36")	5.24	5.11	(-2.48)	4.32	(-17.55)	6.35	(21.18)	5.66	(8.02)	6.12	(16.79)	-		-
MARINE (FOREIGN) #2B	9.83	9.03	(-8.13)	8.87	(-9.76)	10.95	(11.39)	11.21	(14.04)	10.91	(10.99)	10.05	(2.24)	9.83
MARINE (CANADIAN) #2A	9.78	8.98	(-8.17)	8.80	(-10.02)	10.93	(11.75)	11.16	(14.11)	10.84	(10.84)	-		9.77
MEDIUM VOLUME														
DEMPSTER PIPELINE #4 (36")	10.08	9.95	(-1.28)	8.01	(-20.53)	12.66	(25.59)	10.65	(5.65)	12.01	(19.15)	-		-
MARINE (FOREIGN) #5B	11.18	10.26	(-8.22)	10.09	(-9.74)	12.53	(12.07)	12.65	(13.15)	12.50	(11.81)	11.67	(4.38)	11.15
MARINE (CANADIAN) #5A	11.08	10.05	(-9.29)	9.96	(-10.10)	12.46	(12.45)	12.54	(13.18)	12.37	(11.64)	-		11.07
MACKENZIE PIPELINE #7 (30")	11.07	10.88	(-1.71)	8.88	(-19.78)	13.81	(24.75)	11.84	(6.96)	13.06	(17.98)	-		-

pipelines, marine terminal, icebreakers and icebreaking tankers --ice conditions, oil spills, safety, regulatory process, environment, cost overruns, oilfield reserves and location, and financing complexity. Therefore, a risk-adjusted social discount rate of 13 per cent or even higher may be more appropriate than the risk-free rate of 10 per cent assumed in our base case.

Capital Cost Overrun

The heavier weight of front-end capital in pipelines, makes that mode more sensitive to changes in capital cost. A 25 per cent capital cost overrun would help narrow down the cost differential between the Dempster pipeline and marine scenarios. A capital cost overrun of 12.95[1] per cent in the Dempster pipeline scenario would be sufficient to equalize the unit costs of the Dempster and Canadian marine scenarios. Conversely, a capital cost reduction of 19.38[1] per cent in the Canadian marine scenario would be required to bring down the unit cost of the Canadian marine option to the level of the Dempster.

Operating Cost Overrun

The larger share of operating cost in total costs, in the marine mode, explains the greater sensitivity of marine costs to changes in operating costs, thereby widening the cost differential between the Dempster and marine scenarios and even making the Mackenzie pipeline more attractive than the marine mode. For example, a reduction of 17.12[1] per cent in the Canadian marine operating cost would be necessary to equalize the Dempster and the Canadian marine unit costs, while the Dempster would require an operating cost increase of 43.90[1] per cent.

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[1] Not shown in Table 6-3.

Domestic Tanker Capital Cost Overrun

The domestic marine mode is not sensitive to capital cost overruns on domestic tankers, mainly because these capital costs represent a small proportion of total marine costs; also the effect of discounting on present values is reduced as the construction of domestic tankers tends to be concentrated more towards the end of the study period.

Foreign Financing

The base case assumed domestic financing of imported tankers. Given the lack of realism of that hypothesis, it is now assumed that low cost foreign financing is available on the following terms: 8¾ per cent interest rate; 8 year term with equal repayment of principal and AFUDC, in Canadian dollars; interest paid on the declining balance and; foreign shipyard directly paid by foreign lending institutions (i.e. no inflow of foreign capital to Canada).

From an economic efficiency point of view, the principal and interest paid to non-residents, including a 7 per cent foreign exchange premium, are considered a social cost.

The results show that the unit economic costs of both domestic and foreign marine scenarios are invariant to our foreign financing assumptions.

7. IMPACT ANALYSIS

The following section discusses the methodology and results of the macro and regional economic impact analyses of Beaufort development and transportation.

While the financial and economic cost analyses were limited to the transportation system, the impact analysis has a wider scope as it encompasses the effects of the transportation as well as non-transportation systems, e.g. exploration, development and production. Beaufort development will not proceed without a transportation system and the transportation system will not be built without Beaufort development. Thus, the two are interdependent and the economic shock emanates jointly from Beaufort field development and production as well as from construction of the transportation system.

7.1 Methodology

7.1.1 Macro-Economic Impact

The Informetrica macro-economic model (TIM) is employed to estimate the economic impact of Beaufort development, production and transportation of each scenario on the national economy to the year 2000. The study focusses on the impact differences between alternative modes for a given volume of oil throughput.

Analysis of macro-economic impacts involves developing two sets of simulation of the Canadian economy - one with, and one without Beaufort Sea oil development and transportation. The base case without Beaufort oil is discussed in Section 7.2.1, followed by a discussion of the direct shocks in Section 7.2.2. The macro economic analysis assesses the degree to which a project alters the overall state of the economy. The model estimates the effects on a variety of variables such as gross national product, real domestic product,[1] employment, balance of payment, government balance, inflation, industrial sector activity, etc. The model is dynamic and non-linear and allows for supply constraints and fully induced impacts. For a summary description of the Informetrica model, see Annex 7-2.

7.1.2 Regional Economic Impact

The Statistics Canada Provincial Input-Output model[2] is used to simulate the provincial impacts of each scenario on key variables such as the provincial gross domestic product and employment. The Input/Output model is less sophisticated than the macro model to the extent that it is static, linear, dated (1974), unconstrained on the supply side and allows for partially induced impacts only. These weaknesses are partly corrected by distributing or scaling up or down the key national economic impacts from the TIM model, e.g., gross domestic product and employment, among the provinces on the basis of the regional distribution of the Input/Output provincial impacts.

7.1.3 Internal Linkages of Impact Study

Chart I provides the basic linkages between the various models and information flows that ultimately feed into the TIM and Statistics Canada regional Input/Output models. These various models include the Beaufort Planning model, the DREE Halifax/Canso Shipyard model and the NEB tariff model. Other important sources of information are the Carin study, the Beaufort proponents, the Industry, Trade and Commerce Supply/Demand Shipbuilding forecast (Annex 7-3) and general DREE intelligence.

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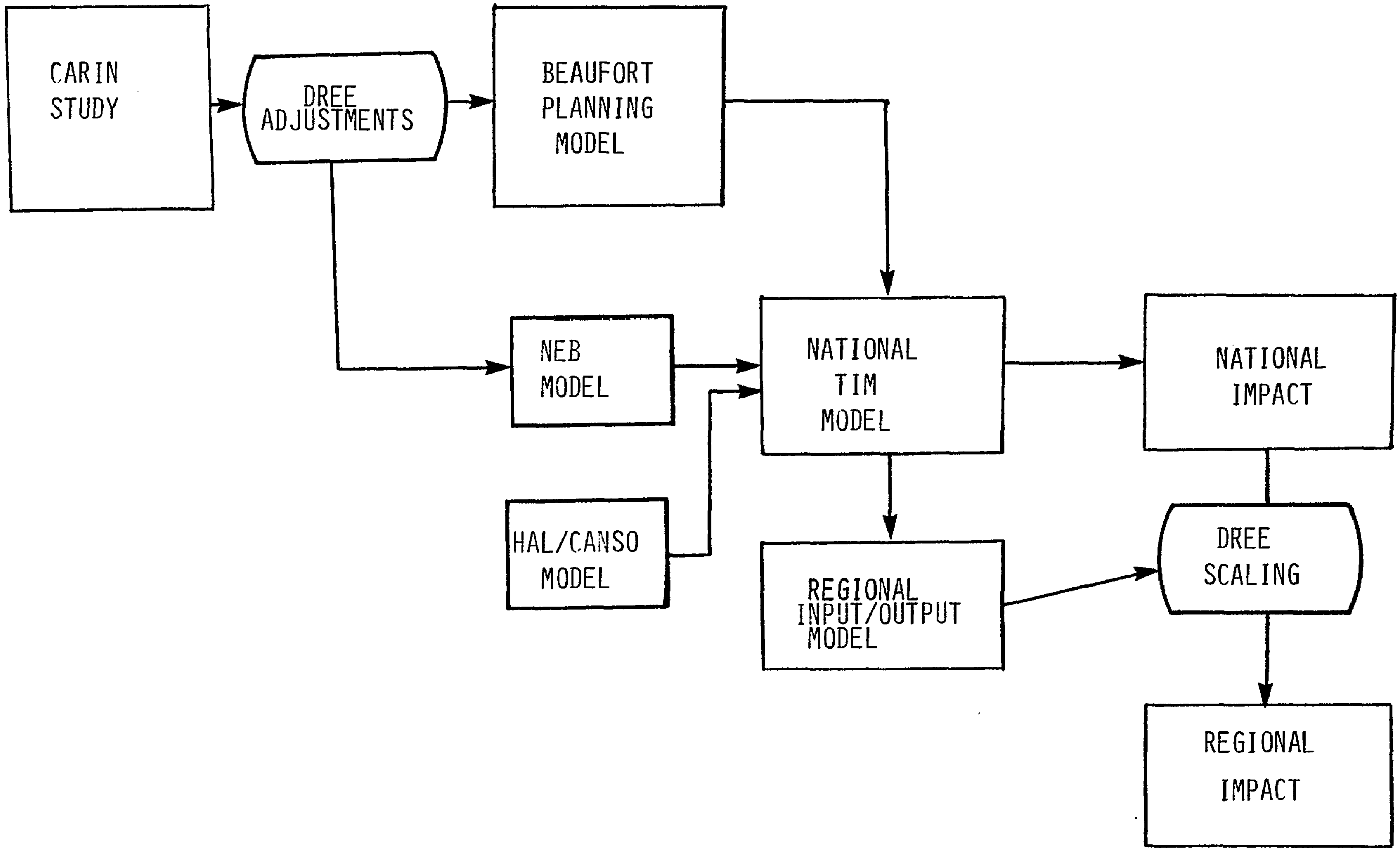
[1] Real domestic product (or gross domestic product) at factor cost is equal to GNP at market prices less (indirect taxes minus subsidies, investment income received from non-residents and residual error of estimate) plus investment income paid to non-residents.

[2] Statistics Canada (Structural Analysis Division), Structural Econometric Models: A User's Guide, Chapter 7.

CHART 1

NATIONAL-REGIONAL ECONOMIC IMPACTS



The Beaufort Planning Model

The Beaufort Planning model, which was specifically designed for the industry EIS submission, is a computerized descriptive model owned by Dome, Gulf and Esso, which assesses the direct costs and input requirements of the various Beaufort production scenarios. Driven by the timing and magnitude of oil/gas reserves, it shows the direct impact that the exploration, development, production and mode of transportation will have on equipment, material, personnel requirements and expenditures. These expenditures are then allocated among provinces and imports, for each year. The project's costs defined by Input/Output commodity, can readily be fed as inputs into the TIM and regional Input/Output models. For a fuller explanation of the Beaufort model, and adjustments made to it, see Annex 7-1.

National capital costs flow from the Beaufort model to TIM model, while their regional allocation is fed into the Statistics Canada regional Input/Output model.

It should be pointed out that the Beaufort model was initially developed to provide a general representation of the project for a volume of 1.2 million BOPD by year 2000. In the case of a pipeline, a 42" diameter was assumed. The same linear model structure is posited to accommodate our study's smaller throughput. In reality, at a lower throughput, say 350,000 BOPD, the proportionality assumption, particularly regarding pipelines, may be too strong due to changes in system design, e.g. pipeline diameter, steel requirements, number of pump stations, etc... Given the great uncertainties associated with the specific project's design, the model is likely to be weak on detailed input requirements e.g. commodity type and cost, geographic sourcing, manpower requirements by skill and region, etc...

The DREE Halifax/Canso Shipyard Model

In the case where a VLCC yard is built in Canada (scenarios 2A and 5A), the DREE Halifax/Canso model[1] replaces the Beaufort model specifications. The DREE model supplies the output and input requirements associated with the production of tankers and other vessels in the new yard.

While the Halifax/Canso model has been run to fit Carin's high and medium marine scenarios, it can provide a fair approximation of the shipyard input requirements associated with the new oil throughput.

The DREE model contributes to the assessment of the differential impact of the Halifax yard on the national and regional economies (Scenarios 2A and 5A) relative to a no yard situation (Scenarios 2B and 5B).

The NEB Tariff Model

The National Energy Board Tariff model is used to compute financial transportation tariffs. The resulting NEB tariffs, in the form of average discounted tariffs, feed into TIM so that the wellhead price in Beaufort is set equal to the world price at the point of destination less the transportation tariff.

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[1] Dome Greenfield Shipyard, op.cit., p.6.

7.2 Impact Results

7.2.1 Base Case

Scenarios are simulated with respect to the Informetrica base case which excludes the Beaufort project. The base case incorporates EMR energy supply/demand forecasts.[1] The basic premises of EMR forecasts are achievement of oil self-sufficiency by 1990 and frontier oil production from Hibernia by 1988, Syncrude expansion and three tar sand plants coming on stream in 1989, 1993 and 1997 respectively. The base case highlights summarized in Table 7-1, show the following trends: the 1981 unemployment rate of 7.6 per cent will be exceeded until 1994 and then drop to 5.9 per cent by 2000. The GNE deflator will fall to about 7.5 per cent in the 1990s[2]. The deficit in oil trade will be reduced from $5 billion in 1985 to $0.6 billion in 1990, in current dollars. Large federal deficits persist until the early 1990s and it is only by 1996 that federal balances return to a surplus position.

The base case projections indicate considerable slack in the economy from the present to the mid-1990s, a period during which the impetus for growth provided by the construction of Beaufort's production and transportation facilities may reasonably be expected to be the greatest. For more explanation on the base case assumptions, see Annex 7-4. Detailed base case results by year are presented in Annex 7-7.

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1 National Energy Program Update 1982 - Supplementary Information on Canadian Energy Supply/Demand Outlook, 1981-2000; EMR, 1982.

2 From 1971 to 1981, the implicit GNE deflator rose 2.57 times. As a rough rule of thumb, the reader may envisage prices doubling once from 81 to 90 and again from 90 to 2000 so that the current dollar values in 2000 are inflated about four times relative to 1981 levels and about 9.5 times relative to 1971.

Table 7-1

BASE CASE HIGHLIGHTS

% Growth (annual rates - compounded)

	1982	1982-1985	1986-1990	1991-2000
Real GNP	-5.0	4.7	3.4	2.8
RDP	-3.9	4.4	3.2	2.7
Consumption	-1.9	3.3	3.2	3.0
Business Investment	-13.9	5.6	4.8	3.5
Labour Force	1.8	1.8	1.6	1.2
Employment	-2.0	1.9	2.0	1.5
Implicit GNE Deflator	10.4	7.7	6.7	7.5
CPI	11.3	7.4	6.4	7.2
GNP ($ current)	4.9	12.7	10.4	10.5
Government Revenues ($ current)	8.6	10.5	9.7	9.8

Levels - billions $ current

	1982	1985	1990	2000
Energy Trade Balance	2.3	7.6	24.2	63.3
Oil Trade Balance	-4.8	-5.0	-0.6	-0.6
Merchandise Trade Balance	10.4	19.8	37.7	76.0
Current Account Balance	-7.8	-3.6	8.0	-4.6
Exchange Rate ($Cdn/$U.S.)	1.225	1.220	1.180	1.140
Federal Government Balance	-17.2	-21.6	-19.2	26.6
Unemployment Rate (%)	11.0	11.1	9.2	5.9

7.2.2 Initial Shock

This section of the study establishes the impact of six investment and oil production scenarios until year 2000. Economic impacts for the pipeline medium volume scenario 7 (30") were not run due to time constraints on a contract with Informetrica. Given that oil self-sufficiency would be, according to EMR, achieved by 1990 without Beaufort oil and that a large amount of oil surplus would result from Beaufort, tar sand production was arbitrarily reduced in order to minimize that surplus. Two tar sand plants which would have started up in 1993 and 1997 have been dropped in the high production cases while only one tar sand plant is expunged in 1997 in the medium volume case. Tar sand cost estimates ($10 billion in 1981 dollars per plant)[1] and input requirements were already built-in the TIM base case.

Under the high volume scenarios, eight offshore fields are required - four deep and four shallow - while under the medium scenarios only four fields are expected - one deep and three shallow. Most of the actual oil discoveries have been concentrated in deeper waters. While there has been natural gas finds (not yet commercially proven) in the Beaufort area, the study ignores the economic impact of natural gas production and transportation.

Investment Shocks

Among the high volume scenarios, the pipeline constitutes a slightly lower investment shock at 70.6 billion, in 1981 dollars, than the foreign marine at $73.6 billion and the domestic marine at $74.4 billion[2]. The domestic marine scenario

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1 Current estimates are about $14 billion, in 1981 dollars.
2 Expressed in prices before subsidies.

incorporates the effect of icebreaker-tankers and other vessels that would have been imported[1] otherwise without a large domestic VLCC yard. By 2000 the high volume marine scenario cummulatively produces marginally more oil - about 50 million barrels - than the high volume pipeline scenario.

In the medium volume cases, the investment shocks in 1981 dollars, are: $45.3 billion for the pipeline, $43.8 billion for the foreign marine and $44.9 billion for the Canadian-built scenarios or about one third lower in value than the high volume shocks. All medium scenarios produce the same volume of oil. Table 7-2 indicates the investment shocks, gross and net of tar sands, in 1981 dollars. Equivalent 1971 dollar values are displayed in Annex 7-5.

Both transportation modes show a high investment stimulus in the late 80's and 90's resulting from the construction of production and transportation facilities. However the pipeline cases are characterized by a more concentrated shock in the late 80's.

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1 It is assumed that Halifax/Canso production will not displace production from other domestic yards.

TABLE 7-2

SUMMARY OF DIRECT INVESTMENT

SHOCKS

($MM 1981)

	Scenario: High Volume			Scenario: Medium Volume		
	Pipeline #1	Marine (Foreign) #2B	Marine (Canadian) #2A	Pipeline #4	Marine (Foreign) #5B	Marine (Canadian) #5A
GROSS INVESTMENT	70 635	73 590	74 406	45 254	43 756	44 897
TAR SANDS PLANT	(20 000)	(20 000)	(20 000)	(10 000)	(10 000)	(10 000)
NET INVESTMENT	50 635	53 590	54 406	35 254	33 756	34 897

7.2.3 Macroeconomic Impact

Impacts measure the differences in economic variables net of the base case. A brief summary comparison between senarios is presented below. Cumulated impact for key variables by 1990 and 2000 appear in Tables 7-3 and 7-4 for the high and medium volume scenarios respectively. Corresponding differential impacts between scenarios follow in Tables 7-5 and 7-6. Industrial sectors experiencing the greatest impacts are identified in Table 7-7.

It should be pointed out that the TIM model expresses dollar impacts in 1971 or current dollars, according to the variable. As a rough rule of thumb, 1981 dollar impacts for GNP and RDP could be derived by multiplying 1971 dollar values by 2.5

The reader will find a detailed discussion[1] of the macroeconomic impact of each scenario in Annex 7-5. A comparison between scenarios follows in Annex 7-6 including a separate graphic representation of twelve selected impact variables for the high and medium volume scenarios. These variables are: oil trade balance, energy trade balance, current account balance, exchange rate, real domestic product, gross national product, implicit gross national expenditure deflator, consumer price index, employment, unemployment rate, federal government balance and construction wages as share of total wages.

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[1] Excerpts from "Macroeconomic Impacts of Beaufort Sea Oilfield Development", Informetrica, Ottawa, March 1983. Study commissioned by DREE.

High Volume Cases

The earlier oil production of the high marine cases advances the impact of construction and consumption relative to the pipeline case, which leads the marine scenarios to show greater employment impacts by 1990. However by year 2000, the pipeline shows slightly greater impacts than either marine cases for such key variables as GNP, RDP and employment. But in terms of effects on the current account and federal government balances, the pipeline impacts, expressed in current dollars, are slightly below the domestic marine case. The latter impacts would likely be much closer to one another if expressed in 1971 dollars.

Table 7-5 exhibits the differential impacts among the high volume scenarios on GNP, RDP and employment. For example, the pipeline would add $1.7 billion (1971 dollars) to GNP and 94 thousand person-years (about 5,000 jobs per year) compared to the domestic marine case, which itself would add about $1.6 billion (1971 dollars) to GNP and 190 thousand person-years (about 10,000 jobs per year) compared to the foreign marine case. As expected, the pipeline indicates the greatest investment multiplier (cumulated GNP/cumulated investment): 1.79 compared to 1.68 for the domestic marine and 1.65 for the foreign marine scenario.

Medium Volume Cases

The medium volume cases, because of their similar start-up date and volume of oil production, provide a better framework for the comparison of impacts between scenarios, as indicated by

TABLE 7-3

KEY IMPACTS - NATIONAL

(CUMULATED)

HIGH VOLUME SCENARIOS

	To 1990			To 2000		
	PIPELINE #1	MARINE FOREIGN #2B	MARINE CANADIAN #2A	PIPELINE #1	MARINE FOREIGN #2B	MARINE CANADIAN #2A
(THOUSANDS - MY)*						
EMPLOYMENT	1 285	1 368	1 432	3 309	3 025	3 215
(MILLION $1971)						
REAL GNP	23 472	19 227	20 114	47 558	44 239	45 854
RDP	31 679	25 706	26 724	61 104	55 090	57 428
(BILLION $ CURRENT)						
CURRENT ACCOUNT BALANCE	-36.1	-21.7	-23.8	87.8	83.2	75.4
FEDERAL GOVERNMENT BALANCE	9.7	6.9	7.3	161.4	167.2	169.4
OIL TRADE BALANCE	- 4.0	12.6	12.4	250.0	252.1	251.7

*MAN-YEAR

TABLE 7-4

KEY IMPACTS - NATIONAL

(CUMULATED)

MEDIUM VOLUME SCENARIOS

	To 1990			To 2000		
	PIPELINE #4	MARINE (FOREIGN) #5B	MARINE (CANADIAN) #5A	PIPELINE #4	MARINE (FOREIGN) #5B	MARINE (CANADIAN) #5A
(THOUSANDS - MY)						
EMPLOYMENT	1 241	985	1 051	2 576	2 170	2 341
(MILLION $1971)						
REAL GNP	20 886	15 328	16 107	31 129	27 334	28 548
RDP	27 237	20 422	21 315	41 316	35 381	37 240
(BILLION $ CURRENT)						
CURRENT ACCOUNT BALANCE	-32.7	-27.7	-29.6	-24.0	-19.0	-26.6
FEDERAL GOVERNMENT BALANCE	11.6	3.6	4.0	64.1	50.6	51.8
OIL TRADE BALANCE	- 4.8	- 3.2	- 3.4	75.0	76.4	76.0

Table 7-4. This time, cumulated impacts of the pipeline on key variables are greater by 1990 and by 2000 relative to the domestic marine case, except for energy and oil trade balance variables, where effects are about the same. For variables such as GNP, RDP and employment, the pipeline surpasses the domestic marine case by about 10 per cent. On the federal goverment balance account the difference is about 25 per cent.[1] Unlike the high volume cases, the cumulated current account balance impact is negative for all medium volume cases because oil exports are more than offset by the imports of materials and service payments on funds borrowed abroad to pay for investment goods.

The differential impact between scenarios, as shown by Table 7-6, indicates that the pipeline would add to GNP and employment about $2.6 billion (1971 dollars) and 235 thousand person-years (about 13,000 jobs per year) respectively relative to the domestic marine scenario. If a marine mode were selected, the Halifax/Canso yard would create about 170 thousand additional person-years relative to a situation where all tankers are imported. Investment multipliers for the medium volume cases, while consistently lower than the high volume cases maintain the same ranking between scenarios - 1.72 for the pipeline, 1.58 for the domestic marine and 1.57 for the foreign marine scenarios.

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[1] The federal government balance variable is expressed in current rather than constant dollars; differences between scenarios tend to be greater than if these had been expressed in constant dollars. Unfortunately, constant dollar values for such variables were not available.

TABLE 7 - 5

DIFFERENTIAL IMPACTS BETWEEN SCENARIOS - NATIONAL

(Cumulated to 2000)

HIGH VOLUME SCENARIOS

(% difference)

	GNP ($MM 1971)	RDP ($MM 1971)	EMPLOYMENT (000 MY)
Pipeline (#1) minus Marine Canadian (#2A)	1704 (3.7%)	3675 (6%)	94 (2.9%)
Pipeline (#1) minus Marine Foreign (#2B)	3320 (7.5%)	6013 (10.9%)	284 (9.4%)
Marine Canadian (#2A) minus Marine Foreign (#2B)	1616 (3.7%	2339 (4.2%)	190 (6.3%)

TABLE 7-6

DIFFERENTIAL IMPACTS BETWEEN SCENARIOS - NATIONAL

(CUMULATED TO 2000)

MEDIUM VOLUME SCENARIOS

(% DIFFERENCE)

	GNP ($MM 1971)	RDP ($MM 1971)	EMPLOYMENT (000 MY)
PIPELINE (#4) MINUS MARINE CANADIAN (#5A)	2581 (8.3%)	4077 (10.9%)	235 (10%)
PIPELINE (#4) MINUS MARINE FOREIGN (#5B)	3795 (13.9%)	5934 (16.8%)	407 (18.8%)
MARINE CANADIAN (#5A) MINUS MARINE FOREIGN (#5B)	1214 (4.4%)	1858 (5.3%)	171 (7.9%)

Table 7-7 lists the main sectoral impacts in terms of both employment and RDP. Irrespective of the volume of production, the industrial sectors most stimulated in terms of employment are the service, manufacturing and trade sectors. The greatest RDP is created in the mining sector - particularly the oil sector - with manufacturing and construction sectors lagging far behind. The domestic marine scenario generates the largest impact in the manufacturing sector, in terms of both employment and RDP.

None of the effects on prices suggest that increased inflation will be a major consequence of Beaufort development because of the large amount of slack assumed in the base case and the appreciation of the Canadian dollar. The magnitude of the GNE deflator impact, in percentage terms, is small - between 2 per cent (medium cases) and 2.5 per cent (high cases) difference - between the impact and base cases.[1] Impact changes to the consumer price index are even lower.

According to the model simulations, governments are significant beneficiaries from the Beaufort project. The cumulated impact on federal government balances is 2.5 to 3.3 times higher in the high production cases relative to the medium cases. It may be useful to think of the surpluses that are generated as representing part of the room that might exist to meet such real contingencies as the chance that the real price of oil may grow by less than 2 per cent, that the cost of economic and social dislocation will be larger than may be implied in the simulations, or that the private investment or associated public infrastructure will require much more resources than has been estimated by the projects sponsors or by DREE regarding the Halifax/Canso yard.

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[1] If the base case GNE deflator is say 10%, the new GNE deflator would vary between 10.20 and 10.25%.

TABLE 7-7

SECTORAL IMPACTS - NATIONAL

(Cumulated to 2000)

	High Volume			Medium Volume		
	Scenario					
	Pipeline	Marine (Foreign)	Marine (Canadian)	Pipeline	Marine (Foreign)	Marine (Canadian)
	#1	#2B	#2A	#4	#5B	# 5A
EMPLOYMENT						
(thousands - MY)						
TOTAL	3 309	3 025	3 215	2 576	2 170	2 341
Services	774	689	717	652	516	542
Manufacturing	705	786	898	554	560	668
Trade	647	623	648	489	424	446
RDP						
(Million $1971)						
TOTAL	61 104	55 090	57 428	41 316	35 381	37 240
Manufacturing	9 340	9 760	11 235	6 727	6 784	8 140
Construction	7 765	5 847	6 056	5 696	4 062	4 211
Mining	20 175	20 017	19 943	12 937	12 500	12 257

Possible supply bottlenecks in pipelaying capacity (identified in Chapter 8) may occur and delay the construction of the high volume pipeline. Such supply constraints were not explicitly accounted for in the impact analysis.

The readers should ask themselves whether the current structure of macroecoomic models are adequate for providing "reasonable" impacts of mega-projects such as the Beaufort project. Widely divergent impact results are likely to be obtained from different macro models currently in use in Canada. Such impact differences have recently been assessed in a seminar sponsored by the Department of Finance and the Bank of Canada[1]. For example, Chart 2 displays the impact multipliers, for a number of Canadian macroeconomic models, of a $1 billion in federal current non-wage expenditures[2] (GNP/Federal Expenditure). The models' multipliers vary over a wide range with the CANDIDE and TIM models simulating the greatest impacts on GNP relative to the other models.

It is fair to believe that, had we used, say the MACE model, the Beaufort impacts on GNP and employment would have been smaller. It is not clear how the pipeline would have fared relative to the marine scenarios.

No absolute objective criteria exist to help decide which model simulation is the correct one. However, the authors of

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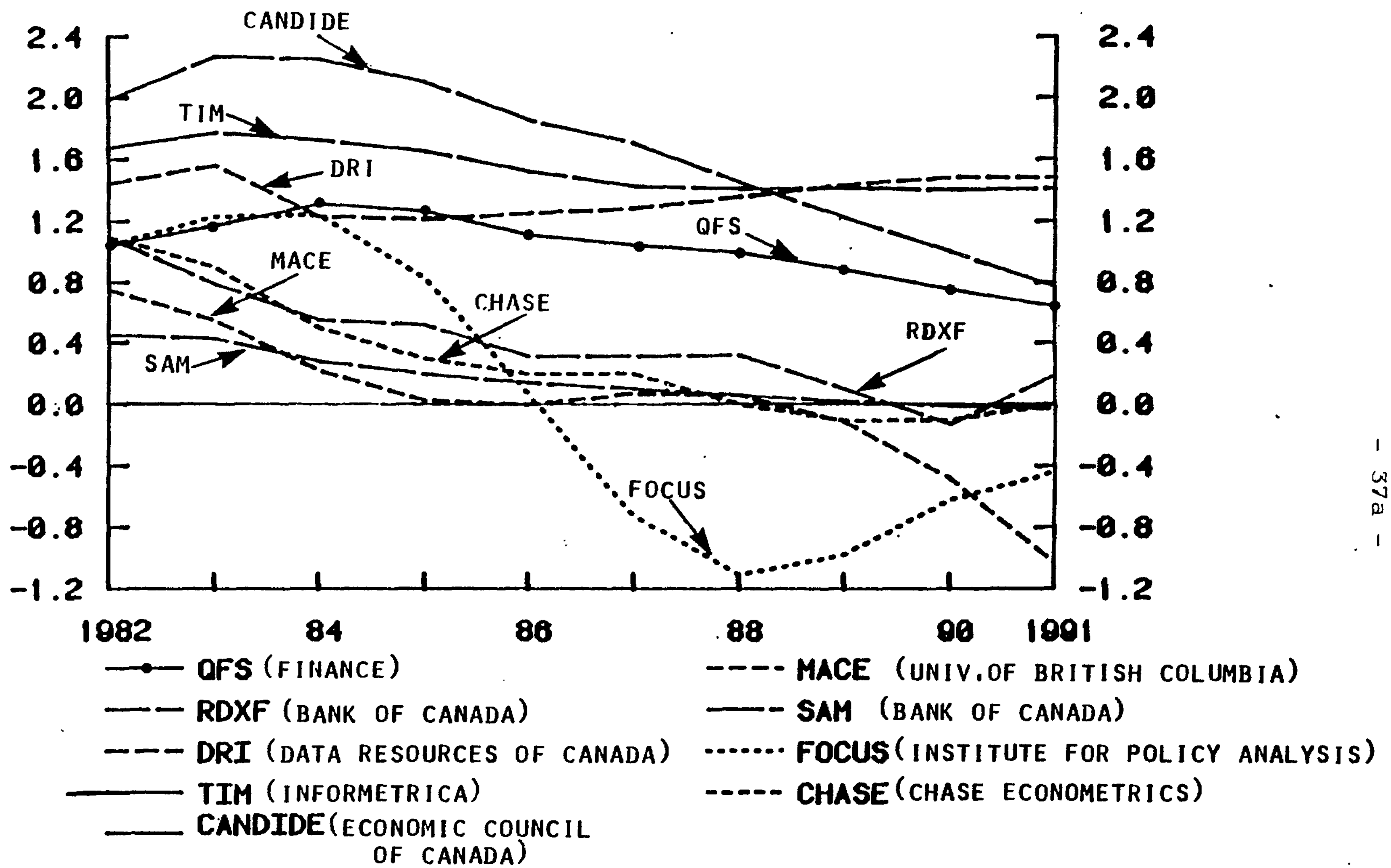
[1] "Seminar on Response of Various Models to Selected Policy Shocks" sponsored by the Bank of Canada and the Department of Finance, Ottawa, 1982.

[2] The federal non-wage expenditure shock was the closest stimulus example found in the seminar comparisons to the private investment stimulus in Beaufort. The shock is permanent in real terms, meaning it is repeated for each year for the period 1982-1991.

CHART 2

REAL EXPENDITURE MULTIPLIERS

(Non-accommodating multipliers)*



Real multipliers	QFS	RDXF	CHASE[1]	DRI	FOCUS	TIM[2]	CANDIDE 2.0	SAM	MACE
Year 1	1.04	1.09	1.1.	1.44	1.05	1.67	1.98	.42[4]	.75
3	1.31	.58	.5	1.23	1.24	1.72	2.25	.14	.22
5	1.11	.34	.2	1.25	.07	1.52	1.85	-.27	.00
10	.64	.06	.0	1.48	-.44	1.41	.77	-.23	-1.03

(1) Total federal government expenditures.
(2) Nominal interest rates fixed

(4) These multipliers derive from a subsequent run of the SAM model; for more discussion go to Section 9, page 29 of that paper.

*B.O'Reilly, P.Smith: "Comparison of Model Responses,with Cross Model Summary Tables" in Seminar on Responses...

this study are of the opinion that the TIM model would probably show larger real output impacts from given investment shocks then most other Canadian models.

7.2.4 Regional Economic Impact

The macroeconomic impact analysis simulates the potential economic activity created in Canada by the construction and operation of alternative Beaufort developments. As for the regional analysis, it attempts to estimate the regional distribution of Beaufort construction impact among Canadian provinces. Uneven quality and lack of regional data prevented the analysis from incorporating also the regional effects of the operating phase of Beaufort.

Table 7-8A summarizes the percentage distribution of Beaufort on GDP among provinces and regions. Table 7-8B translates these percentages into GDP values[1]. Similarly, Tables 7-9A and 7-9B exhibit the regional impact in terms of employment.

Results indicate that all regions should expect considerable economic stimulus from the Beaufort Project. Irrespective of the scenario, Ontario and the Prairies gain the most, with Quebec and the Atlantic occupying the middle ground, and B.C. and the Northwest Territories and Yukon ranking last. In the pipeline cases, Ontario ranks first closely followed by Alberta, with Quebec and B.C. ranking third and fourth. In the marine domestic cases, Ontario, Alberta and Quebec keep the lead with Nova Scotia edging out B.C. and the North.

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[1] For example, the Nova Scotia GDP value for scenario 5A is equal to the national GDP value (Table 7-4) times Nova Scotia's share of Beaufort impact (Table 7-8A).

Relative to the existing provincial share of GDP and employment (Table 7-10), the North, P.E.I. and Nova Scotia would improve their share significantly, irrespective of the scenario. Their relative gain would even be greater with marine scenarios. On the other hand, Ontario and Quebec would lose share irrespective of the scenario.

In terms of both GDP and employment, all provinces, except Nova Scotia, would be better off with the pipeline senarios.

If, for example, the Atlantic, Quebec and Manitoba regions were to be designated they would, in absolute impact terms, gain slightly as a group with the domestic marine scenarios, compared to the pipeline scenarios.

It is anticipated that, during the operating phase, the relative share of Beaufort activity accruing to regions such as the North, Alberta, Nova Scotia and Ontario may have been underestimated in our study. In effect, a large portion of the materials, wages and salaries, provincial taxes and Canadian dividends would be paid to these regions during the operating stage. It should be stressed that the impact estimate for the Northwest Territories and Yukon should be interpreted with extreme caution. The 1974 Statistics Canada model, for example, does not account for the future production of commodities, say barite, or existence of an industry if they did not exist in the North, in 1974. In many instances, when regional specific data were not available, national data, including national import patterns were imposed for that region.

TABLE 7-8A

GROSS DOMESTIC PRODUCT IMPACT
REGIONAL DISTRIBUTION (%)

(CUMULATED TO 2000)

SCENARIOS

	HIGH VOLUME			MEDIUM VOLUME		
	PIPELINE #1	MARINE #2B	MARINE #2A	PIPELINE #4	MARINE #5B	MARINE #5A
CANADA	100	100	100	100	100	100
ATLANTIC	12.83	13.19	16.20	13.05	13.41	17.02
NEWFOUNDLAND	2.11	2.17	2.10	2.10	2.09	2.05
PRINCE EDWARD ISLAND	1.59	1.69	1.67	1.61	1.69	1.69
NOVA SCOTIA	6.32	6.52	9.65	6.51	6.78	10.45
NEW BRUNSWICK	2.81	2.81	2.78	2.83	2.85	2.83
QUEBEC	15.42	14.74	14.63	15.39	14.89	14.75
ONTARIO	26.45	24.84	24.75	26.37	24.90	24.66
PRAIRIES	25.19	25.44	24.07	25.05	25.19	23.66
MANITOBA	3.29	3.39	3.35	3.24	3.29	3.30
SASKATCHEWAN	4.13	4.16	4.02	3.95	3.94	3.81
ALBERTA	17.77	17.89	16.70	17.86	17.96	16.55
BRITISH COLUMBIA	10.50	10.83	10.29	10.58	10.88	10.22
YUKON & NORTHWEST TERRITORIES	9.61	10.96	10.06	9.56	10.73	9.69
DESIGNATED REGIONS (ATLANTIC, QUEBEC, MANITOBA)	31.54	31.32	34.18	31.68	31.59	35.07

TABLE 7-8B

GROSS DOMESTIC PRODUCT IMPACT
REGIONAL DISTRIBUTION (MM$1971)
(CUMULATED TO 2000)

	SCENARIOS					
	HIGH VOLUME			MEDIUM VOLUME		
	PIPELINE #1	MARINE #2B	MARINE #2A	PIPELINE #4	MARINE #5B	MARINE #5A
CANADA	61,104	55,090	57,428	41,316	35,381	37,240
ATLANTIC	7,840	7,266	9,304	5,392	4,745	6,338
NEWFOUNDLAND	1,289	1,195	1,206	868	740	763
PRINCE EDWARD ISLAND	972	931	959	665	598	629
NOVA SCOTIA	3,862	3,592	5,542	2,690	2,399	3,892
NEW BRUNSWICK	1,717	1,548	1,597	1,169	1,008	1,054
QUEBEC	9,422	8,120	8,402	6,358	5,268	5,493
ONTARIO	16,162	13,684	14,213	10,895	8,810	9,183
PRAIRIES	15,392	14,016	13,823	10,350	8,912	8,811
MANITOBA	2,010	1,868	1,924	1,339	1,164	1,229
SASKATCHEWAN	2,524	2,292	2,309	1,632	1,394	1,419
ALBERTA	10,858	9,856	9,590	7,379	6,354	6,163
BRITISH COLUMBIA	6,416	5,966	5,909	4,371	3,850	3,806
YUKON & NORTHWEST TERRITORIES	5,872	6,038	5,777	3,950	3,796	3,609
DESIGNATED REGIONS (ATLANTIC, QUEBEC, MANITOBA)	19,272	17,254	19,629	13,089	11,177	13,060

TABLE 7-9A

EMPLOYMENT IMPACT

REGIONAL DISTRIBUTION (%)

(CUMULATED TO 2000)

	SCENARIOS					
	HIGH VOLUME			MEDIUM VOLUME		
	PIPELINE #1	MARINE #2B	MARINE #2A	PIPELINE #4	MARINE #5B	MARINE #5A
CANADA	100	100	100	100	100	100
ATLANTIC	12.57	13.92	19.31	12.78	13.59	19.42
NEWFOUNDLAND	1.55	1.72	1.67	1.65	1.74	1.70
PRINCE EDWARD ISLAND	1.06	1.29	1.36	1.15	1.31	1.46
NOVA SCOTIA	6.97	7.79	13.21	6.97	7.50	13.20
NEW BRUNSWICK	2.99	3.12	3.07	3.01	3.04	3.06
QUEBEC	18.91	18.23	17.63	18.55	17.66	17.11
ONTARIO	28.72	26.02	25.39	28.51	26.01	25.22
PRAIRIES	20.21	19.55	17.79	20.58	20.97	19.00
MANITOBA	2.29	2.20	2.23	2.46	2.45	2.53
SASKATCHEWAN	2.99	2.79	2.62	2.91	2.94	2.77
ALBERTA	14.93	14.56	12.94	15.21	15.58	13.70
BRITISH COLUMBIA	9.41	9.96	9.12	9.69	10.18	9.24
YUKON & NORTHWEST TERRITORIES	10.18	12.32	10.76	9.89	11.59	10.01
DESIGNATED REGIONS (ATLANTIC, QUEBEC, MANITOBA)	33.77	34.35	39.17	33.79	33.70	39.06

TABLE 7-9B

EMPLOYMENT IMPACT

REGIONAL DISTRIBUTION (000's MAN-YEARS)

(CUMULATED TO 2000)

	SCENARIOS					
	HIGH VOLUME			MEDIUM VOLUME		
	PIPELINE #1	MARINE #2B	MARINE #2A	PIPELINE #4	MARINE #5B	MARINE #5A
CANADA	3309	3025	3215	2576	2170	2341
ATLANTIC	416	421	621	329	295	455
NEWFOUNDLAND	51	52	53	42	38	40
PRINCE EDWARD ISLAND	35	39	44	30	28	34
NOVA SCOTIA	231	236	425	179	163	309
NEW BRUNSWICK	99	94	99	78	66	72
QUEBEC	626	552	567	478	383	401
ONTARIO	950	787	816	734	564	590
PRAIRIES	669	591	572	530	455	445
MANITOBA	76	67	72	63	53	59
SASKATCHEWAN	99	84	84	75	64	65
ALBERTA	494	440	416	392	338	321
BRITISH COLUMBIA	311	301	293	250	221	216
YUKON & NORTHWEST TERRITORIES	337	373	346	255	252	234
DESIGNATED REGIONS (ATLANTIC, QUEBEC, MANITOBA)	1118	1039	1260	870	731	915

TABLE 7-10

TYPICAL REGIONAL DISTRIBUTION (%)
GROSS DOMESTIC PRODUCT* (GDP) AND EMPLOYMENT**

	GDP	EMPLOYMENT
ATLANTIC	5.50	7.56
NEWFOUNDLAND	1.59	1.71
PRINCE EDWARD ISLAND	0.24	0.44
NOVA SCOTIA	1.87	3.02
NEW BRUNSWICK	1.79	2.40
QUEBEC	21.49	24.56
ONTARIO	37.07	38.29
PRAIRIES	23.49	18.17
MANITOBA	3.44	4.23
SASKATCHEWAN	4.40	3.95
ALBERTA	15.65	10.00
BRITISH COLUMBIA	11.97	11.41
YUKON & NORTHWEST TERRITORIES	0.48	N/A
DESIGNATED REGIONS (ATLANTIC, QUEBEC, MANITOBA)	30.43	36.35

* 1979
** 1981

8. CANADIAN MANUFACTURING CAPABILITIES AND OPPORTUNITIES

This part of the report provides an overview of the Canadian manufacturing capabilities and opportunities with respect to the materials required for the construction of Arctic Class 10 oil tankers or a pipeline. Primary and secondary research were used to carry out the study. In general, no attempt has been made to assess the price competitiveness of the various items that could be produced in Canada. Extreme caution will have to be used so that surplus capacity does not result at the end of the Beaufort Sea development. Emphasis should be placed on opportunities where Canada could become internationally competitive.

This study defines the percentage of Canadian material content as the ratio of the value of Canadian materials to the value of total materials, excluding wages and salaries and indirect imports.

8.1 Canadian Manufacturing Capabilities - Tanker

The prime objective of the tanker market study is to provide an initial assessment of the industrial benefits arising from the construction of Arctic Class 10 crude carriers in Canada. The study focusses on the supply of components required for the construction of a ship, with a diesel propulsion system. A fuller description of the study is provided in Annex 8-1.

A description of the design characteristics of the tanker has been assembled using secondary information and discussions with Dome representatives. Since the ship is still at the preliminary design stage certain assumptions are made whenever necessary. The components of the ship are organized into 16 groupings. A summary of the groupings is provided in Table 8-1. Three groupings namely steel, propulsion and the

Table 8-1
CLASS 10 ICEBREAKING OIL TANKERS
CANADIAN MATERIAL CONTENT AND COST ESTIMATES SUMMARY

Material	Canadian Material Content[1] Existing	Potential	Estimated Price Range ($MM)
1. Steel	M	H	$58 - 70
2. Propulsion	L	M	56 - 64
3. Steering	M	M	1.5 - 2
4. Electrical System	L	M	5 - 7
5. Accommodation	H	H	.13 - .18
6. Piping and Fittings	M	M	.8 - 1
7. Valves	L	M	1.5 - 2
8. Pumps and Compressors	M	M	2 - 3
9. Deck Machinery	M	H	.6 - 1
10. Paint	H	H	1.2 - 1.7
11. Boilers	-	L	1.2 - 1.5
12. Communication & Navigation	M	M	.4 - .8
13. Hatches, Doors and Windows	H	H	1 - 1.6
15. Lifeboat & Liferaft Systems	L	M	.3 - .4
16. Miscellaneous	H	H	12 - 13
Total			143 - 170

Note:
1. Canadian Material Content: Existing refers to present capability to supply the requirements of the Canadian shipbuiding industry. Potential refers to the Canadian content which could be achieved in the supply of components for a Class 10 tanker after the fifth ship was built.

%	Symbol
0-15	-
16-49	L
50-79	M
80-100	H

electrical system account for over 80 per cent of the total value of the ship's components. As a result, a decision was made early on to focus on these three groupings.

Steel

The estimates for the steel requirements of each ship are 80,000 tonnes of which 70-75 per cent are plates, 20-30 per cent are sections and less than 3 per cent are castings. The steel requirements make up approximately 40 per cent of the total cost of the components of the ship. Canadian steel firms have indicated to Dome Petroleum that they could provide the grades and plate sizes required given some modification of their facilities. Present prices being quoted for steel show a premium for Canadian steel over imports varying from 10 to 28 per cent depending upon the grades. Some steel sections may still have to be imported in spite of the fact that attempts were made to "design out" as much as possible sections which cannot be sourced in Canada. Overall, a Canadian material content of over 80 per cent is possible for the steel.

Propulsion System

The propulsion system accounts for approximately 40 per cent of the total cost of the ship's components. The most costly items of this group are the diesel engines. These large engines could not be manufactured in Canada today. Given a certain market volume, the Canadian content of the diesel engines and accessories could be increased in a number of steps. The first step would consist of the setting-up of a facility to do the assembly and final testing of the diesel engines. A Canadian content of approximately 25 per cent could be achieved. The capital cost associated with such a facility would be approximately $3-5 million. The next step would consist of progressively increasing the manufacturing of engine parts in

Canada. One engine manufacturer estimated that the Canadian content could be raised up to 78 per cent using this approach. The choice of engine suppliers is quite limited given the engine characteristics sought.

The gear boxes are also costly items. Large international firms have entered into negotiations with Canadian manufacturers of small gears to increase the Canadian content of their gear boxes. A Canadian content ranging between 40 and 50 per cent is judged possible at present. The foreign content consists of the large gear system while the Canadian content would consist of the gear box casing, final assembly, and testing of the gear boxes. Another source stated that 100 per cent Canadian content could be achieved over a five year period by upgrading existing Canadian gear manufacturing capability.

The transverse thrusters and propeller nozzles could have a high Canadian content. The controllable pitch propeller equipment could achieve a Canadian content of approximately 50 per cent with existing capabilities. Certain parts such as the hubs would have to be imported. Given a high volume scenario and an upgrading of Canadian facilities a Canadian content of up to 80 per cent could be realized.

Overall, a Canadian material content of over 70 per cent appears possible for the propulsion system, given an adequate market volume.

Steering

The Canadian content for the steering gear is expected to be above 50 per cent but less than 80 per cent. A more exact figure would depend upon whether or not some steel forgings are imported and whether or not the machining of certain parts is done in Canada.

Electrical System

The Canadian content of the electrical system could reach over 75 per cent of its total cost. The generator sets are the most costly components of this grouping. The electrical package of the generator sets could have a high Canadian content. The Canadian content of the diesel engine would be subject to the same constraints expressed earlier for propulsion engines. Consequently, a high Canadian content could be achieved with the domestic fabrication of generator sets.

Other

Other groupings which have a high potential for Canadian content are Accommodation, Deck Machinery, Paint, Hatches, Doors and Windows and Miscellaneous.

For most groupings it would appear that significant increases in Canadian content could be achieved given a certain market volume. The market opportunities vary from component to component. The production of the various items for Class 10 tankers would not require new Research and Development. The requisite manufacturing capabilities could be added through licensing arrangement.

The overall Canadian content achieved on the components of the latest Dome icebreaker (Robert LeMeur) is approximately 51 per cent. This market study leads to the conclusion that a Canadian material content in the range of 65 to 80 per cent is achievable. Existing capabilities would be in the order of 25 to 40 percent. The Canadian content achieved would depend largely on one hand on the size of the demand for icebreaking tankers, its timing and scheduling and on the other hand the degree of competitiveness of domestic suppliers versus imports.

Table 8-2

Canadian Capability for the Manufacture of Important Materials Required for Beaufort Sea Pipeline

Material	Canadian Manufacturing Capability[1] Existing	Potential
STEEL	H	H
Line Pipe	H	H
Plates	H	H
Structurals	H	H
PUMPS	M	H
Centrifugal pumps	M	H
DRIVERS	M	M
Aeroderivative turbine	M	M
Industrial turbine	H	H
VALVES	M	H
PROCESS CONTROL EQUIPMENT	-	L
ELECTRICAL MACHINERY	H	H
Motors	H	H
Transformers	H	H
Switchgear	H	H
Cable	H	H
PIPELINE CONSTRUCTION MACHINERY	-	-

* Total material cost for Mackenzie Valley route pipeline approx. $5 billion (1981$)

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1 Canadian Manufacturing Capability: Existing refers to current capability to supply the requirements, potential refers to the capability that could be developed if markets materialize.

Symbol	Per Cent
-	0 - 15
L	16 - 49
M	50 - 79
H	80 - 100

* Source: Esso and Beaufort Planning Model estimates.

The federal government could affect to a significant degree the level of Canadian content achieved through the policies it adopts towards the development of frontier oil, and its shipbuilding policy.

8.2 Canadian Manufacturing Capabilities - Pipeline

The purpose of this overview was to assess the Canadian manufacturing capability to supply material and equipment required for the construction of a Beaufort Sea oil pipeline. A fuller description of the study is provided in Annex 8-2.

The assessment is based on the material requirement for the construction of 2,250 kms long and 914 mm (36") diameter pipeline (Mackenzie Highway route). This is the longest and largest diameter pipeline among the three pipeline alternatives, and therefore if the Canadian industry can meet its material requirements (worst case) then other alternatives are unlikely to pose any material sourcing problems.

The study's focus was a macro rather than a comprehensive micro assessment of the industrial capabilities relevant to a specific pipeline.

The proposed pipeline would require myriad items such as steel (mostly as line pipe), construction and electrical machinery, insulation, pumps and drives, communication equipment, valves, etc.

Steel and construction machinery are the most important material components of the pipeline cost.

Table 8-2 lists the estimated Canadian manufacturing capability for the major items required for the pipeline.

Virtually all the steel required for the pipeline could be produced in Canada. The Canadian steel industry has shown that it can provide steel for the various domestic pipelines at competitive prices.

The centrifugal pumps required for a 914 mm pipeline have not yet been produced in Canada, but can be readily manufactured by several pump manufacturers. These pumps would have a Canadian content of about 95 per cent.

A number of pump stations would use an aeroderivative or industrial power plant as a prime driver. Canadian content ranges from 60%-90% depending on the type of equipment used. This would be very specific as to the scenario developed.

The valves required can be manufactured in Canada. Canadian content for large valves would be about 70 per cent and that for smaller sizes about 90 per cent.

Manufacturing capabilities for process control items are almost non-existent in Canada. The Canadian petroleum industry has relied heavily on imports. This is also a relatively low cost item.

The electrical equipment such as motors, switchgear, cable required for the pipeline is available in Canada. The Canadian content of the electrical equipment would be of the order of 90 per cent.

Almost all of the pipeline construction machinery would have to be imported. High capital cost and small Canadian market deter establishment of Canadian facilities.

Our assessment indicates that the overall Canadian content of the material and equipment required for a Beaufort Sea pipeline based on the current capabilities, would be in the range of 80 to 90 per cent. However, there is potential for achieving little more than 90 per cent Canadian material content. There is sufficient capacity to supply goods needed for the pipeline.

The current annual Canadian capacity to produce large diameter pipe (greater than 406.4 mm) is estimated to be about 1,600 km (about 500,000 tonnes), and the pipelaying capacity is said to be of the order of 1,280 km. Barring an unprecedented level of activity this is probably sufficient capacity to meet demand.

8.3 Comparison of Manufacturing Capability - Tanker versus Pipeline

The Canadian material content, based on the existing manufacturing capabilities, would be of the order of 80 to 90 per cent for a pipeline compared to approximately 25 to 40 per cent for the proposed Arctic Class 10, Crude Carriers. There is potential to increase the Canadian material content to about 90 per cent for the pipeline mode and up to 80 per cent for the tanker mode. Thus, there is potentially more scope to expand manufacturing facilities for the tankers. This assumes that there is domestic capacity to build the required type of tankers.

Manufacturing capabilities with respect to the pipeline are well established in the country and potential for new capabilities is quite small. Almost all the pipeline related materials can be produced in Canada except for the pipeline construction machinery, some specialty items associated with gas turbines, and most of the process control equipment. Small Canadian market, absence of any comparative advantages and high capital investment rule out establishment of manufacturing facilities for the construction machinery. However, presence of a large and broad based petroleum industry combined with changes in procurement policy should help in establishing process control equipment facilities in Canada. It could not be ascertained if such facilities would be price competitive.

It is estimated that a Canadian material content of the order of 80 per cent is potentially feasible for the Class 10 tankers. The attainment of this level of Canadian content presents a large potential for the establishment of major manufacturing facilities for tanker components. The manufacturing opportunities would include production of new grades of steel plates, upgrading of propeller equipment capability, higher powered diesel engines, large gearboxes, generator sets and a broader line of valves.

The technological know-how for the production of these items and others exists outside Canada, and could most likely be accessed through licensing arrangements. Such an arrangement would broaden and augment marine manufacturing capabilities in Canada. However, it is premature to say if the product from these facilities would be price competitive.

SPECIAL ANNEX

LOW VOLUME SCENARIO #8 - 20" MACKENZIE PIPELINE

The objective of this Annex is to calculate the financial tariffs and economic transportation costs of a 20" Mackenzie pipeline.

1. Scenario Description

Two variants of a 20" pipeline scenario are considered:

a) Short Pipeline

The pipeline is buried all the way from Richards Island to Zama (Northern Alberta); the oil is then transported to Edmonton using the existing Rainbow Pipeline and then to Chicago, using the Interprovincial Pipeline.

b) Extended Pipeline

The pipeline is buried all the way from Richards Island to Edmonton; the oil is then transported to Chicago via the Interprovincial Pipeline.

Under both variants, a peak throughput of 200,000 BOPD is assumed. Table 1 displays the volume profile.

On the basis of a joint industry study (not yet completed) there is strong evidence supporting the feasibility of constructing essentially buried pipelines up to 30" diameter from Richards Island to Zama.

TABLE 1

BEAUFORT OIL THROUGHPUT

LOW VOLUME SCENARIO #8 - 20" MACKENZIE PIPELINE

(000's BOPD)

YEAR	THROUGHPUT(1)
1990	50
1991	120
1992	160
1993	190
1994	200
1995	200
1996	200
1997	200
1998	200
1999	200
2000	200
2001	200
2002	200
2003	200
2004	200
2005	200
2006	200
2007	200
2008	200
2009	200
2010	200
Total Throutphut (Million Barrels)	1,430

Source: Joint Industry Task Force.

Under the Short Pipeline variant, the capital cost of a 20" line from Beaufort to Zama is $1.6 billion[1]. The Rainbow Pipeline current capacity of 150,000 BOPD would be increased, by adding a few pump stations, in order to accommodate Beaufort throughput. A tariff of 55 cents per barrel is assumed. This tariff would account for the additional cost of pump stations and the cost saving resulting from a higher throughput. The existing tariff on a current throughput of 120,000 BOPD is 48 cents, in 1983 dollars.

Under the Extended Pipeline variant, the capital cost is $2.25 billion, including the construction of a 20" twin line between Zama to Edmonton at a cost of $650 million. The operating cost from Beaufort to Edmonton is estimated to be 145 per cent of the Short Pipeline operating cost between Beaufort and Zama. Given the low throughput of scenario 8, excess capacity may occur in the Edmonton-Chicago line; therefore the tariff is increased from 60¢ (full capacity assumption in previous pipeline scenarios) to 71¢ (Edmonton-Chicago tariff in 1981).

The Joint Industry Task Force would point out that only a portion (about 20 per cent) of the Rainbow Pipeline would need to be looped and only after the excess capacity of the Rainbow pipeline has been used up during the early years of Beaufort production. In addition a parallel line would benefit from efficiency gains during the operating phase (use of common manpower and materials between the Rainbow and twin pipeline). These possible savings were not accounted for in the cost estimates of the Extended Pipeline.

Pipeline specifications and costs are listed in Table 2. Annual capital and operating costs are indicated in Tables 3a (Short Pipeline) and 3b (Extended Pipeline).

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[1]All costs are expressed in 1981 dollars, unless specified.

TABLE 2

PIPELINE SPECIFICATIONS AND COSTS

SCENARIO #8 - 20" MACKENZIE PIPELINE

($MM 1981)

SPECIFICATIONS	Short Pipeline	Extended Pipeline
- Length (km (mi)) Total	1,493 (928)	2,250 (1,400)
- above ground	-	-
- buried	1,493 (928)	2,250 (1,400)
- Line size (mm (in))	508 (20)	508 (20)
- No. of pump stations	16	24
- Construction time (yrs)	3	4
CAPITAL COST		
- Land	7	10
- Pipeline	645	901
- Stations	260	363
- Terminal	24	33
- O&M Facilities	90	126
- Logistics & Support	100	140
- Construction camps	82	114
- Freight	27	38
TOTAL DIRECT	1,235	1,725
- Pre-permit Costs	9	13
- Engineering	90	126
- O&M Prior to Service	12	17
- Regulatory Costs	18	25
- Owner Costs	36	50
- Contingency	210	294
TOTAL INDIRECT	375	525
- Total (Ex. AFUDC)	1,610	2,250
(Inc. AFUDC)	1,857	2,580
OPERATING COST		
@ PEAK RATE		
- Energy	29	42.0
- Maintenance	7.2	10.4
- Admin., Insur., Indir. Taxes	26.4	38.4
TOTAL ANNUAL	62.6	90.8
CONFIDENCE LEVEL RATING OF COST DATA	2	2

Source: Joint Industry Task Force.

Table 3a

BEAUFORT SEA PIPELINE TRANSPORTATION - CAPITAL & OPERATING COST

LOW VOLUME PIPELINE SCENARIO #B (20" SHORT PIPELINE) ($ x 10^6 1981)

	Total	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Capital Expenditure (New Facility)																									
Mainline Pipeline (Beaufort/Zama/P/L) (excl. AFUDC)	1610	170	640	605	65	65	65																		
AFUDC	247	12	67	156	4	4	4																		
Total Capital Expenditure (Incl. AFUDC)	1857	182	707	761	69	69	69																		
Operating Cost (New Facility)																									
Energy Cost	564				5.5	14.5	22	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29
Labour	99				2	3	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Field Expense	44.1				1.1	1.5	1.9	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Administration	48.7				1.4	1.9	2.2	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Insurance	183.9				6	7.5	8.4	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Indirect Taxes	306.5				10	12.5	14	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Total Operating Cost	1246.2				26	40.9	52.5	62.6	62.6	62.6	62.6	62.6	62.6	62.6	62.6	62.6	62.6	62.6	62.6	62.6	62.6	62.6	62.6	62.6	62.6
Tariff - Zama/Edm/P/L	787.4				9.9	24.2	31.9	38	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2
- Edm/Chicago/P/L	1014.9				12.8	31.3	41.2	49	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8
Total Tariff	1802.3				22.7	55.5	73.1	87	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92	92
Total Annual Cost																									
Including AFUDC	4905.5	182	707	761	117.7	165.4	194.6	149.6	154.6	154.6	154.6	154.6	154.6	154.6	154.6	154.6	154.6	154.6	154.6	154.6	154.6	154.6	154.6	154.6	154.6
Excluding AFUDC	4658.5	170	640	605	113.7	161.4	190.6	149.6	154.6	154.6	154.6	154.6	154.6	154.6	154.6	154.6	154.6	154.6	154.6	154.6	154.6	154.6	154.6	154.6	154.6
Throughput (M BOPD)					50	120	160	190	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
(MM BPY)	1430				18	44	58	69	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73

Table 3b

BEAUFORT SEA PIPELINE TRANSPORTATION - CAPITAL & OPERATING COST

LOW VOLUME PIPELINE SCENARIO #8 (20" EXTENDED PIPELINE) **($ x 10^6 1981)**

	Total	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Capital Expenditure (New Facility)																									
Mainline Pipeline (Beaufort/Edm. P/L) (excl. AFUDC)	2250	238	894	845	91	91	91																		
Total AFUDC	330	17	92	203	6	6	6																		
Total Capital Expenditure (Incl. AFUDC)	2580	255	986	1048	97	97	97																		
Operating Cost (New Facility)																									
Energy Cost	817.8				8	21	32.8	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0
Labour	143.6				2.9	4.4	6.7	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Field Expense	63.9				1.6	2.2	2.8	2.9	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
Administration	70.6				2	2.7	3.2	3.2	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Insurance	266.7				8.7	10.9	12.2	12.2	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1
Indirect Taxes	444.4				14.5	18.1	20.3	20.9	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8
Total Operating Cost	1807.0				37.7	59.3	78.0	88.4	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8
Tariff - Edm/Chicago/P/L	1014.9				12.8	31.3	41.2	49	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8	51.8
Total Annual Cost																									
Including AFUDC	5401.9	255	986	1048	147.5	187.6	216.2	137.4	142.6	142.6	142.6	142.6	142.6	142.6	142.6	142.6	142.6	142.6	142.6	142.6	142.6	142.6	142.6	142.6	142.6
Excluding AFUDC	5071.9	238	894	845	141.5	181.6	210.2	137.4	142.6	142.6	142.6	142.6	142.6	142.6	142.6	142.6	142.6	142.6	142.6	142.6	142.6	142.6	142.6	142.6	142.6
Throughput (M BOPD)					50	120	160	190	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
(MM BPY)	1430				18	44	58	69	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73

The general methodology for calculating financial tariffs and economic transportation costs for scenario 8 is essentially similar to the one applied to preceding pipeline scenarios (Sections 5 and 6 of the report).

2. Financial Transportation Tariffs

As indicated in Table 4, the average discounted financial tariffs to deliver oil to Chicago vary between $5.28 (Short Pipeline) to $6.41 (Extended Pipeline).

Tables 5 and 6 display the annual "traditional" tariffs and wellhead prices respectively. Under both variants, the 20" pipeline scenario allows a higher wellhead price in the early years than any other scenario, leaving potentially more money for oil producers and the federal government.

3. Economic Transportation Costs

Tables 7 & 8 display the total and unit economic costs respectively, under both variants. Table 9 shows employment and wages & salaries. The economic unit cost of the 20" pipeline varies between $4.77 (Optimistic)[1] and $6.17 (Conservative)[2], ranking very close to the 36" Mackenzie pipeline and far ahead of the alternative pipeline and marine scenarios considered in this study.

4. Conclusion

On the basis of preliminary data the 20" pipeline scenario (Short or Extended) appears quite attractive, particularly since lower reserves than initially forecast are likely to be proven. The small pipeline is also expandable by looping.

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[1]Indirect labor benefits included
[2]Indirect labor benefits excluded

TABLE 4

UNIT FINANCIAL TARIFFS TO MOVE OIL TO MARKET

(Discounted* 1981 dollars per barrel)

LOW VOLUME SCENARIO #8 - 20" MACKENZIE PIPELINE

SCENARIO	NEW FACILITIES ONLY	NEW AND EXISTING FACILITIES
Extended Pipeline	5.70	6.41
Short Pipeline	4.02	5.28

*Discounted at a real rate of 10%.

TABLE 5

ANNUAL TRADITIONAL TARIFF TO MOVE OIL TO MARKET

(Constant 1981 dollars per barrel)

LOW VOLUME SCENARIO #8 - 20" MACKENZIE PIPELINE

	EXTENDED PIPELINE	SHORT PIPELINE
1990	25.79	19.16
1991	11.08	8.63
1992	8.64	6.85
1993	7.32	5.96
1994	6.54	5.38
1995	6.12	5.08
1996	5.74	4.81
1997	5.40	4.56
1998	5.09	4.33
1999	4.81	4.13
2000	4.54	3.94
2001	4.31	3.77
2002	4.10	3.62
2003	3.91	3.48
2004	3.74	3.36
2005	3.59	3.25
2006	3.45	3.15
2007	3.33	3.06
2008	3.22	2.98
2009	3.12	2.91
2010	3.04	2.85

TABLE 6

WELLHEAD PRICE NET OF TRANSPORTATION[1]

(Constant 1981 dollars per barrel)

LOW VOLUME SCENARIO #8 - 20" MACKENZIE PIPELINE

	NEW OIL REFERENCE PRICE[2]	EXTENDED PIPELINE	SHORT PIPELINE
1990	39.22	13.43	20.06
1991	40.00	28.92	31.37
1992	40.80	32.16	33.95
1993	41.62	34.30	35.66
1994	42.45	35.91	37.08
1995	43.30	37.18	38.22
2000	47.81	43.27	43.87
2005	52.78	49.19	49.53
2010	58.28	55.24	55.43

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[1] The Wellhead price (before taxes and royalties are paid) is the oil price at point of destination less transportation cost to market.

[2] Carin Study New Oil Reference Price adjusted for a real increase of 2% after 1984 rather than after 1981.

TABLE 7

ECONOMIC TRANSPORTATION COSTS - TOTAL

(Undiscounted $MM 1981)

LOW VOLUME SCENARIO #8 - 20" MACKENZIE PIPELINE

	Private Transportation Costs (2)	Private Costs Plus 2% Annual Escalation of Fuel Prices (3)	Corpor. Taxes Minus Subsidies, Plus Duty, Plus Interest (4)	Foreign Exchange Premium (5)	Direct Labour Benefit (6)	Indirect Labour Benefit (7)	Conservative Economic Transportation Costs (3)-(4)+(5) -(6)	Optimistic Economic Transportation Costs (3)-(4)+(5) -(6)-(7)
SCENARIO #8								
- EXTENDED PIPELINE	5,402	5,665	534	57	114	100	5,074	4,974
- SHORT PIPELINE	4,906	5,087	670	51	126	71	4,342	4,271

TABLE 8

ECONOMIC TRANSPORTATION UNIT COSTS

(Discounted $1981)

LOW VOLUME SCENARIO #8 - 20" MACKENZIE PIPELINE

	Present Value of Cumulated Throughput (Millions of Barrels)	Present Value of Conservative Economic Costs ($MM 1981)	Present Value of Optimistic Economic Costs ($MM 1981)	Conservative Economic Transportation Unit Cost ($ 1981)	Optimistic Economic Transportation Unit Cost ($ 1981)
	(1)	(2)	(3)	(2)/(1)	(3)/(1)
SCENARIO #8					
- EXTENDED PIPELINE	253	1,562	1,513	6.17	5.98
- SHORT PIPELINE	253	1,241	1,208	4.91	4.77

TABLE 9

EMPLOYMENT AND WAGES & SALARIES

LOW VOLUME SCENARIO #8 - 20" MACKENZIE PIPELINE

	WAGES & SALARIES (including suppl. benefits)[1] ($ x 10^6)	TOTAL EMPLOYMENT (Man-year)
SHORT PIPELINE		
Total	423	6,698
Construction	300	4,110
Operation	123	2,588
EXTENDED PIPELINE		
Total	633	9,495
Construction	419	5,740
Operation	179	3,755

[1]Wages & salaries per man-year and skill distribution are the same as in pipeline scenarios 1, 4 and 7.

10. CONCLUSION

In terms of financial tariff and economic efficiency, the Mackenzie pipeline scenarios #8 (20" Short), #1 (36") and #8 (20" Extended) show the best performance of all the options. In view of the smaller oil reserves required by a low volume pipeline, relative to a high or medium volume option, the 20" low volume pipeline scenario (Short or Extended) appears quite attractive.

At a high volume of throughput, the pipeline creates greater industrial benefits than corresponding marine modes e.g. lower financial and economic transportation costs, greater Canadian material content and marginally stronger economic impacts in all regions, except Nova Scotia.

For a medium throughput, the relative merits of a pipeline are not as clear cut. While the Dempster 36" pipeline appears better than the marine cases in the areas of economic efficiency, Canadian material content, and key national and regional impacts, it has no clear edge in financial tariffs and would be less attractive to Nova Scotia in terms of economic impact relative to a domestic marine option. The elevated 30" Mackenzie pipeline ranks last on financial tariff, ties with the marine scenarios on economic efficiency but outperforms the marine mode on Canadian material content. Therefore, one cannot dismiss at this time the relative merits of a medium volume domestic marine nor a 30" Mackenzie pipeline scenario. In addition the question of buried 20"-30" pipelines would have to be resolved.

If a marine scenario were to be selected, Canada would be as well if not better off with a domestic yard relative to a tanker import scenario, irrespective of the volume of production considered in the study. While financial and efficiency costs are about equal between the foreign and Canadian marine scenarios, greater output and employment would be generated in Canada by a Nova Scotia VLCC yard. The risk of Surplus capacity following the fulfillment of the Beaufort demand could be very high.

Given the uncertainty associated with the study's assumptions, economic efficiency costs were tested for their sensitivity with respect to changes in a few key variables. These tests show that relative to the marine scenarios, pipeline unit economic costs would be more sensitive to capital cost overruns and lower discount rates but would be less sensitive to operating cost overruns, lower fuel prices and higher discount rates. Unit costs among domestic marine scenarios would be neither sensitive to domestic tanker capital cost overruns, nor low cost foreign financing.

Considerable uncertainties remain associated with the Beaufort project including the level of oil reserves, field location and price, the magnitude, timing, pace and cost of the project, the system design associated wth both the development and transportation phases, Beaufort oil markets, the project's financibility, the state of the economy and constitutional developments in the North. While deficiencies have been identified by the Federal Environmental Assessment Review Panel regarding the Environmental Impact Statement submitted by the project's proponents, valuable information have been presented by the private sector and the Carin study on the possible socio-economic and environmental effects of Beaufort development and transportation.

While far from being definitive, the results of our study should provide useful insight in selected key elements affecting the relative industrial benefit merits of alternative Beaufort transportation Scenarios.