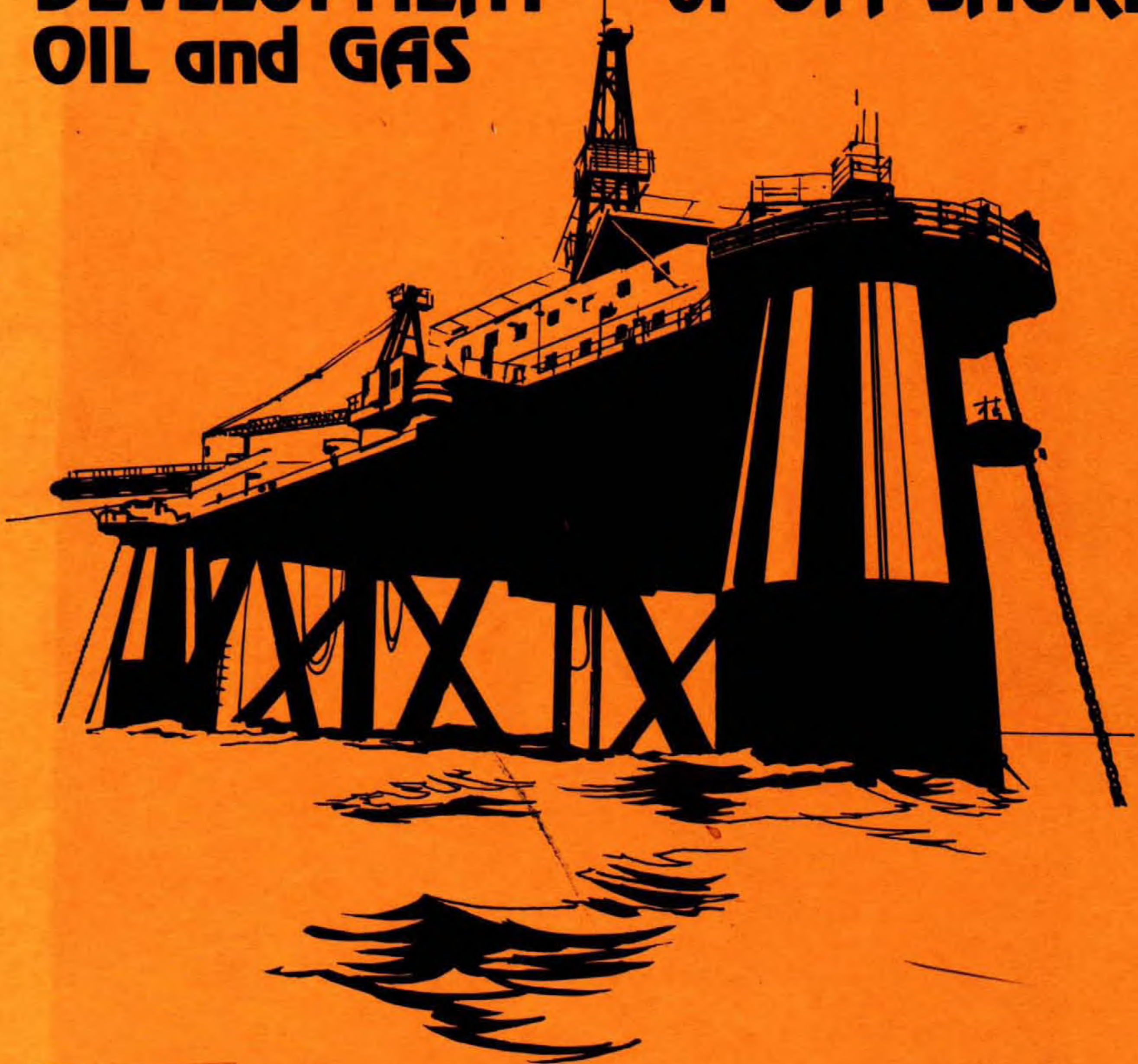
The IMPACT on the REGIONAL ECONOMY of EASTERN CANADA RESULTING from the POTENTIAL DEVELOPMENT of OFF-SHORE OIL and GAS



THE IMPACT ON THE REGIONAL ECONOMY OF EASTERN CANADA RESULTING FROM THE POTENTIAL DEVELOPMENT OF OFFSHORE OIL AND GAS

of offshore oil & gas

SUMMARY OF A
STUDY PREPARED BY
E.I.U. CANADA LTD.
TORONTO

FOR

DEPARTMENT OF REGIONAL ECONOMIC EXPANSION
DEPARTMENT OF ENERGY, MINES AND RESOURCES

Summary Report Prepared in
Consultation with E.I.U. Canada Ltd.
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This report summarizes the findings and conclusions of a study carried out by E.I.U. (Economist Intelligence Unit) Canada Ltd. for the Departments of Regional Economic Expansion and Energy, Mines and Resources, Ottawa. Its results do not necessarily represent the views of the departments concerned.

TABLE OF CONTENTS

GENERAL SUMMARY AND CONCLUSIONS

In this report, the physical nature of an off-shore play is described and the relevant Canadian experience noted. The future market situation and anticipated price structure for oil and gas are also investigated. The North Sea oil and gas play is described for comparison purposes, and the potential economic impacts on the Atlantic Region are analyzed.

The descriptions, comparisons and analyses give strong indications as to what might result from the discovery and exploitation of off-shore oil or gas in the Atlantic Region. Three important conclusions are reached:

A) The greatest employment impact occurs during the exploration and construction stages of an oil or gas play.

B) The direct impact on employment in the Atlantic Region of commercial production of either oil or gas will not be great. At the production stage, the employment is very small.

C) Off-shore oil will not be cheap. Production of Canadian off-shore oil and its share of future markets will depend upon its cost and the quantities discovered relative to the comparative position of alternative supplies.

These conclusions will have important implications in planning industrial strategies for the Atlantic Region.

North American demand for crude oil and natural gas is increasing and new continental reserves are not being found at the same rate as demand is increasing. In this light, a new source of oil or gas from Eastern Canada would be most desirable as a stimulus to regional development and as an addition to Canada's energy resource position. However, at this time the Atlantic off-shore oil and gas play does not appear to rate as a high priority for the international oil companies. The off-shore area has been sparsely explored to date, for only 31 wells have been drilled in an area of 190,000 square miles off the east coast.

The minimum crude oil reserve necessary for development is about 100 million barrels except off the Labrador coast, where as much as 2 billion barrels may be required before development occurs. The minimum gas reserve necessary for development would appear to be between 12 and 25 trillion cubic feet depending on location. It is anticipated that the minimum expenditures in the east coast off-shore area will be about $50 million in 1972, rising to a minimum of about $90 million annually by 1975.

If a commercial discovery is made, the first stage of development will depend largely on imported equipment. If the off-shore play expands and is of longer duration, a potential exists for local involvement in the manufacturing sector.

The international oil and gas industry, and the service companies that depend upon it, move their activities, men and equipment around the world from exploration play to exploration play. When a find is made, specialized equipment is required to evaluate and develop the oil or gas field. The duration of the work and the highly specialized nature of the equipment used usually constitute a very high barrier to the entry of local companies. This does not mean that there is no opportunity for local involvement in the Atlantic Region. On the contrary, there appears to be a good potential for local companies to fabricate drilling rigs and production platforms, manufacture some components, and supply many of the services to the oil and gas industry. In all cases, the potential for local manufacturing and services will be good provided that the products are price competitive, of satisfactory quality, and are delivered on time.

The best potential lies in shipbuilding and in manufacturing associated with shipbuilding. In addition, it is recognized that the east coast off-shore activity is in a frontier zone. The inhospitable environment dictates that new technology and different operating procedures will be necessary if oil or gas are produced in commercial quantities. In this respect, the Atlantic Region has an opportunity to lead in the development of new technologies that may become standard as the industry moves into increasingly difficult environments all over the world.

It is emphasized that the conclusions reached in this report related only to the impact of potential off-shore oil and gas developments in the Atlantic Region. The report does not therefore concern itself with those other sectors of the oil industry that are involved in the trans-shipment or refining of crude oil, whose investment decisions for plants in the Atlantic Region are not predicated upon the availability of off-shore oil. However, if off-shore oil is developed, it could displace some of the foreign crude presently being refined in Eastern Canada. In this report, "off-shore oil" refers to oil that may be produced from the continental shelf areas off Canada's east coast. This is not to be confused with the expression as it is often used by the oil industry. To oil companies, off-shore oil also refers to crude oil imported from foreign sources by tanker.

CHAPTER 1

INTRODUCTION

The Problem.- There have been considerable discussions on the potential development of an oil and gas industry in the Atlantic Provinces, and on the anticipated economic impact that this could have on the Region. The absence of reliable data has resulted in considerable differences of opinion regarding the economic implications of such an industry.

This document summarizes the results of a study by the Economic Intelligence Unit (Canada) Ltd., that was commissioned by the Canada Departments of Regional Economic Expansion [DREE] and Energy, Mines and Resources [EMR]. DREE required the study because of its commitment to the reduction of regional disparities. EMR's need was due to its responsibility for the management of oil and gas exploration and development. This report contributes to the factual information and informed judgements that are necessary background for effective Federal-Provincial planning to maximize the Atlantic Region's benefits from oil and gas developments.

The Economic Intelligence Unit (Canada) Ltd. collated the various elements that constitute the Atlantic oil and gas play, and analysed them to provide answers to the following questions:

(1) What are the threshold reserves necessary for development?

(2) Where will the products be marketed?

(3) How many jobs will be created in the exploration, construction and production phases?

(4) Where will the jobs be concentrated if they are created?

(5) How much expenditure will be incurred in the region, and how will it be distributed?

(6) What are the industrial opportunities that may arise in the region?

Data.- The data for the study were collected from various sources. The most important of these were the oil companies that have already been involved in both off-shore and on-shore oil and gas exploration in the Region. A great deal of the data collected were from individual companies and are confidential. Therefore, this summary highlights the significant findings of the study.

Assumptions.- The study utilized the following assumptions as constraints in its analysis:

(1) Federal Government policies with respect to oil and gas remain unchanged.

(2) Potential production comes from a single location, spotted approximately in the centre of one of the four active off-shore areas analysed.

(3) The size of the resource would be minimum threshold, medium or large, and the magnitude of each would depend on location.

(4) Timing - in the period 1972 to 1985.

Methodology.- Based upon published data, data furnished by oil and gas companies and on professional judgement, a series of simulated oil and gas discoveries were postulated and then analysed to determine their economic impact. For example: one simulation assumes a minimum threshold reserve of 100 million barrels of oil discovered on the Scotian Shelf in late 1972 with production starting at 30,000 barrels per day in 1977. In addition, exploration rigs are built, a production platform is imported, and supply vessels are built in Nova Scotia and New Brunswick in 1973 and 1974.

Outline of Study.- Chapter 2 sets out the significant findings of the study as they relate to the potential for employment in the Atlantic Region, while Chapters 3 to 6 summarize the supporting technical and economic data used to assess the economic impact of a potential oil and gas industry in the Atlantic Region.

CHAPTER 2

THE POTENTIAL IMPACT ON THE ATLANTIC REGION

(a) Introduction

The study was carried out in two complementary parts, namely a detailed physical analysis of the off-shore play, and an economic impact analysis. The impact analysis was based on a number of simulations of possible situations that may occur in the future. Each major area of exploration activity was covered separately. The figures quoted in this report concerning employment and spending are indications of magnitude rather than actual anticipated figures.

Each simulation runs for 14 years. In all cases, production continues beyond the period studied. The total impact of production employment is, therefore, not fully calculated over the lives of the simulated oil or gas fields.

Direct employment in this report is to be considered as employment that is closely related to the exploration, construction and production activities of the oil and gas industry. It does not include employment in the secondary or service sectors or employment associated with the spending of wages paid to industry employees.

(b) Direct Employment Impact of a Development on the Scotian Shelf

Any oil or gas development on the Scotian Shelf will have its greatest impact on Nova Scotia, for most operations will be based out of Halifax. Table 1 shows the employment created by finds of differing sizes and types, and by year. Thus, it is possible to compare the magnitude and duration of direct employment opportunities and to compare the impact on employment of different types of development.

TABLE 1

DIRECT EMPLOYMENT IMPACT FOR SIMULATED 14 YEAR DEVELOPMENTS ON THE SCOTIAN SHELF

Year*	Direct Employment in Hundreds				
	Minimum Oil	Medium Oil	Major Oil	Minimum Oil	Major Oil
1	8	8	9	6	11
2	23	23	23	23	31
3	22	22	39	21	31
4	13	48	38	17	38
5	10	29	78	14	59
6	6	21	57	44	64
7	4	22	29	32	32
8	2	15	29	15	48
9	x	9	24	9	29
10	x	4	17	4	21
11	x	4	14	4	22
12	x	1	9	4	11
13	x	1	5	4	7
14	x	1	3	4	5

* - Year 1 is the year of discovery,which in simulations was taken to be 1972.

x - Very small.

Note: Due to rounding, column totals may not add to those shown in Chapter 6.

From Table 2, a number of important points should be noted. The major oil and gas developments generate the most employment, but it will be seen that the employment generated is neither large nor of great duration.

The long term, or production, employment as shown in the later years for each simulation indicates that at best only some five hundred jobs will be created. The years of greatest employment are those when both exploration and construction activity take place.

TABLE 2

PERCENTAGE DISTRIBUTION OF DIRECT EMPLOYMENT BY ACTIVITY AND PROVINCE - 14 YEAR SCOTIAN SHELF DEVELOPMENT

Activity and Province	Percentage Distribution of Direct Employment				
	Minimum Oil	Medium Oil	Major Oil	Minimum Gas	Major Gas
Exploration	71.4	61.5	51.5	39.7	47.2
Construction	26.6	36.4	42.0	44.1	43.5
Production	2.0	2.1	6.6	16.2	9.3
Nova Scotia	63.0	66.4	70.4	61.3	67.7
New Brunswick	15.2	14.6	16.5	27.4	19.6
P.E.I.	4.4	3.3	1.9	2.3	1.8
Newfoundland	17.2	15.7	11.2	9.0	10.8

From the simulations for the Scotian Shelf that were analysed, it may be noted that in oil developments, exploration activity creates the most employment whilst in the case of gas, exploration and construction employment are more in balance. This is due to the fact that gas developments require pipelines from the gas field to the market, whereas oil is unlikely to be moved by pipeline except in the case of larger developments. From the data in Table 2, it may also be noted that in every case the majority of employment goes to Nova Scotia.

(c) Direct Employment Impact of a Development in the Gulf of St. Lawrence

A commercially viable oil or gas discovery in the Gulf of St. Lawrence would have its greatest impact upon the Provinces of Prince Edward Island and New Brunswick. It has been assumed that a pipeline would come ashore in one of these Provinces, but it is also possible that a pipeline landfall from a development in the Gulf could be in Quebec or in Nova Scotia. The direct employment impact of finds varying in size and type is shown in Table 3.

TABLE 3

DIRECT EMPLOYMENT IMPACT FOR SIMULATED 14 YEAR DEVELOPMENTS IN THE GULF OF ST. LAWRENCE

	Direct Employment in Hundreds				
Year*	Minimum Oil	Medium Oil	Major Oil	Minimum Gas	Major Gas
1	8	8	11	8	14
2	23	22	37	23	37
3	22	32	43	21	52
4	13	47	55	26	46
5	10	28	64	17	62
6	6	19	53	31	56
7	7	24	33	32	42
8	2	15	27	14	39
9	x	9	22	8	39
10	x	3	15	3	19
11	x	3	12	3	20
12	x	1	7	3	10
13	x	1	3	3	6
14	x	1	1	3	4

* - Year 1 is the year of discovery which in simulations was taken to be 1972.

x - Very small.

Note: Due to rounding, column totals may not add to those shown in Chapter 6.

The most significant conclusion to be drawn from these data is that employment generated as a result of commercial off-shore developments is not large, it fluctuates quite widely, and falls off rapidly once production is reached. Production employment (i.e. year 14 figures in this case) shows a maximum of only 400 jobs. The year of greatest employment is year 5 in the cases of both major oil and major gas, but here again, employment created is not great at over six thousand.

The data in Table 4 below support the conclusion drawn previously as to the small number of production jobs created. Here, it can be noted that in only one case does production employment exceed ten per cent of total created employment. Once more, the heavy pipeline construction costs appear in all but the minimum oil simulation (where no pipeline is used). The most employment created in all cases goes to New Brunswick, usually followed by Prince Edward Island, which consistently attracts about one quarter of the jobs created.

TABLE 4

PERCENTAGE DISTRIBUTION OF DIRECT EMPLOYMENT BY ACTIVITY AND PROVINCE - 14 YEAR GULF OF ST. LAWRENCE DEVELOPMENT

Activity and Province	Percentage Distribution of Direct Employment				
	Minimum Oil	Medium Oil	Major Oil	Minimum Gas	Major Gas
Exploration	72.5	58.5	50.1	40.9	43.2
Construction	25.6	39.5	47.6	48.6	50.6
Production	1.9	2.1	2.3	10.4	6.2
Nova Scotia	26.3	22.6	18.1	12.2	18.4
New Brunswick	33.2	38.6	44.5	58.1	45.4
P.E.I.	23.9	23.1	25.4	22.1	25.1
Newfoundland	16.6	15.8	11.9	7.6	11.1

(d) <u>Direct Employment Impact of Development on the Grand Banks</u>

The Grand Banks are situated closest to the Province of Newfoundland. In addition, the Laurentian Trench in the ocean floor between Newfoundland and Nova Scotia is an insuperable barrier to pipelining at the present state of technology. Therefore, any pipeline from the Grand Banks must make landfall in Newfoundland, and in the case of gas, must traverse the Island and cross to the north shore of the Gulf of St. Lawrence. Thus, Newfoundland would receive the bulk of the employment created by an offshore development.

A further item to note is that in the simulations, the minimum and major gas developments were the same. The basis for this assumption was predicated on the minimum quantity of gas reserves necessary to justify a pipeline. So great was this economic minimum that it became a major gas find by industry standards. This emphasizes the fact that in "frontier" areas such as the Grand Banks, only massive gas reserves are of real interest to the companies involved at present.

As in the cases of the Scotian Shelf and the Gulf of St. Lawrence, the Grand Banks case once more demonstrates that after a brief flurry of activity, the employment created by oil and gas developments tails off dramatically to almost insignificant amounts when the production phase is reached (Table 5). The gas development simulation in this region is the heaviest generator of employment, but it should be remembered that the reserve requirements are also greater than on the Scotian Shelf, or in the Gulf of St. Lawrence. In the gas case, however, the greatest employment generated is less than nine thousand, occurring in year 7.

TABLE 5

DIRECT EMPLOYMENT IMPACT FOR SIMULATED 14 YEAR DEVELOPMENTS ON THE GRAND BANKS

Year*	Direct Employment in Hundreds			
	Minimum Oil	Medium Oil	Major Oil	Minimum/ Major Gas
1	7	7	17	17
2	24	38	38	47
3	22	30	52	42
4	13	52	46	44
5	10	36	73	61
6	6	19	59	51
7	4	18	35	89
8	2	15	29	51
9	x	9	22	30
10	x	4	15	26
11	x	4	12	15
12	x	1	7	11
13	x	1	3	7
14	x	1	1	5

* - Year 1 is the year of discovery which in simulations was taken to be 1972.

x - Very small.

Note: Due to rounding, column totals may not add to those shown in Chapter 6.

It can be seen from Table 6 that the value of construction activity, as an employment generator, is most important in all but the minimum oil simulation. Again, production employment is not very large. In the distribution of jobs in the Atlantic Region, Newfoundland benefits considerably in each case.

TABLE 6

PERCENTAGE DISTRIBUTION OF DIRECT EMPLOYMENT BY ACTIVITY AND PROVINCE - 14 YEAR GRAND BANKS DEVELOPMENT

Activity and Province	Percentage Distribution of Direct Employment			
	Minimum Oil	Medium Oil	Major Oil	Minimum/ Major Gas
Exploration	70.2	54.4	48.5	40.0
Construction	28.0	43.7	49.3	53.7
Production	1.9	1.9	2.2	6.3
Nova Scotia	26.9	23.1	17.3	12.4
New Brunswick	15.2	15.1	12.7	15.9
P.E.I.	4.3	2.9	2.0	2.0
Newfoundland	53.5	58.9	68.0	69.7

(e) <u>Direct Employment Impact of Exploration But Development.</u>

Based upon simulated exploration activity on the Scotian Shelf, in the Gulf of St. Lawrence and on the Grand Banks, it is assumed that after a number of years of unsuccessful drilling, the exploration companies retire from the area.

It will be seen from Table 7 that the greatest direct employment level reached is only 1300, and that activity ceases after seven years. In Table 8, it will be seen that the bulk of the employment created falls in Nova Scotia and Newfoundland. In all cases, the employment impact is rather small.

TABLE 7

DIRECT EMPLOYMENT IMPACT FOR SIMULATED EXPLORATION ACTIVITY WITH NO DEVELOPMENT

Year*	Direct Employment in Hundreds
1	9
2	9
3	13
4	13
5	8
6	4
7	2
8	0
9	0
10	0
11	0
12	0
13	0
14	0

* - Year 1 is taken to be the first year of simulated exploration which in this case is assumed to be 1972.

Note: Due to rounding, column total does not add to that shown in Chapter 6.

TABLE 8

PERCENTAGE DISTRIBUTION OF DIRECT EMPLOYMENT BY ACTIVITY AND PROVINCE - EXPLORATION BUT NO DEVELOPMENT

Activity and Province	Percentage Distribution of Direct Employment
Exploration	100.0
Construction	0
Production	0
Nova Scotia	32.1
New Brunswick	14.7
P.E.I.	14.7
Newfoundland	38.5

(f) The Coast of Labrador Simulations

This series of simulations proved to be so totally different from those of the other areas that the standard analysis was not considered meaningful because commercial development is really beyond the time span considered. Three simulations were considered:

i) Exploration but no discovery,

ii) Oil strike (2 billion barrels by year 10), and

iii) Gas strike (10 trillion cubic feet by year 14 and eventually 20 to 25 trillion cubic feet).

In the exploration-no-discovery case, a maximum of two drilling rigs work in the area, but all activity ceases by year 7. Over 6 years of exploration, in which the weather limits drilling to only three months of each year, about one million dollars of wages are generated locally, the bulk of which would be in Newfoundland.

The oil and gas strikes must both be major to be commercially viable, and the technology for extraction in this hostile environment must also be developed. In the oil strike case, the decision to produce comes only after perhaps nine or ten years with production in year 14 or 15. In the exploration phase, some 2,500 man years of direct employment would be created of which the majority would be in Newfoundland.

The gas strike is assumed to occur in year 2, and by year 14 reserves may be proved of up to 10 trillion cubic feet. However, as reserves of 25 trillion cubic feet are needed to justify production, the decision to produce would not be made in the time span of the study. Once more, the largest part of the 3,500 man years of employment generated in a 14 year time period would go to Newfoundland.

(g) Direct Employment Impact of a Multiple Simulation

All simulations described previously have been somewhat static in that they predicate a discovery of a specific size in a specific location. In fact, this is not normally the experience, and one discovery often leads to increased exploration and thence to other discoveries. One multiple simulation was attempted in order to give an indication of what impact a dynamic simulation might have (Table 9). The simulation saw a minimum oil find on the Scotian Shelf, followed by a major gas find on the Grand Banks, and later by another minimum oil find on the Scotian Shelf.

TABLE 9

DIRECT EMPLOYMENT IMPACT FOR SIMULATED 14 YEAR MULTIPLE DEVELOPMENT

Year*	Direct Employment in Hundreds in Multiple Simulation	Type and Year of Discovery
1	8	Minimum Oil Find
2	23	
3	22	
4	13	
5	21	Major Gas Find
6	49	
7	42	
8	44	
9	53	
10	65	Minimum Oil Find
11	97	
12	55	
13	37	
14	33	

* - Year 1 is the year of initial discovery which in multiple simulation was taken to be 1972.

NOTE: Due to rounding, column totals may not add to those shown in Chapter 6.

The multiple simulation shows a far more consistent direct employment pattern than have most of the other simulations, but it should be noted that even in this case, the maximum direct employment generated is less than ten thousand jobs in year 11, and it falls dramatically in the following year.

From the data in Table 10 below, it may be noted that production employment is very small indeed. The provincial distribution of direct employment is affected by the nature of the simulation where the Grand Banks gas find dominates the picture and hence favours Newfoundland. Therefore, the provincial distribution should not be taken to indicate a typical pattern of all multiple simulations in the off-shore area.

TABLE 10

PERCENTAGE DISTRIBUTION OF DIRECT EMPLOYMENT BY ACTIVITY AND PROVINCE - 14 YEAR MULTIPLE SIMULATION

Activity and Province	Percentage Distribution of Direct Employment in Multiple Simulation
Exploration	43.3
Construction	54.5
Production	2.2
Nova Scotia	27.8
New Brunswick	18.3
P.E.I.	2.0
Newfoundland	51.9

(h) Indirect Employment Impact in the Atlantic Region

Thus far, only the direct employment created by the off-shore oil and gas industry has been considered.

In these simulations the direct jobs are defined as those occurring on the drilling rigs, on the supply vessels, in the shipyards and in occupations where the wages and salaries can be said to have come directly from the off-shore industry. This is the major and immediate impact on the economy, but the expenditures by direct employees of the industry and by the industry itself also create jobs in the region. Thus, there may be more shop assistants needed, garages may hire more mechanics and more salesmen, hotels may increase their staff, and potentially most important of all, local manufacturers may begin to move into the production of parts and equipment for the industry and thereby reduce imports. This is the indirect sector.

The indirect employment created by oil and gas developments was not determined for every one of the simulations described previously. It was, however, calculated in terms of man years of indirect employment for five examples as shown in Table 11.

TABLE 11

MAN YEARS OF DIRECT AND INDIRECT EMPLOYMENT CREATED IN SELECTED SIMULATIONS

Simulation	Total Direct Employment in Hundreds of Man Years	Total Indirect Employment in Hundreds of Man Years	Indirect/ Direct %
Minor Oil Scotian Shelf	88	55	63.2
Minimum Gas St. Lawrence	200	124	61.9
Major Oil Grand Banks	408	254	62.1
Major Gas Grand Banks	495	328	66.2
Exploration No. Development	59	37	63.1
AVERAGE	-	-	63.3

In general, it may be assumed that the indirect employment created in the Atlantic Region will go largely to residents of the region, as opposed to the direct employment that went to non-local labour when the necessary skills were locally unavailable. The average of five simulations suggests that indirect employment is distributed initially in an almost identical pattern to the distribution of direct employment, and amounts to over sixty per cent of direct employment.

An apparent conclusion is that local entrepreneurs and manufacturers must be encouraged to enter this new field of activity in the full knowledge that in future, their major markets will be export oriented unless the Atlantic off-shore oil and gas play becomes a major significance in an international sense. Thus, a local manufacturer entering a new local market resulting from the off-shore oil play will have to compete in international markets if he is to survive when his local advantage is diminished at the production stage.

(i) <u>The Industrial Opportunities in the Atlantic Region</u>

The study clearly indicated that in the early stages of this oil and gas play, there is little local or regional ability to contribute significantly to the play. This situation changes for the better with time as local skills and expertise are developed. For the greatest impact on the region, it is therefore implicit that regional labour skills and manufacturing ability should be upgraded as high and as rapidly as possible. Local content regulations may artificially promote this improvement, but the benefit may be short lived unless all the aspects are competitive in the long run with international activity.

The industrial opportunities for the Atlantic Region in respect of the off-shore oil and gas industry lie in satisfying the present and future demands of the industry. Of prime importance is the ability of the region to attract the construction phase of any development, or as much of it as is possible. This in realistic terms comes down to three sectors, namely: rig and platform construction, supply vessel construction, and pipeline construction. The Halifax shipyard has now proved that rigs can be built, but imported steel is largely used.

In the broadest terms, it would appear that a regional facility to produce the desired steels for rig and platform construction, and for local pipe manufacturing could have a good potential. This, linked to the use of coal from the region, could make a significant contribution to the regional economy. An anticipated world shortage of large diameter steel pipe suggests that a regional facility on tidewater could enjoy better access to world markets, and also claim regional markets if they develop.

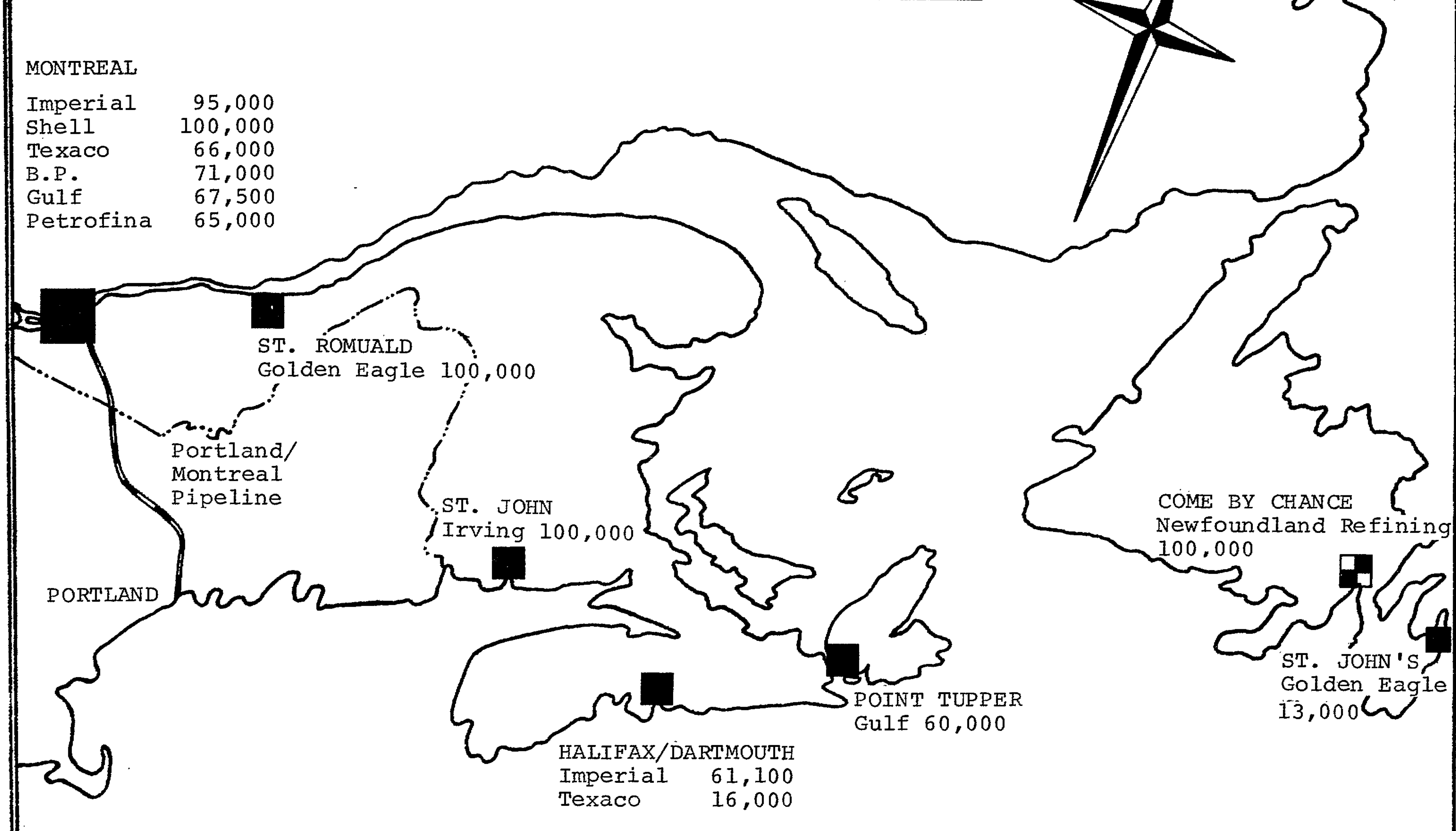
The Atlantic off-shore play is in a new and hostile environment, and commercial development would undoubtedly bring with it the need for new technology. The region in this instance would be on an equal footing with other areas of the world, and therefore "frontier technology" could become established in the region. Of particular importance would be problems of under-sea well completion, and extraction at depth in a cold sea with ice problems. Also, environmental research with an oil industry orientation is both relevant to the present and to the future situation. Regardless of whether oil is found in the off-shore area or not, the East Coast of North America will continue to receive ever increasing quantities of imported crude oil. The environmental implications of this suggest that a significant research and possibly manufacturing potential rests in the Atlantic Region.

Off-shore oil and gas is not anticipated to be cheap. Based on regional production, the petrochemical prospects for the region are poor. However, it is still possible that a petrochemical facility might be built on the basis of cheap imported feedstocks.

Service industries are an important part of the world oil and gas industry. Companies supplying drilling mud, well workover services and numerous other functions may be established by local entrepreneurs, but the field is both specialized and competitive. It is suggested that perhaps the best potential for local involvement is for local companies to go into partnership with existing companies, thereby bringing in the technical and marketing expertise to complement their own special abilities in the region. The assembly of service packages for production platforms could be accomplished regionally in this manner.

It is through the Atlantic Region's involvement in off-shore oil and gas plays leading hopefully to commercial production, that the nature of the industrial base of the region will be diversified. In so doing, the regional consumption pattern will change and dependency upon imports from outside the region could fall. This, in turn, could promote more investment in the region in industries totally unconnected with oil and gas, and could help to pave the way to greater self sufficiency and prosperity.

Refineries in Eastern Canada



Capacities in barrels per day

CHAPTER 3

THE MARKETS FOR OIL AND GAS

1. Introduction

The purposes of this Chapter are to outline the demand and price situations for oil and gas in Canada and the United States, to identify potential markets in these two countries for off-shore oil and gas, and to assess the international implications of an off-shore oil and gas discovery.

If commercial development of either oil or gas occurs in this off-shore area, then the principal consideration will be that for the first time Canadian markets would have a supply of domestic oil and gas originating in both the west and the east. The initial marketable threshold or reserves required to justify development is substantially higher in the case of gas than crude oil due to the fixed nature of a supply system, based entirely on pipelines.

The most logical markets for gas from the off-shore play would be in the New England States -- high priced, high density, established gas markets facing increasing supply pressures -- and these markets are physically closer and easier to reach than major Canadian markets. Depending on the volume of proven reserves, it seems logical that significant exports to the United States would be considered by the industry once the Montreal load had been established.

It is almost certain that off-shore oil or gas will not be cheap. The very nature of the play is predicated on expensive technology, the cost of which has to be recouped. In fact, oil and gas developed off-shore will face severe competition from existing sources of supply.

2. Oil Markets and Prices

(a) General.- The National Oil Policy (N.O.P.) Line established in 1961, divides Canada into two separate and quite distinct markets. East of the line, including the Provinces of Quebec, New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland, and the Ottawa Valley in Ontario, is supplied by imported crude and products.

The latest data on the major sources of imported crude oil for 1969 are set out in Table 12 below.

TABLE 12

IMPORTS OF CRUDE OIL INTO CANADA 1969

Country of Origin	000 Barrels per day	% of Total
Venezuela	345	66.2
Iran	44	8.4
Saudi Arabia	33	6.3
Trucial States	26	4.9
Nigeria	22	4.2
Kuwait	12	2.3
Libya	11	2.1
Trinidad	7	1.3
Other	21	4.0
Total Imports	521	100.0

The area west of the N.O.P. Line, including approximately 87% of total Ontario demand, and all the provinces west of Ontario, is supplied for the most part by Western Canada crude, with some product imports.

(b) Market for Crude Oil East of the National Oil Policy Line.- From 1960 to 1965, refinery capacity east of the N.O.P. Line increased at an average annual rate of 2.9%, whilst refinery production grew at 3.5% per annum, and demand grew at 7.7% per annum. The result of these differing rates of growth of domestic produce supply and demand was that imports of product grew at 15.6% per annum.

The period 1965 to 1970 saw demand increasing at approximately the same rate, 7.0% per annum, but refinery capacity grew 9.1% per year, and refinery production at 7.4% over the period. Thus, the growth rate of product imports fell to 5.3% per annum over the period.

By 1973, refinery capacity will be approximately 945 MB/d which is rather more than the expected domestic demand of 865 MB/d. Assuming a utilization rate of 92.0%, refinery production and domestic demand will be in balance. However, some 150 MB/d of refinery production will be designated to export markets, and about the same amount of domestic demand will be served by imported products.

Assuming that refining capacity grows at the same rate as domestic demand, total crude requirement would then be as shown in Table 13 below.

TABLE 13

ESTIMATED CRUDE OIL REQUIREMENT EAST OF N.O.P. LINE 1970-1985

Year	Crude Oil Requirement .000 Barrels Per Day
1970	726.9
1971	770.5
1972	816.7
1973	865.7
1974	917.6
1975	972.6
1976	1,026.1
1977	1,082.5
1978	1,142.0
1979	1,204.8
1980	1,271.1
1985	1,622.3

Assumptions: Average annual rates of growth in demand 1970-75, 6.0%. 1975-80, 5.5%. 1980-85, 5.5%.

Although there is no direct relationship between the acreage held, the possibilities of finding oil, and eventual production, the potential influence of the off-shore company on marketing possibilities can be demonstrated by showing companies' refining capacity and their off-shore acreage (Table 14).

TABLE 14

EASTERN CANADA REFINING CAPACITY AND OFF-SHORE ACREAGE, 1971

Company	Refining Capacity (MB/d)			Net Acreage (000's)		
	Quebec	Atlantic	Total	Gulf St. L.	Labrador	Total
Shell	100.0	-	100.0	47,369	-	47,369
Gulf	67.5	60.0	127.5	8,496	-	8,496
Texaco	66.0	16.0	82.0	9,238	-	9,238
Fina	65.0	-	65.0	-	-	-
B.P.	71.0	-	71.0	7,720	4,929	12,649
Golden Eagle	100.0	13.0	113.0	-	-	-
Imperial	95.1	61.1	156.2	23,720	10,792	34,512
Irving	-	100.0	100.0	-	-	-
Total	564.6	250.1	814.7	96,543	15,721	112,264
Total Permits Issued				224,690	56,587	281,277

(c) Market for Crude Oil West of the National Oil Policy Line in Ontario.- It is assumed that, in the event of a very large oil discovery off the Canadian East Coast, a portion of the region west of the N.O.P. Line, presently being served by Western Canada crude oil, would be displaced by East Coast crude. The area most vulnerable would be the Oakville-Toronto complex of refineries, while the Sarnia complex would probably continue to use western crude.

In the period 1960-1965, Ontario refining capacity increased at an average annual rate of 4.3%. Demand grew at 5.4%, and since there was considerable unused refinery capacity, production was able to grow at 7.9% per annum. Between 1965 and 1970, refinery capacity continued to grow at a slower rate than production, 2.6% versus 4.2%, while demand increased at a slower rate of 4.3% per annum.

The bulk of present demand in Ontario is supplied by Ontario refineries, in keeping with the spirit of the National Oil Policy. However, a certain portion has always been supplied from outside the Province, either from the Montreal refineries, or by product imports from abroad to meet the demand that is in excess of Ontario's refining capacity.

In projecting possible markets for East Coast crude, it is assumed that product imports into the Province will be at a rate roughly comparable to that of the immediate past. Thus, imports would increase from 46.9 MB/d in 1970, to 55.0 MB/d in 1975, rising to 80.0 MB/d in 1980, and to 105.0 MB/d in 1985.

If the entire Toronto-Oakville complex were supplied by East Coast crude oil, then the market for such from the off-shore area is projected to reach 232.8 MB/d in 1975, 281.1 MB/d in 1980, and 344.0 MB/d in 1985.

The estimated total demand for crude oil in Ontario west of the N.O.P. Line is shown in Table 15 below.

TABLE 15

ESTIMATED CRUDE OIL REQUIREMENT
IN ONTARIO WEST OF N.O.P. LINE
1970-1985

Year	Crude Oil Requirement 000 Barrels Per day
1970	417.9
1971	436.7
1972	456.3
1973	476.8
1974	498.2
1975	520.6
1976	542.9
1977	566.3
1978	590.7
1979	615.9
1980	642.3
1980	792.8

Assumptions: 1970-75 growth rate 4.5%. 1975-85 growth rate 4.3%.

(d) <u>The Market for Crude Oil in the United States.-</u>
A primary market for a major off-shore oil development will be the northern part of the United States, including all of U.S. Petroleum Administration (P.A.) District I with the exception of Florida, Georgia and Virginia, plus the State of Ohio in U.S. P.A. District II.

In this market area, there are at present seven refineries taking Western Canadian crude, five in Ohio and two in New York State. The latter, Ashland Oil in Tonawanda and Mobil Oil in Buffalo, obtain virtually their entire crude diet from Canadian sources. The Ohio refineries are not so dependent on Canadian crude, since U.S. authorities have until recently restricted imports of Canadian crude. That a higher proportion of their requirements will be supplied from Canadian sources can be anticipated, but it is difficult to predict whether off-shore oil from the East Coast would displace Western oil.

The demand for crude oil in U.S. P.A. Districts I and II is expected to increase over the years 1972-85 as shown in the following table.

TABLE 16

DEMAND FOR CRUDE OIL IN U.S. P.A. DISTRICTS I AND II 1970-1985

Year	U.S. P.A. District I	District II	Total Districts I and II
1970	1,253.0	450.0	1703.0
1971	1,303.1	468.0	1771.1
1972	1,355.2	486.7	1841.9
1973	1,409.4	506.2	1915.6
1974	1,465.8	526.5	1992.3
1975	1,524.4	547.6	2072.0
1976	1,577.7	566.8	2144.5
1977	1,632.9	586.6	2219.5
1978	1,690.0	607.1	2297.1
1979	1,749.1	628.3	2377.4
1980	1,810.3	650.3	2460.6
1985	2,098.3	753.8	2852.1

Assumptions: Rate of demand increase:

1970-75, 4.0%;
1975-80, 3.5%;
1980-85, 3.0%.

Most forecasts point to increasing dependence by the U.S. on foreign crude, mainly from the Middle East. The security of supply and price escalation elements are of great concern to U.S. energy policy-makers. Against this background, a new source from off-shore Eastern Canada would be welcome.

Oil from such a new source could also be shipped by tanker, thereby fitting into the existing supply pattern, and would be developed by the major U.S. companies for their own refineries. This presents a stable marketing background.

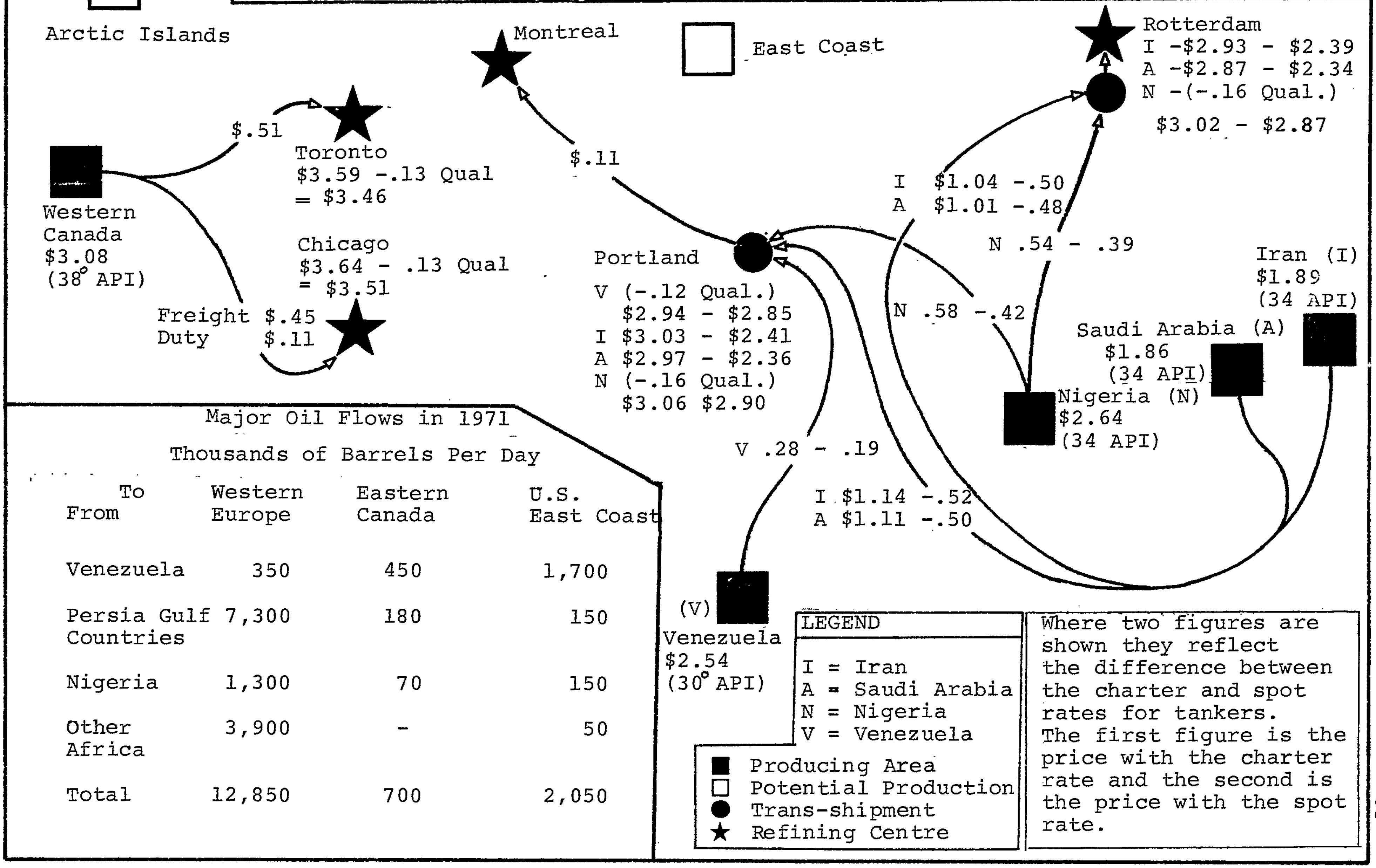
(e) Oil Prices.- Another international implication of the possible crude oil production is pricing. If off-shore crude oil were priced on the basis of North American crude oil prices, then Montreal might be regarded as the logical limit of extension. On the other hand, if off-shore oil were priced on an international basis, then off-shore oil might even move as far as Sarnia, displacing substantial volumes of Canadian crude oil production. Here, the implications for both commercial production and Canada's National Oil Policy become apparent.

The basis upon which crude oil prices would be established would depend largely on the size of the reserves discovered and hence the production rate. Production of one million barrels per day could satisfy the Montreal requirements, and most of the Atlantic Provinces refineries. In this instance, there is a strong possibility that the crude oil might be priced down towards international levels. If, on the other hand, production was below 100 thousand barrels per day, only a relatively small portion of Montreal requirements would be satisfied. Here, it is likely that East Coast oil would be priced on the basis of North American prices.

Based upon current prices, crude oil would probably land at a regional refinery at between $3.00 and $3.50/bbl. Thus, local refineries would not enjoy any overnight cost advantage by virtue of using off-shore oil. The actual value of off-shore oil will be affected by its own physical characteristics, such as gravity, and sulphur content.

The East Coast off-shore location is also favourable for major shipments to Europe, should reserves and producibility justify such a move.

1971 Crude Oil Supply & Prices In $ US/bbl



Major Oil Flows in 1971

Thousands of Barrels Per Day

To / From	Western Europe	Eastern Canada	U.S. East Coast
Venezuela	350	450	1,700
Persia Gulf Countries	7,300	180	150
Nigeria	1,300	70	150
Other Africa	3,900	-	50
Total	12,850	700	2,050

The influence of East Coast oil in European markets would, of course, depend on price considerations as well as on physical availability, but any new major source of crude oil in the Western Hemisphere must be regarded as a bargaining tool in negotiations with the OPEC countries.

(f) The Influence of the Organization of Petroleum Exporting Countries (OPEC)*.- Agreements reached at Teheran and Tripoli in 1971 by the Organization of the Petroleum Exporting Countries (OPEC) and the international oil companies, will raise the posted prices of crude oil over the period 1971-75. The price of a representative type of Middle East crude will rise by approximately 11 cents/barrel/year from $2.18 in February, 1971 to $2.615 in 1975. It can be assumed that the average annual rate of increase in price between 1971 and 1975 will represent the minimum demand, when negotiations are started in 1975, for price increases in subsequent years. Therefore, at this rate of increase it can be anticipated that the minimum price for a representative Middle East crude would be $3.22 in 1980.

Continued increases in prices and tax rates are not the only OPEC demands which the oil companies will have to face. OPEC's efforts are now being directed towards participation by host governments in the producing operations of the concessionaire companies. It is possible that nothing will come of this latest demand but this is unlikely. The stage may have been set by Algeria's nationalization of non-French producing companies and its takeover of a 51 per cent interest in French firms.

There is still disagreement among OPEC members about the initial level of participation that they should seek, but all agree that it is only the initial level which is being debated.

Iran envisages complete operational control by 1979 with present producers purchasing crude at export terminals from state companies. Venezuela has already passed legislation to ensure that all production facilities, and the oil and gas concessions, will be handed over in full working order to the state mainly in the period 1983-85.

*The OPEC countries are Abu Dhabi, Iran, Kuwait, Qatar, Saudi Arabia, Libya, Iraq, Algeria, Nigeria, Venezuela, and Indonesia.

The relevant point is that the role of the international oil companies is already in process of alteration. By 1985, most of the production in OPEC member countries will be under national control. The technology required for oil operations -- at least for land and shallow-water production -- is now within the competence of OPEC countries, or can be hired from other countries if needed.

(g) Venezuela: Price and Politics.- About two-thirds of the crude oil imported into Eastern Canada originates in Venezuela, while a similar proportion of total oil exports from Venezuela finds its way to the Eastern Seaboard of North America as a whole.

It may be postulated that any crude oil produced from the Eastern Canadian off-shore would have to be competitive with Venezuelan crude at the Eastern Seaboard. Venezuelan crude already has an established position in the U.S. market which may, for political reasons, present difficulties in regard to the free disposal of Canadian oil in that market. At the present time, Venezuelan crude falls in the range \$2.55 - \$2.95/barrel for a 35° A.P.I. crude landed at Portland.

The U.S. attitude to Venezuelan oil is conditioned by their preoccupation with security, but a change appears to be inevitable by reason of the increasingly nationalistic stance adopted by Venezuela concerning both the United States and the oil companies themselves. In this regard, Venezuela is not alone either in Latin American or among oil-exporting countries. Such as it is, the "special relationship" currently existing between the United States and Venezuela seems unlikely to endure, and there is no reason to believe that the substitution of a more frankly commercial relationship would be affected, except in its timing, by a greater availability of crude oil from across the Canadian border.

(h) Other National and International Implications.- The oil companies exploring for oil off-shore from Eastern Canada are, and will be, operating in conditions of increasing prices in the main oil exporting countries of the world, and of declining control over production. This is the positive side of the equation. The negative side is represented by the high costs involved in the East Coast play, including those caused by the need for technical innovation to cope with the particular conditions of the area. The relationship between the favourable and adverse factors will partly determine the extent and the timing of the Eastern Canadian oil play, and its impact upon the economies of the Atlantic Provinces.

The trend towards more national control by OPEC members does not leave the international oil companies without a role, for it is on them that the responsibility lies for the development of increasingly sophisticated techniques for use in more and more inaccessible parts of the world.

The implications for the Atlantic off-shore area are twofold. The major international oil companies have relied on production from a wide range of countries. The range is narrowing, and so are the profits. The companies are, therefore, being forced to look at new areas of potential production such as the Atlantic off-shore area. Here, political stability is undoubtedly a prime attraction together with the relative nearness of major consumption centres.

International oil companies gear their world-wide exploration activities to an extended time-scale, for an entirely new oil province takes from ten to fifteen years to reach production. Also, the most intensive effort will be directed to the best prospect. On this scale of priorities it cannot be said that Eastern Canada, from the results to date, ranks high. In an international sense, the Atlantic off-shore oil play is still only a precautionary move, not a necessity.

One of the important aspects of any off-shore oil exploration program is the high international component. Oil companies participate in an internationally fluid game where drilling and exploration facilities move freely from one area to another. Thus, activities in the East Coast area are competing with exploration programs elsewhere such as Australia, the North Sea, and the China Sea.

When an oil company embarks upon an exploration program, it tries to obtain the necessary hardware from the most economic source. Only very rarely is this source close to the area of exploration. The major exception is the Gulf of Mexico, where a well-established oil industry was operating for decades before the exploration activity moved off-shore. Usually, the initial impact of an off-shore oil exploration program on the adjacent shore communities is minimal.

If a commercial strike is made in the East Coast area, the international implications of the play become important. The imported flow of crude oil to North America is by sea through Atlantic ports while the major indigenous sources of crude oil originate in the west and southwest. A new source of supply from off-shore Eastern Canada would present a countervailing flow to present North American supply patterns.

One of the principal objections raised recently within the United States with regard to Canada/U.S. trade negotiations concerns the increased imports of Canadian crude oil to the United States and the alleged susceptibility of Canadian crude supply, because of the substantial volumes of crude oil imported into Eastern Canada under the existing National Oil Policy. A major source of crude oil off-shore would presumably displace much of this imported oil and would therefore compel U.S. energy policy-makers to reconsider their attitude towards the security aspect of Canadian supply.

Marketing oil from a discovery in the Atlantic off-shore area would appear to offer no problem in light of the major North American energy shortages which are envisaged for the balance of the 1970s and beyond. A crude oil discovery of modest proportions would probably serve local Atlantic region refineries. The excess would feed into the Portland-Montreal pipeline system for use by Montreal refiners. In the case of local refineries which have deep-water tanker facilities there will be little advantage in using off-shore oil in terms of harbour depth capability. Once Eastern Canadian oil markets had been accommodated, any additional production would find a ready market in the Eastern Seaboard of the United States.

Different attitudes may be expected from different companies if development occurs. If a Montreal refining company finds oil, it might logically move some, or all, of it into Montreal. If an Atlantic region refiner finds oil, it will likely use local production. On the other hand, if the refiner has deep-water harbour facilities, it might be less interested. Finally, if the oil-discovering company has no refining facilities in Canada, a wide range of possibilities emerges, including U.S. East Coast markets. Also, the size of the discovery and daily production rates will influence the geographical extension of the market for off-shore oil and its price basis.

3. Gas Markets and Prices

(a) Markets. One of the major decisions in developing off-shore gas will be to identify the minimum threshold reserves. Production costs, distance from shore, depth of water and product quality will all affect the landed cost of the gas. To be economic, a land pipeline must have sufficient throughput to amortize the investment, which in this case is estimated to be in excess of $400 million. The related off-shore pipeline and land based processing plant are estimated to cost another $150 million.

The throughput of such a system would have to be approximately half total present Canadian gas consumption. The logical initial market would be Montreal, which at present is not a major gas market because of the strong competitive position of fuel oil, based upon low cost imports.

Off-shore gas therefore would have to proceed beyond Montreal into Ontario, displacing or backing up Western Canadian gas. This displacemennt should not create any significant problems, since the backed up volumes would be available for U.S. markets.

The development of gas markets in the Atlantic region is less certain, for the region has only a few significant metropolitan areas and these are relatively small in the context of gas marketing. Thus, the attraction of residential gas market development in the Atlantic region is not very great. The same may be said of commercial load. There is the possibility of a few large industrial loads being added to the line.

It is certain that off-shore gas will not be developed specifically for local markets (Table 17).

TABLE 17

1975 EASTERN CANADIAN MARKETS FOR OFFSHORE GAS

Area	Annual Rate (B.C.F.)
Quebec	
Quebec City	11
Eastern Townships	11
Montreal	80
Sub-total Quebec	102
Ontario*	236
Total	338

*Assumes displacement of some markets presently supplied from Western Canada.

An area of interest to potential off-shore Canadian gas producers includes the New England States, and New York. If production is reached then it is assumed that a spur gas pipe line would be built to the New England States where there is a huge demand for natural gas.

The following forecast is more an estimate of what consumers in the Northeast U.S. will demand of gas suppliers, than a forecast of how much gas will be consumed. This assures that gas is available to them at cost relationships similar to those prevailing for competing fuels.

TABLE 18

1975 DEMAND FOR NATURAL GAS-NEW ENGLAND STATES AND NEW YORK STATE

State	Annual Rate (B.C.F.)
New England	346
New York	988
Total	1,344

Source: Future Natural Gas Requirements of the United States

(b) Thresholds. The National Energy Board rules that reserves required for domestic markets are calculated at 25 times the expected fifth year production volume. Using the 1975 estimation of potential off-shore Eastern Canadian gas markets of 338 billion cubic feet, and a load factor of 90% then reserves necessary for exploitation are:- 338 B.C.F. x 0.9 x 25 = 7.6 TCF.

If in addition an arbitrary level of exports to the U.S. of 225 BCF in 1975 is assumed with the same 90% load factor and a 20 year market, then export reserves necessary for exploitation are:- 225 BCF x 0.9 x 20 = 4.1 TCF.

This gives a total reserve requirement of 11.7 TCF for a gas field to be developed in the off-shore area. Despite the number of assumptions made in deriving the reserve requirement figure, the major points remain valid, namely,

(a) The gas must satisfy all markets in Quebec and displace some markets in Ontario.

(b) There will be no significant gas sales in the Atlantic Region in the early stages of market development.

(c) There will be a need for considerable exports to the United States.

(c) <u>Prices and Production Implications.</u> In the case of natural gas, no bargain energy is in sight. The outlook for natural gas prices in North America is for substantial increases in the next few years. By the time off-shore gas could reach Montreal, assuming an imminent discovery, the value of the gas in this market could be 75¢/M.C.F. by 1976. Thus, assuming 75¢/M.C.F. and a 15¢ pipeline tariff from the point of landing to Montreal, the commodity value of the gas in the Atlantic region would be about 60¢/M.C.F. This indicates clearly that the Atlantic region cannot expect a major economic thrust from cheap oil or gas energy.

The international implications for natural gas are less obvious than they are for oil. The natural gas situation in the Eastern United States points to increasing dependence on alternate sources of supply, such as liquified natural gas (LNG) and synthetic gas. A new, major source of natural gas, such as might be discovered off-shore, could greatly reduce future U.S. Eastern Seaboard dependence on imported LNG from North Africa.

Another basic factor in the natural gas situation is that no natural gas production from the East Coast off-shore can be envisaged without a substantial export volume to the United States. Therefore, the international movement of gas is a prerequisite to production, whereas relatively small volumes of oil could come on production without significant international implications.

CHAPTER 4

THE PHYSICAL NATURE OF THE CANADIAN OFF-SHORE PLAY

A. Introduction.

This Chapter sketches the development of Canadian experience in off-shore oil and gas plays. It outlines the process of the development of an oil field with special reference to the Canadian experience, and then it assesses the transportation problems involved in the flow of oil to markets. It also examines some environmental considerations with respect to the development of an oil and gas industry.

The off-shore sector of the oil and gas industry is relatively young. It originated in the Gulf of Mexico, primarily off the Louisiana coast. The evolution of mobile drilling units began in 1949, when the first one was placed in service, capable of drilling in 20 feet of water. Today, there are in excess of 200 available, including some capable of drilling exploration wells in up to 1,300 feet of water. As the international off-shore industry has moved from one area of interest to another, technology has been compelled to adapt to an increasingly hostile environment.

While technology has advanced in geophysical and exploration procedures, the production and transportation of off-shore hydrocarbons have also been compelled to keep abreast of changing circumstances. This has meant continuing improvement in production platforms, underwater pipelines, work barges, service boats and the like. Perhaps the most stimulating factor has been the move from the relatively sheltered waters of the Gulf of Mexico to less friendly areas such as the North Sea and the Atlantic off-shore area of Canada.

The significance of the world-wide off-shore oil and gas industry may be measured roughly by the current level of expenditures, which are estimated to exceed $2 billion per annum. These outlays are involved in activities and operations adjacent to some eighty countries. Off-shore activity is expected to continue to increase rapidly through the balance of the 1970s, as oil and gas companies look increasingly to off-shore areas for additions to reserves.

It is tempting to compare this East Coast off-shore exploration play with that off-shore of Louisiana in the Gulf of Mexico. As both are North American areas of operation, it might seem that the economic impact implications would be comparable. However, the Atlantic East Coast play is quite different from that in the Gulf of Mexico. The principal difference is that in the Gulf of Mexico, the off-shore activities were merely a geographical extension of on-shore oil and gas activity. Over the decades, these on-shore plays have generated a substantial local service sector, which in many cases merely adapted to the off-shore requirements. Other activities such as supply vessels, helicopter support, etc., evolved with the off-shore play.

In the Atlantic area, on the other hand, there is no on-shore oil or gas production industry of note; consequently, the off-shore activities are being superimposed upon a completely unrelated on-shore activity base. A better comparison by far would be the North Sea play, not only in terms of the lack of on-shore oil activity, but also from the viewpoint of climate and weather conditions. Even here the comparison is not always meaningful. For example, icebergs that move into the Grand Banks area, one of the principal targets of exploration, average 100,000 tons, and often measure 300 to 500 feet across. This type of potential hazard poses problems for rig and production platform designers.

B. <u>History.</u>

Canada became actively interested in the geology and structure of the Atlantic continental margin in the mid 1950s. In 1962, the Bedford Institute of Oceanography at Dartmouth was founded, and a new phase of increased federal government involvement in off-shore science surveys began. Since 1963, universities in the Atlantic Region have joined in carrying out off-shore geo-science programs.

In 1959, the petroleum industry began to show some interest in the region when Mobil Oil undertook an air magnetic survey of the Sable Island area and later took up federal and provincial exploration permits on 1.1 million acres.

In late 1963, Shell Canada took up 20 million acres in federal permits covering a large part of the Scotian Shelf. By early 1965, the remainder of Scotian Shelf and most of the Grand Banks and Georges Bank were under permit largely by major multi-national oil companies.

Filing on fringe areas has continued and is still active, so that federal permits now all but blanket the Shelf from the coastline as far out as 425 miles (Flemish Cap area) and extend well down the continental slope to water depths of over 4,000 metres. Total area permitted is now greater than 200 million acres, involving some seventy companies.

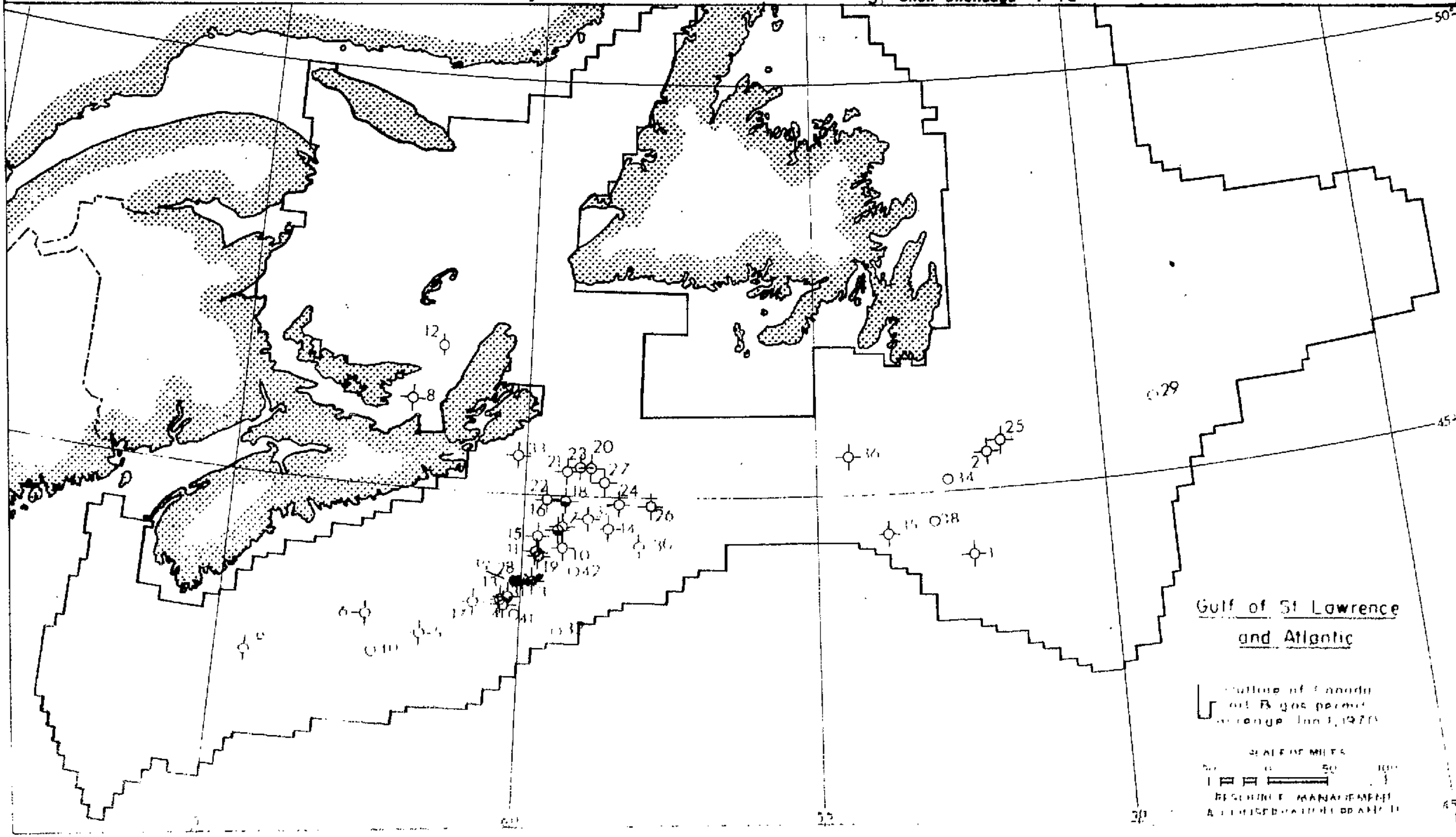
Shallow core drilling was undertaken on the Grand Banks and Scotian Shelf in 1965, with several holes penetrating to 1,500 feet below the seafloor. Exploratory drilling commenced in 1966 on the Grand Banks, when two relatively shallow wells were put down by Amoco and Imperial. In 1967, Mobil Oil drilled a deep well on Sable Island which reached a depth of 15,106 feet.

The current phase of sustained and increasing off-shore exploratory drilling activity began in September, 1969, when Shell contracted the Sedneth 1 semi-submersible drilling vessel to drill on the Scotian Shelf. This rig was joined in May, 1970, by the Sedco H, an even larger semi-submersible. Both rigs have been operating almost continuously on the Scotian Shelf since the commencement of these programmes, and have drilled 23 wells to date. Sedco H was loaned to Mobil in 1971 to drill two holes on Banquereau Bank, while Sedneth 1 was sub-contracted to Elf Oil for an exploratory test on Green Bank.

A third large semi-submersible, the Sedco I, sister vessel to the "H", has been under contract to Amoco and Imperial since the winter of 1970 for a programme on the Grand Banks. Mobil has drilled a second land-based well on Sable Island, eleven miles west of the original 1967 test. In October 1971, this well was announced as a significant oil and condensate gas discovery with hydrocarbons flowing to surface from 17 zones between 4,400 and 7,900 feet during production tests. This is Canada's first off-shore discovery and the first in the sprawling Atlantic Coastal Plain geologic province.

OIL AND GAS EXPLORATORY WELLS

1 Pan Am IOE Tors Cove, D-52
2 Pan Am IOE Grand Falls H-09
3 Mobil Sable Island C-67
4 Shell Onondaga E-84
5 Shell Oneida O-25
6 Shell Naskapi N-30
7 Shell Mic Mac J-77
8 HB Fina Northumberland Strait F-25
9 Shell Mohawk B-93
10 Shell Missisauga H-54
11 Shell Abenaki L-57
12 HB Fina East Point E-49
13 Shell Onandaga O-95
14 Shell Huron P-96
15 Shell Iroquois J-17
16 Shell Mic Mac H-86
17 Shell Cree E-35
18 Shell Wyandot E-53
19 Shell Abenaki J-56
20 Shell Argo F-38
21 Shell Fox I-22
22 Shell Erie D-26
23 Shell Crow F-52
24 Mobil-Tetco Esperanto K-78
25 Amoco-IOE A-1 Eider M-75
26 Mobil-Tetco Dauntless D-35
27 Shell Sauk A-57
28 Mobil-Tetco Sable Island E-48
29 Amoco-IOE A-1 Murre G-67
30 Shell Chippewa L-75
31 Shell Onondaga F-75
32 Shell Triumph P-50
33 Shell Eurydice P-36
34 Amoco Gannet O-54
35 Amoco Puffin B-90
36 Elf Hermine E 94
37 Shell Chippawa F-67
38 Amoco Petrel A-62
39 Mobil Sable Island O-47
40 Shell Mohican I-100
41 Shell Marmora C-34
42 Shell Primrose N-50



Shell's first Scotian Shelf test, 20 miles southwest of Sable Island, was actually a marginal dry gas discovery at around the 9,000 feet level. Operators have announced that indications of hydro-carbons have been found in several other wells on the Scotian Shelf. On the Grand Banks, a show of gas was recorded while non-commercial oil showings were reported by Amoco in the second well of their current drilling programme.

To date, only 31 wells have been drilled in a prospective area of 190,000 square miles. This represents an area three-quarters as large as the Province of Alberta. Of these, 27 have been drilled on the Scotian Shelf.

Total spending to date (late 1971) is estimated at $200 million, and the current level of expenditures is approximately $75 million per annum. For comparison, an estimated $500 million was spent before the first commercial discovery in the North Sea. In that area, it is estimated to take $2,000 to find and develop each barrel/day of production. Should a commercial discovery be made, then significant acceleration might be anticipated. The main deterrent would probably be availability of drilling rigs capable of operating in this area. Again for comparison, in the North Sea, after eight years and with several billions of barrels of oil reserves already proven, there were only seventeen rigs drilling.

C. General Geology

Estimates based on sediment volumes for hydrocarbon potential of the submerged Atlantic Coastal Plan beneath the Scotian Shelf and Grand Banks have been made at 16.5 billion barrels of oil and 100 trillion cubic feet of gas, with an additional but currently unrecoverable 100 billion barrels of oil and 60 trillion cubic feet of gas from beneath the slope and rise.

The stratigraphy and structure of the Scotian Shelf and Grand Banks, including trap types, reservoir rocks and source beds, are remarkably similar to those of the highly prolific U.S. Gulf Coast region, which suggests that this area should have a similar hydrocarbon potential. It remains to be seen why a better record of hydrocarbon discoveries has not been forthcoming to date, since one industry discovery in 31 attempts is certainly not as favourable a record as that of many productive off-shore basins explored to date.

Despite the low density, drilling has <u>confirmed</u> the presence of those ingredients which appear to be essential to providing a major hydrocarbon province, that is, thick marine section, good reservoir and source rocks, and plenty of structural traps beneath the continental shelf, and, at Sable Island, the presence of hydrocarbons in at least local abundance. The history of exploration in some other off-shore oil basins of the world (e.g. the North Sea) demonstrates that the first major discovery may be frustratingly elusive, and may require scores of dry preliminary probes before the key to oil accumulation in a particular habitat is found.

D. Work Obligations

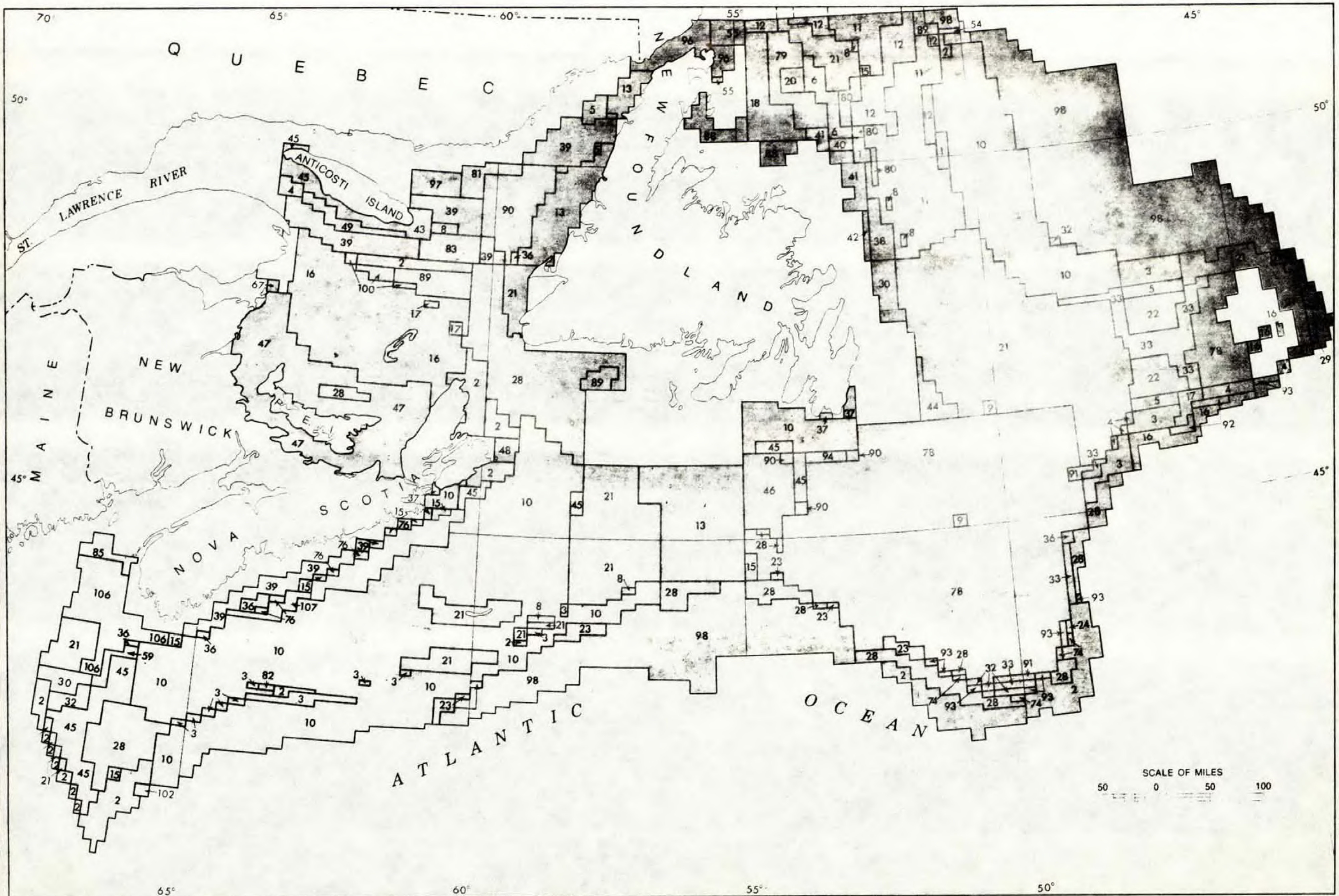
When exploration permits are taken out, the companies are obligated to perform a certain minimum amount of exploration work each year in order to maintain validity of their permits. These obligations range from $2.65 to $2.70 per acre for the full twelve-year life of a permit. Therefore, it is possible to anticipate the minimum total exploration expenditures in the ensuing years. As of July, 1971, the minimum work obligation for 1972 in the East Coast off-shore area was $46 million assuming that none of the permit holders relinquish their acreage. By 1975 the total minimum work obligation should reach $87 million (Table 19). Thereafter, a decline in the minimum will probably set in unless commercial oil or gas reserves are proved.

TABLE 19

ESTIMATED PERMIT WORK OBLIGATIONS 1972-1975

Year	Scotian Shelf		Gulf of St. Lawrence		Grand Banks		Coast of Labrador		Total
	$ Million	%	$ Million	%	$ Million	%	$ Million	%	$ Million
1972	15.0	32.6	5.0	10.9	22.0	47.9	4.0	8.7	46.0
1973	16.0	28.1	7.0	12.3	26.0	45.6	8.0	14.0	57.0
1974	20.0	25.6	10.0	12.8	34.0	43.6	14.0	18.0	78.0
1975	20.0	23.0	12.0	13.8	39.0	44.8	16.0	18.4	87.0
Total 1972-1975	71.0	26.5	34.0	12.7	121.0	45.2	42.0	15.7	268.0

Source: Department of Energy, Mines and Resources.



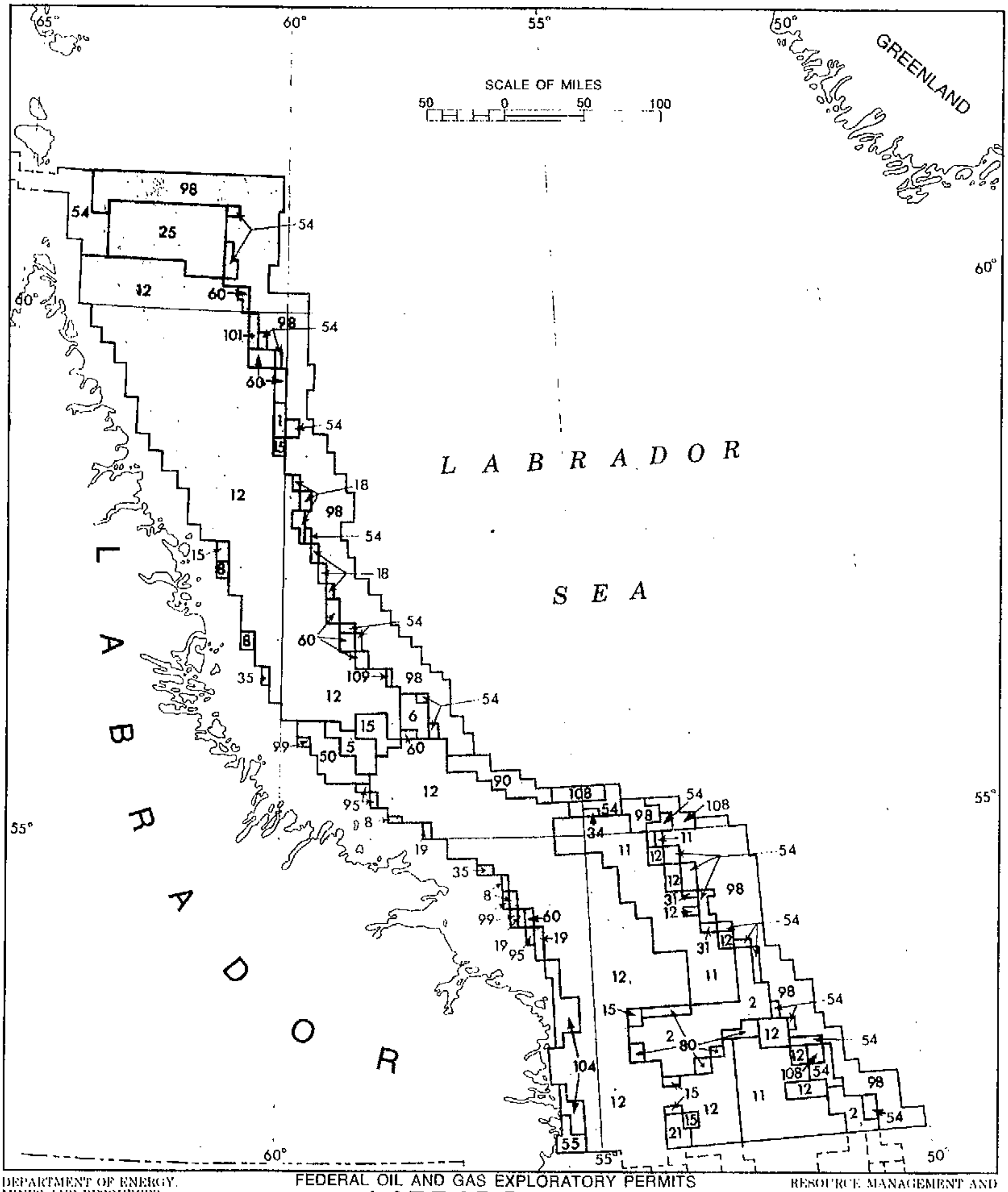
DEPARTMENT OF ENERGY, MINES AND RESOURCES

FEDERAL OIL AND GAS EXPLORATORY PERMITS

GULF OF ST LAWRENCE AND ATLANTIC

JANUARY 1, 1972.

RESOURCE MANAGEMENT AND CONSERVATION BRANCH



DEPARTMENT OF ENERGY, MINES AND RESOURCES

FEDERAL OIL AND GAS EXPLORATORY PERMITS

LABRADOR SEA

JANUARY 1, 1972.

RESOURCE MANAGEMENT AND CONSERVATION BRANCH

INDEX TO PERMIT MAPS

	PERMITTEE
1	Citizens Pipeline Limited
2	Siebens Oil & Gas Ltd.
3	Ranger Oil 92%
	Bow Valley 8%
4	Bow Valley Industries
5	Trudel Minerals Ltd.
6	Western Decalta Petroleum 45%
	Petrol Oil & Gas Company 5%
	Petrorep (Canada) Ltd. 25%
	Corexcal, Inc. 25%
7	Ulster Oil Enterprises
8	Ranger Oil (Canada) Ltd.
9	Canadian Homestead Oils
10	Shell Can/Shell Explorer
11	B.P. Oil & Gas Ltd. 50%
	B.P. Exp. Can. Ltd. 50%
12	Tenneco Oil & Minerals
13	Gulf Oil Canada Ltd.
14	Transalta Oil & Gas 90%
	Offshore Exploration 10%
15	Shenandoah Oil Corp'n
16	Amoco Canada Petroleum
17	Canada Trust Company
18	Canadian Industrial G & O
19	Darling Hydrocarbons Ltd.
20	Lawrence Oil Co. Ltd. 1/3
	Solar Energy Resources 2/9
	Success Oil Ltd. 2/9
	Troy Oils Ltd. 2/9
21	Mobil Oil Canada Ltd.
22	Dome Petroleum
23	Star Oil & Gas Ltd.
24	Success Oil Ltd.
25	Wainoco Oil & Chemicals
26	Sulpetro of Canada Ltd.
27	Western Minerals Ltd.
28	Texaco Exploration
29	Summit Oils
30	Transalta Oil & Gas
31	B.P. Oil & Gas Ltd. 50%
	B.P. Oil Ltd. 50%
32	Canadian Superior Oils
33	Voyager Petroleums
34	Solar Energy Resoures 50%
	Success Oils Ltd. 50%
35	A.R. Campbell
36	R.F. Goss 50%
	American Eagle Petroleum 50%
37	A.S. McLean
38	Anco Exploration
39	Cananadian Reserve O. & G.
40	Inter-rock Oil Company
41	Acroll Oil & Gas
42	Columbia Northland Explorn
43	Scurry-Rainbow Oil Ltd.
44	Northern Oil Explorers 75%
	Andex Oil Company 25%
45	Standard Oil of B.C.
46	Elf Oil Exploration
47	Hudson's Bay Oil & Gas
48	Murphy Oil Company

KEY No.	PERMITTEE
49	New Associated Development
50	Paddon Hughes Development
51	Duncan Oil Limited 37.5%
	Fairlane Resources Ltd. 12.5%
	Delta Petroleum Corp'n 15.0%
	Trans-Canada Resources 10.0%
	Amarex, Inc. 25.0%
52	J.E. Mitchell
53	Atlantic Richfield
54	Aquitaine Co. of Canada
55	A.M. Fielding
56	Sunlite Land Ltd.
57	Kestrel Exploration Ltd.
58	Peyto Oils Ltd.
59	Baramy Investments
60	Ulster Oil Enterprises 50%
	Can. Export Gas & Oil 50%
61	Mobil Oil Canada 50%
	Can. Export Gas & Oil 50%
62	Northwest Oils Ltd.
63	Teck Corporation
64	Sogepet Ltd.
65	Opekar Investments
66	Worldwide Energy Co.
67	Ram Petroleums
68	J.C. Millikin
69	Home Oil Company
70	Bluewater Oil & Gas
71	Western Oil Consultants Ltd.
72	Ulster Petroleums Ltd.
73	Mid Eastern Oil & Gas 50%
	H. Cravit 50%
74	North American Energy Co.
75	Offshore Oil & Gas Corp'n.
76	Ulster Oil Enterprises 25%
	United Canso Oil & Gas 25%
	Canadian Export Gas & Oil 50%
77	Mobil Oil Canada 25.0%
	Canada-Cities Service 30.0%
	Hamilton Bros. Can. Gas 27.5%
	Siebens Oil & Gas Ltd. 17.5%
78	Amoco Canada Petroleum 50%
	Imperial Oil Enterprises 50%
79	Houston Oils Ltd. 25%
	Asamera Oil 25%
	Pan Ocean (Can) Ltd. 25%
	Lochaber Oil 25%
80	Trans-Prairie Pipelines
81	Ballindery Explorations
82	Buttes Resources Canada
83	J.M. Huber Corporation
84	Axel Heiberg Oil 98%
	Artik Leaseholds 2%
85	Transocean Oil Canada 50%
	General Crude Oil Alberta Ltd. 50%
86	Texas Gulf Sulphur 40%
	Teck Corporation 20%
	Canadian Homestead 20%
	Sogepet Limited 20%
87	Banner Petroleum 40%
	Sogepet Limited 20%
	Asamera Oil 20%
	Teck Corporation 20%

KEY No.	PERMITTEE
88	Total Petroleums (North America) Ltd. 50%
	Amerada Minerals Corporation 50%
89	Siebens Oil & Gas Ltd. 50%
	Transalta Oil & Gas 50%
90	Can. Homestead Res. Ltd.
91	Siebens Oil & Gas Ltd. 75%
	Aquitaine Co. of Canada 25%
92	Altana Exploration Company
93	Western Decalta Petroleum 30.0000%
	Petrol Oil & Gas Company 3.3334%
	Petrorep (Canada) Ltd. 16.6666%
	Corexcal, Inc. 16.6666%
	Pacific Lighting Exploration 33.3334%
94	Sun Oil Company 50.00%
	Pacific Petroleums 25.00%
	Canadian Homestead 18.75%
	Castle Oil & Gas 6.25%
95	Canadian Minerals (1960) Ltd.
96	Europa Oil Concessions Ltd.
97	M.S. Simon
98	Imperial Oil Enterprises Ltd.
99	Patrick Petroleums
100	Siebens Oil & Gas Ltd. 50%
	Canadian Superior Oils 50%
101	Sultan Exploration Ltd. 50%
	Pan Northern Petroleum 50%
102	Lemieux, J.F.
103	Maryland Natural Res.
104	Oil Ventures Int. Inc.
105	Petrotar Development Ltd.
106	Transalta Oil & Gas 60%
	Offshore Exploration 20%
	Marwood Petroleum 5%
	Scurry-Rainbow 15%
107	Transalta Oil & Gas 40%
	Offshore Exploration 20%
	Marwood Petroleum 20%
	Scurry-Rainbow 20%
108	Lochiel Exp. Ltd.
109	Pan Northern 66 2/3%
	Sultan Expl'n 33 1/3%

E. Initial Surveys

In the early exploration stages, various geophysical and geological surveys must be conducted to establish the area's basic characteristics. This usually involves the use of specialized craft which conduct seismic gravity and magnetic surveys. A typical geophysical boat can stay in the work area for weeks at a time and has facilities for the installation and operation of complex electronic gear. It may accommodate up to 30 scientific personnel. The trend to conducting multiple operations from a single vessel and the move into more difficult operating areas has tended to increase the size of seismic vessels. It is on the basis of these initial surveys that the decisions are made as to further work on a company's permit. The surveys may indicate that there is insufficient justification to proceed further, or else they may reveal the areas of greatest interest for a drilling program.

It should be emphasized that such surveys do not necessarily reveal the areas with the greatest oil or gas potential; rather, they indicate areas that offer the greatest interest based on present knowledge. In fact, despite some similarities, most oil and gas fields exhibit their own individual set of geological characteristics, the true nature of which is only known once a discovery or series of discoveries have been made.

F. Exploration Drilling

The initial geophysical and geological work is followed by exploration drilling, normally conducted by mobile drilling rigs of which there are four basic types.

The floating vessel is a specially-designed ship-shape vessel, up to 400 feet long with a derrick amidships and a drill well in the centre of the hull. The recently completed Tenneco drilling on the Labrador coast used a vessel of this kind.

The submersible type rig is bottom-supported. Once the rig is in place, the lower part of the structure is filled with water and the rig settles on to the bottom of the ocean, giving good stability. Depth of water and prevailing weather conditions limit the areas in which these rigs can be used.

The semi-submersible type rig is capable of operating in deeper water. When on location, it does not contact the ocean floor but floats on the surface with a large sub-structure below the wave action, resulting in minimum movement. Because the semi-submersible is a floating vessel, a large and complicated mooring system is required to keep the rig on station during the drilling operation.

The jack-up drilling rig is essentially a platform supported by a number of legs, usually three or four, which are hydraulically jacked down to meet, and penetrate, the ocean bottom to some depth. Once the feet have been firmly planted, continued jacking then raises the platform above the water and maximum wave action. This type of rig is limited to water less than 250 feet, and to relatively sheltered waters.

Except in the case of the floating vessel ship-shape type rigs, which are self-propelled, mobile rigs must be towed from one location to another by powerful tugs. Tugs are now being constructed that are capable of handling the very large anchors and mooring systems of drilling rigs, as well as transporting supplies and personnel between the rigs and shore. The Atlantic off-shore area is ideal for development of these larger, multi-purpose craft.

The principal exploration rigs used in the Atlantic off-shore play have been semi-submersible rigs of the Sedco 135 series that cost approximately $15 million, and about the same to operate annually. Two have been built in the Halifax Shipyard and another is nearing completion. The Sedco 135 series has a deck height of 146 feet, is 280 feet on side, and has living accommodation for 65 men.

Construction of these three rigs is the most easily identifiable local impact of the off-shore play to date. There has been a substantial leakage in terms of the materials and equipment which have had to be imported into the region for construction of the rigs. These imports came from Europe, the United States and other parts of Canada. As the company acquired experience, more local substitution has been noted, and hopefully this trend will continue. Recently, the Halifax Shipyard was awarded the contract for another unit consisting of a new design of self-propelled rig for operation in the North Sea.

Drilling rigs are normally owned and operated by drilling companies who contract their services to companies engaged in oil and gas exploration throughout the world. Companies in the East Coast Atlantic area are competing for rigs with other companies operating in comparable areas, such as the North Sea. Even supply boats, which are relatively small but highly specialized vessels, move from one theatre of operations to another. It would seem, for example, that the Atlantic Provinces, being essentially a maritime economy, could move quickly to fill demand for supply boats. This has not turned out to be the case, however, due to the highly specialized nature of these vessels, which motivates against conversion of existing hulls for this function. However, a significant number of crew members have been employed locally by the supply boat companies.

Operating supplies such as casing, bits, mud, chemicals, etc., are mostly imported to the region from principal supply centres in the United States and Western Canada. It is unlikely that there will be any significant local substitution of these supplies at the present exploratory stage of the play. Only when a commercial discovery is announced would service and equipment companies be convinced to manufacture locally. Until such time, most of these companies will retain local offices, generally in St. John's, Newfoundland or Dartmouth, Nova Scotia.

G. Establishing the Oil or Gas Field

Once an initial discovery has been made, the prospective pool must be delineated by a series of step-out wells around the discovery well. If a pool is found to be commercially viable, then the next stage is to design and establish a permanent fixed platform for drilling the development wells from which the field will produce.

However, one of the most critical problems facing the oil companies, is the actual identification of a commercial or viable discovery. In a normal land play, commercial production can be contemplated on the basis of a relatively small reserve. Off-shore, however, the minimum threshold requirements rise sharply, depending largely upon depth of water, and distance from shore. Thresholds have already been discussed in greater detail, but will be summarized again here.

The position taken in this study is that the hostile environment and the distance to final market, combined with the many unknowns, suggest a conservative attitude to threshold reserves.

In the Gulf of St. Lawrence-Nova Scotian Shelf-Grand Banks area, a minimum crude oil reserve requirement of 100 million barrels is anticipated, assuming development in 200 feet of water 100 miles from shore. Such a field could be developed with between one and four production platforms housing between sixteen and twenty-eight wells, with an average field production of approximately 30,000 barrels per day.

Off the Labrador Coast, however, where a discovery today would be ten years ahead of technology, it is anticipated that close to 2 million barrels of oil might be required before commercial production could be justified. The above estimations assume that the oil would be of desirable quality. It has been suggested that crude oil production would be difficult or impossible if oil gravity were to fall below 25 degrees.

In other samples from Sable Island, 39 gravity oil and 50 range condensate were recovered. If these are typical of the type of liquid hydrocarbons which are to be recovered, then the producers should be quite pleased with the prospect.

For a minimum natural gas development in the Gulf of St. Lawrence or Nova Scotian Shelf area, development costs would be $35 million, plus another $120 million for a pipeline to shore. Once on-shore, however, another $420 million might be required to construct a processing plant and pipeline to Montreal, with a spur line to the New England area giving a total cost of $575 million. Such developments would indicate a necessary reserve of almost 12 trillion cubic feet.

Should a major natural gas discovery be made on the Grand Banks, a pipeline would have to be laid to Newfoundland, proceed north and cross over to the Coast of Labrador, then southwest along the north shore of the St. Lawrence River to Quebec City and Montreal. A total estimated capital cost of $1 billion with a reserve requirement of 25 trillion cubic feet. A find off the coast of Labrador might require a reserve of from 25 to 30 trillion cubic feet to be considered commercial.

The characteristics of the gas, if found, are a critical factor. Gas samples recovered from Sable Island had methane contents ranging from 71% to 97%. The implications of a high methane low ethane content are not encouraging for petrochemical possibilities, which would require over 10% ethane.

There has been no mention of sulphur content in any of these preliminary results and this again would be a positive factor, helping to keep down gas processing costs.

H. Development of the Field

Once a reservoir has been designated as commercially viable, a production platform is designed and built. When established in place, the platform is first used as a drilling platform and is then converted to be a production platform. It should be remembered that an initial discovery well is not necessarily used for production purposes, it merely serves to identify the reservoir. The production wells are drilled from the production platform.

The construction of first stage development facilities would depend almost entirely on imported equipment from the U.S. Gulf of Mexico industries.

Units such as construction barges and lay barges are highly specialized and operate on a project-to-project basis. Total mobilization costs for equipment to develop a gas field are estimated at approximately $12 million. It is unrealistic to expect local entrepreneurs to construct these very expensive and highly specialized units in the early development stages. The oil companies are vitally aware of the cost of time and the need to manufacture and install offshore production facilities to a rigid time schedule.

A production platform consists of a deck supported on a tower extending from the ocean floor to an elevation high enough to clear the highest ocean waves. To minimize costs, as many wells as practical are drilled directionally from a single platform. For instance a three-leg platform could have 30 wells, 10 contained within each leg. Once the complete drilling programme has been concluded the drilling portion of the platform is removed for use on another platform.

The exceptional conditions in the Eastern Canada off-shore area will impose a long design and fabrication schedule. Design might require six months followed by two months to bid and award contracts. The fabrication stage varies from 12 to 14 months, depending upon water depth, and another 3 months are required to install the platform. Thus, total elapsed time is between 23 and 25 months from start to finish.

In the East Coast area, meteorological and oceanographic conditions cause other time limitations. Installation of a platform is only possible during the months of June, July and August of any one year. Therefore the timing of the construction schedule must be rigid in order to avoid losing a full production year if the installation window is missed. In considering the possibility of using local manufacturing companies, the companies regard scheduling as one of the major problems.

For an oil platform, the tower portion requires highly skilled fabrication techniques, adhering to high standard specifications. Standards of this quality are seldom found in shipyards, being more prevalent in bridge building and high-rise steel construction companies. Oil companies require American Welding Society specifications, more specifically the A.W.S. Bridge Code. The oil rig companies generally adhere to the A.S.T.M. specifications. The differential between A.W.S. Bridge Code and A.S.T.M. specifications represents 5% additional labour cost, but if the necessary skilled labour is not readily available, the increase could be significantly higher.

In the early stages of off-shore development Canadian yards would not be in a favourable position to bid competitively with U.S. Gulf Coast fabricators or to meet early delivery periods for the structures. This latter point is stressed by the oil companies as being of great concern. As the development programme progresses, several Canadian heavy steel construction companies should be able to supply capital and build fabrication yards on the Nova Scotia coast for the construction of off-shore structures and packages. Such yards would be in a more advantageous geographical location than the Gulf Coast fabricators.

The pile setting component of the platform is a relatively simple fabrication task, although large quantities of steel and tight specifications are required. Normally, about half the construction time of the tower itself involves pile setting, and therefore timing is not as critical.

Canadian manufacturers could enjoy a distinct advantage in this phase of operations. Access to the Atlantic region by barge on the St. Lawrence might allow fabricators from as far away as the Lakehead to bid for this type of work.

The deck of the platform consists essentially of a standard structure, fabricated again to high specifications. The structural portion of the decks is within the capability of inland heavy steel construction companies. However, the packaging of equipment, wiring and piping is a highly specialized technique and experience is at present confined to the Gulf Coast. The units on the deck of a production platform are designed to provide for separating gas and free water from the well effluent as well as for all the equipment and processes necessary for continual production flows from the wells. In addition, quarters for personnel must be accommodated. Most of the major components of these facilities are manufactured in the United States, and in the beginning the packaging and assembly will probably take place on the Gulf Coast. However, when investment opportunities become more apparent in the Atlantic region it is conceivable that these off-shore facility packages could be put together locally.

A natural gas production platform is significantly less expensive than an oil platform but the pipeline to shore is substantially more costly. The tower of a gas platform is not as heavily constructed in its three main legs and has a smaller well drilling capability of 18 to 24 wells compared with 30 for the oil platform. The deck of the gas platform is much less sophisticated and the piles and conductors are substantially less. Also, installation costs are considerably less.

Installing off-shore platforms requires a highly specialized technique and several specific pieces of heavy equipment designed for this type of operation. A new type of marine construction capability has been developed to serve the need for the installation of fixed platforms and pipelines. Floating derrick barges have now been designed to install fixed platforms on location and to transfer heavy equipment loads both to and from the platforms. Once development drilling is complete, the drilling derricks are often moved from the fixed platform to another site.

Highly specialized barges have also been designed to lay oil and gas pipelines on the ocean floor. There is now a highly-sophisticated, internationally-oriented industry specializing in these operations. Units are moved around the world to emerging oil and gas plays. They take with them highly skilled personnel to optimize the advantage of a new strike.

Only in very few circumstances would there be any on-shore capability to cope with the many problems of a new off-shore play. Thus, for example, after eight years and despite considerable local capability, most of the off-shore equipment used in the North Sea is still imported from other areas, with the exception of drilling rigs that may have up to 75% local content. A typical installation spread of equipment comprises the following:

1. One 500 to 600-ton derrick barge;
2. Three 4,000 hp. tugboats;
3. Three 2,400 hp. tugboats;
4. One crewboat;
5. Three 250 ft. x 75 ft. materials barges.

The total value of this equipment is approximately $19 million and the total daily rate of rental would approach $40,000. Since the seasonal working period in the Atlantic Region is restricted to three months of the year, local companies could not provide this service unless they were prepared to seek off-season business in other oil provinces throughout the world. During installation, about 150 people would be involved of whom approximately 50 might be hired locally from the Atlantic Region.

I. Transportation

The next stage is to transport production from the wellhead to markets on shore. Natural gas moves to shore by a pipeline laid on the ocean floor. Undersea pipelines are influenced by depth of water and distance from shore, but a greater problem lies in the topography of the ocean floor itself, where irregularities and rifts can present major obstacles. Construction of gas liquefaction facilities, either on surface platforms or on the ocean floor, presents enormous problems, which have not yet been resolved. In this particular play, however, the possibility of an L.N.G. plant on Sable Island may be considered as an alternative.

Crude oil may be transported to land by pipeline, or by directly loading to a tanker from a fixed platform. When tanker movement is involved, some interim storage is required. A single 100 million barrel reserve would not be sufficient to justify a pipeline to shore. Therefore, transportation to market would probably be by tanker loading from a single mooring buoy, using some form of interim storage.

Off the Coast of Labrador, it is likely that crude oil production would be developed using a tanker load ing facility, presumably linked with some sub-sea production capability. The prevailing iceberg threat would call for great ingenuity in the design of production facilities. The deepest comparable pipeline in the world to date is in some 340 feet of water, substantially less than the 500 feet in which drilling is being currently conducted.

Production from the Grand Banks of Newfoundland would have to overcome another transportation problem in the form of the Laurentian Channel, lying between the Grand Banks and the Nova Scotia mainland. The companies admit that this obstacle is beyond the horizon of pipeline technology at the present time. If a pipeline is justified, then it would appear to be by far the most costly single component of the production system.

Hopefully, one production platform would be able to share the pipeline facility with other pools developed in the immediate area, and as a result the unit cost per barrel would be reduced substantially. Approximately half of the total cost is for the pipe coating, cathodic protection, valves and other miscellaneous items. Even on the first pipeline to be laid off-shore, a coating yard must be established near the construction site in order to apply a corrosion protection and concrete weight coating to the pipe.

Once more, highly specialized equipment and labour are required. A typical pipe-laying spread would include:

1. One 400 ft. by 100 ft. lay barge;

2. One 300 ft. x 90 ft. burial barge;

3. Three tugs, varying from 2,000 to 6,000 hp;

4. Ten 165 ft. supply boats.

The total value of this equipment is about $32 million, while the total rental including labour would be about $75,000 a day. Climatic conditions restrict working time to five months in the year. To speed completion, it is conceivable that several spreads would be used. Once more, imported equipment would be used for the short construction season and then moved to some other oil operating theatre for the balance of the year. Approximately 320 people would be employed in one spread, and an estimated 80 welders, crane operators, machinists and labourers might be hired locally.

In Canada, all off-shore pipelines and their on-shore landfall and related facilities would come under the jurisdiction of the Federal Government.

J. The Environment

At all stages of an off-shore play, from the initial surveys through to production, concern for the environment is an important consideration for both the companies and the governments involved.

In the early exploratory stages of the off-shore play, the principal environmental effects are associated with the activities of seismic and geophysical boats and the semi-submersible drilling vessels. Geophysical activities extend for thousands of linear miles, but have virtually no effect on the ecology. Recently, new seismic shooting methods have been developed, using compressed air as the detonating device, and this has virtually eliminated the possibility of damage to marine life in the vicinity of the shoot. Therefore, apart from the unpredictable event of a collision, the exploration vessels present virtually no hazard to the environment. The exploration vessels are well equipped with positioning devices, and consequently present a smaller navigational problem than most other types of vessel likely to operate in the area.

In considering the semi-submersible drilling rigs in the exploration phase, the very small number of rigs present in the region should be noted, especially when the total expanse is taken into account.

From the viewpoint of fishing, drilling rigs could have a beneficial effect by attracting fish, although commercial fishing in this off-shore area would probably be unaffected by such orientation. The stringent rules concerning dumping of waste from rigs provides the best assurance that activities will not damage the marine life in the drilling areas.

The Federal Government flies daily patrols over the area to check for oil spills, not only from the rigs but from other vessels in the area. The Federal Government also inspects the drilling operation at each well location, prescribes and approves the amount of protection required for each well. It also ensures that each operation has formulated a Pollution Prevention Plan, and that this Plan has been approved.

Exploratory rigs do not pose any significant problem to navigation and shipping, for their locations are accurately recorded and reported in navigation bulletins. They present a substantial metal structure above the water level, which provides adequate radar echo in poor visibility. One particular period of hazard occurs when rigs are being moved from one location to another. At this point, they are less stable and consequently are most susceptible to weather influences. However, during such moves the rigs are attended by safety vessels, as well as the tugs involved in the actual movement. In this case, therefore, adequate protection is ensured from a safety and navigational viewpoint.

The more significant environmental implications originate from the possibility of commercial production in the off-shore area. Here the problems are somewhat different. For example, in the case of fishing, there is still no real danger of environmental disturbances. Perhaps the best proof is to examine the experience in the Gulf of Mexico. This is where the off-shore oil industry has been in operation the longest, and where all the effects of off-shore drilling for twenty-four years have accumulated.

It has been established in this area that a fixed platform constitutes an artificial reef, and that it attracts a great variety of marine life by offering food, shelter and attachment at every level of the water column, from the bottom of the ocean to the surface of the sea. In Louisiana, there are approximately 2,800 of these artificial reefs off the Coast, and the implication for marine life has been quite remarkable. It has been established that fish which were not present in the area twenty-five years ago are now following migratory feeding patterns into the off-shore producing area of Louisiana.

From the viewpoint of navigation and shipping, the locations of production platforms are extremely well established. Consequently, a minimum of navigational errors should be involved in charting their location. Again, the nature of their construction ensures a very adequate radar echo. Also, it is probable that they will all be located in deep water, averaging possibly 200 feet, leaving adequate room for vessels to observe and avoid their immediate areas.

To date the major impact of the off-shore industry on recreation has been the fear of a major oil spill coming ashore. The distance from shore of most of the present drilling activity is such that any oil ruptures could be largely controlled and cleaned up before any oil came ashore. By contrast, most of the major oil spills, which have received wide publicity over the past three years, have occurred relatively close to shore, where the implications for recreational activities are substantially greater. The establishment of a major off-shore oil and gas industry could possibly provide a limited new tourist attraction.

The location of production platforms would be important for national defence. Being accurately located, the platforms could provide several strategic functions. For example, they could be mounted with radar devices giving early warning more than a hundred miles off-shore, or they could be equipped with instruments that could contribute significantly to weather forecasting. Also, platforms could be used as stable off-shore helicopter locations for air-sea rescue activities or as staging areas for extended search.

In recent years, the petroleum industry has come under fire on a number of points ranging from oil spills (virtually world-wide) to specific ecological instances such as the Alyeska Pipeline from the North Slope of Alaska to Valdez. It is generally agreed that in the past the industry has, from time to time, been lax in its awareness of environmental circumstances.

A very real problem concerns the development of the oil (or gas) reserves possibly to be found around Sable Island. The Island presents an intriguing platform in the middle of the Scotian Shelf. To date, two wells including the discovery have been drilled, and a third is to be started in January, 1972.

If commercial oil production is indicated, then the Island may be used as a production platform, entailing the construction of all the usual production and separating equipment and oil storage facilities. If a gas field were developed, a comparable series of facilities would have to be built. At this stage the possibility of intervention could add costly delays to the development program.

The nature of this play suggests that commercial production will be undertaken only if a very large and prolific reserve is located. This implies a highly concentrated production system, based upon high rates of production from a relatively small number of wells and consequently a relatively small number of permanent structures.

CHAPTER 5

THE NORTH SEA PRECEDENT - A COMPARISON

(a) Introduction

The purpose of this Chapter is to review the North Sea precedents in off-shore oil and gas plays in order to assess the relevance of the Norwegian and British experiences to the Canadian potential oil and gas development off the Atlantic coast.

Early in 1971, the Ekofisk field in the Norwegian portion of the North Sea commenced production from a water depth of 235 feet, 170 miles from shore.

Recompletion of the first four wells with under-sea wellheads, their connection with a new type of production platform, and in turn, its connection with two single-point mooring buoys (SBM) completed the essentials of Phase I of operations in which only the SBMs can be regarded as wholly conventional equipment. Tankers moor alongside the SBMs, and load crude direct from the wells, without intermediate storage. A problem arises concerning the utilization of associated gas produced from the Ekofisk formation, calculated at 50 million cfd in Phase 1 of operations, but likely to rise in concert with the increase of oil production from 40 MB/d to 300 MB/d.

Re-written with greater emphasis on weather conditions and the need for technical innovation, the above description could serve for the start of production off-shore from the Atlantic Provinces.

(b) The Norwegian Experience

The analogy between Norway and the Atlantic Provinces is worthwhile noting in the context of the build-up of oil operations in Norway. The Norwegian Government granted its first North Sea concessions in August, 1965, and drilling commenced eleven months later from a rig brought across the Atlantic from the Gulf of Mexico. The second rig to be moved into Norwegian waters was constructed in Oslo under a contract secured within a month of the award of concessions. Rig-building was completely new to the shipyard, but was completed in ten months.

Both rigs operated out of Stavanger, on the southwest coast of Norway. Stavanger has a sheltered deep-water anchorage and a tradition of shipbuilding. By the end of 1966, four bases for North Sea oil operations had been established at Stavanger at which many international service and supply companies located. The objective has been, from the beginning, to provide a complete round-the-clock service for off-shore operators and contractors.

By establishing themselves at the very start of operations, and committing large amounts of capital and technical staff to the venture, Norwegian companies have been aided, first, by excellent labour relations and secondly, by the Norwegian authorities who have cooperated in reducing red tape to a minimum, particularly in respect of customs formalities.

Stavanger is not, however, the largest base for North Sea oil operations. Great Yarmouth, on the East coast of England had an even earlier start because of gas exploration activity before 1965.

(c) The U.K. Experience

The U.K., unlike Norway, has been a manufacturer and exporter of oil field equipment for many years. In addition, nearby London is the headquarters of two of the world's largest oil companies and the oil capital for operations of companies in the Eastern Hemisphere. For several years British subsidiaries of all the major North American contractors and equipment suppliers have been established in London. It is worth noting that the North Sea search has led to Great Yarmouth becoming the headquarters of some firms that had not been represented previously in the U.K., as well as of new companies, British and foreign, formed specifically to take advantage of the opportunities offered.

The supply of services out of Great Yarmouth has only marginally affected the character of the town, though more so than in the case at Stavanger, where ship-building and repairing have long been established. Although depending chiefly on fishing, agriculture and tourism, light industry was already represented in Great Yarmouth, and the type of labour required for employment on-shore was either available locally, or from the immediate hinterland.

Sixty companies that are related directly to the off-shore play are located in Great Yarmouth. Of these, 5 are drilling contractors, 36 are drilling equipment and service companies, and 19 provide other services.

TABLE 20

ORIGIN OF GREAT YARMOUTH OIL SERVICE COMPANIES - 1971

Nationality of Parent	Total (1)	No. Established Before the Play (2)	Ratio (1) ÷ (2)
U.K.	20	7	35.0
U.S.	31	10	32.2
French	5	1	20.0
Dutch	2	2	100.0
Joint Venture	2	-	-
Total	60	20	33.3

Of great significance is the source of materials handled by oil service companies. Almost without exception, the source of origin is the country of parent nationality. Thus, drilling mud suppliers buy their materials from various parts of the world but their specialized equipment usually comes from the United States.

There are two joint venture companies listed, involving U.K. and foreign interests. One of these involves what is perhaps the world's largest off-shore construction company, and one of the largest U.K. construction companies. This combination seems most logical and sets a pattern which could well be the optimum solution for the Atlantic region participation in the development phase.

The off-shore situation was different. There was a local shortage of certain work categories and also the local population was not always willing to work on the rigs. On the other hand, one company engaged in rig maintenance, platform repair, etc., recruited its entire personnel of 175 men locally. The drilling contractors were, by virtue of the high wages offered to counter the unfavourable work conditions, able to draw on the whole U.K. labour pool. Some training was required, but the U.K. North Sea operation has now continued long enough for some trades to be almost entirely filled by British nationals. According to one U.S. drilling contractor, only 10 per cent of his rig personnel are now non-British. The specialists must still be imported, but on the fifteen rigs working in the North Sea late in 1971, they are believed to have numbered no more than 70 out of a total of perhaps 1,200 employees.

Using Norway and the U.K. as examples, this summary points out the kind of development that might take place in the Atlantic Provinces after a prolonged Eastern Canadian oil search. Certain limitations must be noted. The Eastern Canada off-shore is not, like the North Sea, in the centre of a concentrated industrial zone, with all that it implies in terms of a mobile supply of skilled labour and a widely based entrepreneurial tradition.

French, British and Dutch oil companies are numbered among the major international producers, and in the shadow of their Paris, London and The Hague headquarters, oilfield equipment and service firms have grown large enough to enjoy an international reputation. Even in these favourable circumstances an estimated 25 per cent by value of a North Sea drilling rig is imported from the United States. It is probably true that, in terms of U.K. employment, the Midlands has benefited more than Great Yarmouth.

If there is one particular industry that has benefited from the North Sea search, it is shipbuilding. No off-shore drilling rigs had been built in Europe prior to 1965, but of the fifteen working in the North Sea in late 1971, seven were built in the U.K., one each in France, Norway, the Netherlands and West Germany, and four in the U.S.A. The U.K. undoubtedly had a head start, given that it was in British waters that the earliest and most intensive search was conducted, but it has not been able to maintain its advantage partly due to delivery delays which upset timetables drawn up in the light of the limited North Sea drilling season, and partly due to cost escalation.

This point is most relevant to the Atlantic Region. Wherever they have operated, the oil companies have been willing to obtain as much of their equipment and services as possible from local sources. This willingness takes into account relative costs, including the public relations value of placing orders locally. However, it does not extend, for example, to the point where experience suggests that unbudgetable costs may arise because of bad delivery dates. This is demonstrated by the fact that rig construction in the U.K. has now declined, partly as a result of delivery problems experienced in the past.

CHAPTER 6

THE IMPACT ON INCOME AND EMPLOYMENT IN THE ATLANTIC PROVINCES

(a) Introduction

This Chapter outlines the conceptual and the analytical framework of the study. It also sets out the results of the analyses.

The data available for the Atlantic Region are not fully comprehensive. In making their analyses, the consultants extensively utilized all relevant published information, sought the advice of companies and governments where applicable, and used professional judgement when data were incomplete. It is considered that, overall, the data base can be viewed with confidence.

Four separate and distinct geographical areas where identified, and an economic analysis of the numerous activities that make up an oil or gas play was conducted separately for each of the four. The areas are:

1. The Scotian Shelf,
2. The Gulf of St. Lawrence,
3. The Grand Banks, and
4. The Coast of Labrador.

(b) Activity Blocks

To depict a whole oil or gas play, which is an integrated combination of many highly specialized tasks being performed in a tightly synchronized manner over time, it is necessary to identify each specific activity in terms of costs, timing, employment and what the local economy can do to provide service and hardware inputs.

Each specific activity is called an "activity block". The following "activity blocks" were analysed.

Exploration Activity Blocks	1 rig year	
	2 rig years	
	4 rig years	
	8 rig years	
Capital Construction Activity Blocks	Drilling rig construction	
	Oil production platform	(a) construction
		(b) mobilization, installation
		(c) development drilling
	Gas production platform	(a) construction
		(b) mobilization, installation
		(c) development drilling
	Supply vessels	
	Other vessels (tugs)	
	Offshore pipeline - oil	
	Offshore pipeline - gas	
	Offshore storage facility	
	Onshore gas plant	
	Onshore pipeline - oil	
	Onshore pipeline - gas	
Production Operations Activity Blocks	Operating single oil platform	
	Operating a double oil platform	
	Operating a double gas platform	
	Operating offshore pipelines - oil and gas	
	Operating an onshore gas plant	
	Operating onshore oil and gas pipelines (by case)	

Each "activity block" was analysed in four different ways as follows:

- (a) A breakdown of costs by main items;
- (b) The development of multipliers for each cost items over three rounds of expenditure;
- (c) The calculation of inflation factors;
- (d) The calculation of the number of man-years in each simulation.

Table 21 that follows indicates the number of man years of direct and associated employment generated by each of the "activity blocks". In connection with the table a number of points should be noted. These are listed on the page following the table. Direct employment indicated in the table refers to employment that is closely related to the exploration, construction and production activities of the oil and gas industry. Associated employment refers to employment in those activities that provide goods and services to the oil and gas industry, but excludes further employment that is stimulated by the spending of wages paid to oil and gas industry employees.

From Table 21 it is interesting to note that only in the cases of off-shore pipeline construction does the associated employment exceed that of the direct employment. However, in these instances the employment would be of short duration. In all other cases the associated employment is relatively small, rarely exceeding 20 per cent of direct employment.

TABLE 21

DIRECT AND ASSOCIATED EMPLOYMENT GENERATED BY ACTIVITY BLOCKS IN THE ATLANTIC REGION

Activity Blocks \ Employment	Employment generated in man years: Direct In Petroleum Exploration, Construction & Production	Employment generated in man years: Associated with Exploration, Construction & Production	Employment generated in man years: Total
Exploration Activity Blocks[1]			
1 rig year (i.e. 1 rig for 1 year)	158	37	195
2 rig years (i.e. 2 rigs for 1 year)	304	70	374
4 rig years (i.e. 4 rigs for 1 year)	549	108	657
8 rig years (i.e. 8 rigs for 1 year)	1,024	176	1,200
Capital Activity Blocks			
Drilling rig construction[2]	780	61	841
Production platform, oil:			
construction[3]	1,020	46	1,066
mobilization & installation[4]	50	-	50
development drilling[5]	179	8	187
Production platform, gas:			
construction[6]	435	31	466
mobilization & installation[4]	50	-	50
development drilling[5]	149	8	157
Supply vessel construction[7]	300	12	312
Other vessel construction - tugs[8]	200	12	212
Off-shore pipeline, 100 miles, oil[9]	70	125	195
Off-shore pipeline, 100 miles, gas[10]	250	540	790
Gas plant on-shore[11]	140	30	170
Oil and gas pipeline on-shore - developed for individual cases			
Off-shore oil storage			
Production/Operations Activity Blocks			
Oil platform - single	16	3	19
Oil platform - double	32	6	38
Gas platform - double	32	6	38
Off-shore pipeline, oil/gas	11	4	15
Gas plant on-shore	35	5	40
On-shore oil and gas line - developed by case			

Notes to accompany Table 21.

(1) Due to shorter (on average) helicopter distances, the direct employment figures shown here must be reduced in each activity block as follows, for the Gulf of St. Lawrence: 4 for 1 rig year; 8 for 2 rig years; 14 for 4 rig years; and 23 for 8 rig years.

(2) Construction work extends over eighteen months, over which period some 561 men are employed. This figure has been concentrated in a one-year period, as shown, to be consistent with the manner of presentation of the activity blocks.

(3) Work extends over eighteen months, some 711 jobs for that period. Reduced to one year, the figure is 1,066.

(4) Have some 150 men for one year. In the spending analysis, it is assumed that all would be non-local workers, as the companies would be from Texas or Louisiana, but the employment analysis assumes that 50 of the 150 would be local men.

(5) Development drilling normally extends over one year. Man-year figures shown are for the entire operation, and are put into simulations as one year entry.

(6) Work extends over eighteen months, some 311 jobs over that period. Reduced to one year, the figure is 466.

(7) Jobs for construction period only, viz. 3 months. On simulations, building three vessels is considered one year's work. Data in simulations prorated accordingly if fewer vessels built.

(8) Jobs for construction period - 3 months; prorated accordingly in simulations.

(9) Nearly 100 of the total jobs are created in the cement manufacture and coating of pipe. Assumes pipe-laying year, which is in fact five to six months covering late spring, summer and early fall.

(10) Some 350 of these jobs are concerned with cement manufacture and coating. Pipe-laying man-year is five to six months.

(11) One year construction.

(c) Simulations

Once the "activity blocks" were developed, the next step was to devise realistic oil and gas plays. Given the almost unlimited combinations of exploration, construction and production activities over time a representative number of expected types of oil and gas plays were selected. These combinations of "activity blocks" are known as "simulations". Each simulation was considered for the period 1972 to 1985.

Nineteen "simulations" were developed, each combining individual packages of "activity blocks" over time and subject to estimations as to the magnitude of the resource base.

Scotian Shelf Series A.1	A.1.1	Minimum Threshold Oil (100 million barrel reserve)
	A.1.2	Medium Oil (400 million barrel reserve)
	A.1.3	Major Oil (2 billion barrel reserve)
	A.1.4	Minimum Threshold Gas (12 trillion cubic feet reserve)
	A.1.5	Major Gas (25 trillion cubic feet reserve)
Gulf of St. Lawrence Series A.2	A.2.1	Minimum Threshold Oil (100 million barrel reserve)
	A.2.2	Medium Oil (400 million barrel reserve)
	A.2.3	Major Oil (2 billion barrel reserve)
	A.2.4	Minimum Threshold Gas (12 trillion cubic feet reserve)
	A.2.5	Major Gas (25 trillion cubic feet reserve)
Grand Banks Series A.3	A.3.1	Minimum Threshold Oil (100 million barrel reserve)
	A.3.2	Medium Oil (400 million barrel reserve)
	A.3.3	Major Oil (2 billion barrel reserve)
	A.3.5	Major Gas (25 trillion cubic feet reserve) the major and minimum thresholds are the same, hence there is no A.3.4 model)
No Strike	A.4	Exploration only in three areas A.1, A.2, A.3.

Labrador Series B	B.1	Exploration but not strike
	B.2	Oil (2 billion barrel reserve)
	B.3	Gas (25 trillion cubic feet reserve)

Envelope Simulation Series C	Envelope simulation containing three simulations (a) Simulation A.1.1 with find in 1972 followed by (b) Simulation A.3.5 with find in 1976 followed by (c) Simulation A.1.1 with find in 1981.

To organize and analyze the simulations, a series of plans was developed consisting of:

(a) A physical plan to indicate what "activity blocks" occur and when they occur in the period 1972-1985.
(b) A spending plant to give values to the "activity blocks" as designated in the physical plan.
(c) An allocation of spending plan that allocates spending between the provinces in the Atlantic Region.
(d) An allocation of employment plan that allocates the man-years of employment created by the simulation between the provinces of the Atlantic Region.

For each of the "A" series of simulations, and the "C" simulation, the four plans were developed, plus work sheets for multiplier factoring, multiplier calculations for the activity blocks, inflation factor sheets, and direct labour calculations.

As a first stage of summarizing this material, it was decided that five types of data could be collated from each of the simulations and for each year of these simulations, namely:

(a) Total spending by provinces, and provincial spending as a percentage of total spending (each model, each year).

(b) Total spending by type of activity block (exploration, capital construction, production) and each type of activity block as a percent of total spending (each model, each year).

(c) Total multiplied spending by type of activity in the region, by adding multiplied income derived from each of the three types of activity block. Average multipliers, by type of activity block, were used for each simulation and each year.

(d) Total direct and, of that, induced direct employment, by province for each simulation and each year.

(e) Total direct and, of that, induced direct employment, by type of activity block in exploration, capital construction and production, for each simulation and each year.

(d) The Physical Plans of the Simulations

As many of the figures contained in the detailed plans are confidential, they cannot be shown in detail in this report. However, the physical plans are shown in the following pages to indicate the spread of activities anticipated over time in each model.

It will be noted that the Coast of Labrador Simulations (B Series) are not shown in the physical plans and neither are they included in the analytical sections that follow. The simulations proved to be so different from those of the other areas, and the time framework was so long, that the standard analysis used for other simulations was not considered meaningful for this series. Brief details of the Coast of Labrador Simulations are shown in Chapter 2, Section (f).

PHYSICAL PLAN

SIMULATION A.I.I. - THRESHOLD OIL ON SCOTIAN SHELF

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Total
EXPLORATION															
Rig Years - Scotian Shelf	2	3	4	4	3	3	2	1	-	-	-	-	-	-	22
- Gulf of St. Lawrence	1	1	1	1	-	-	-	-	-	-	-	-	-	-	4
- Grand Banks	1	2	2	2	1	-	-	-	-	-	-	-	-	-	8
- Total	4	6	7	7	4	3	2	1	-	-	-	-	-	-	34
CONSTRUCTION															
Exploration Rigs	-	1 NS	1 NB	-	-	-	-	-	-	-	-	-	-	-	2
Production Platform - Imported	-	1 CO	-	1 MI	1 DD	1 PR	-	-	-	-	-	-	-	-	1
Supply Vessels	-	3 NS	1 NB	-	-	-	-	-	-	-	-	-	-	-	4
PRODUCTION															
Production Platform	-	-	-	-	-	SPL	SPL	SPL	SPL	SPL	SPL	SPL	SPL	SPL	9 SPL

NS - Nova Scotia
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PEI - Prince Edward Isl.
NF - Newfoundland

CO - Construction Ordered
MI - Mobilized & Installed
DD - Development Drilling
PR - Production

PLC - Pipeline Construction
OM - Operation & Maintenance (of Pipeline or Gas Plant)
S/DPL - Single/Double Platform

PHYSICAL PLAN

SIMULATION A.1.2. - MEDIUM OIL ON SCOTIAN SHELF

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Total
EXPLORATION															
Rig Years - Scotian Shelf	2	3	4	5	7	9	9	9	5	2	2	-	-	-	57
- Gulf of St. Lawrence	1	1	1	1	1	1	1	-	-	-	-	-	-	-	7
- Grand Banks	1	2	2	2	2	1	1	-	-	-	-	-	-	-	11
- Total	4	6	7	8	10	11	11	9	5	2	2	-	-	-	75
CONSTRUCTION															
Exploration Rigs	-	1 NS	1 NB	1 NS	1 NF	-	-	-	-	-	-	-	-	-	4
Production Platforms - Imported	-	1 CO	-	1 MI	1 DD	1 PR	-	-	-	-	-	-	-	-	1
- Region	-	-	-	1 CO-NS +1 CO-NB	-	2 MI	2 DD	2 PR	-	-	-	-	-	-	2
Supply Vessels	-	3 NS	1 NS	3 NF	3 NB	-	-	-	-	-	-	-	-	-	10
Offshore Pipeline (18")	-	-	-	-	-	PLC	PLC	-	-	-	-	-	-	-	-
PRODUCTION															
Production Platforms	-	-	-	-	-	SPL	SPL	SPL +DPL	SPL +DPL	SPL +DPL	SPL +DPL	SPL +DPL	SPL +DPL	SPL +DPL	9 SPL +7 DPL
Offshore Pipeline	-	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	OM	7 OM

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S/DPL - Single/Double Platform

PHYSICAL PLAN

SIMULATION A.1.3. - MAJOR OIL ON SCOTIAN SHELF

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Total
EXPLORATION															
Rig Years - Scotian Shelf	2	3	6	8	10	13	15	15	12	9	6	3	1	-	103
- Gulf of St. Lawrence	1	1	1	1	1	1	-	-	-	-	-	-	-	-	6
- Grand Banks	1	2	2	2	2	1	-	-	-	-	-	-	-	-	10
- Total	4	6	9	11	13	15	15	15	12	9	6	3	1	-	119
CONSTRUCTION															
Exploration Rigs	-	1 NS	1 NS + 1 NB	1 NS + 1 NB	1 NS + 1 NB	-	-	-	-	-	-	-	-	-	7
Production Platforms - Imported	-	-	2 CO	2 CO	2 MI	2 MI + 2 DD	2 PR + 2 DD	2 PR	-	-	-	-	-	-	4
- Region	-	-	-	-	1 CO-NS + 1 CO-NB	1 CO-NS	2 MI	2 DD + 1 MI	2 PR + 1 DD	1 PR	-	-	-	-	3
Supply Vessels	1 NS	3 NS	3 NB + 3 NF	3 NB	3 NB + 3 NF	3 NS	-	-	-	-	-	-	-	-	22
Other Vessels (Tugs)	-	-	-	1 NB	1 NS + 1 PEI	1 NS + 1 PEI	-	-	-	-	-	-	-	-	5
Offshore Pipeline & gathering	-	-	-	-	-	PLC	PLC	PLC	PLC	-	-	-	-	-	-
Onshore Pipeline	-	-	-	-	PLC	PLC	-	-	-	-	-	-	-	-	-
PRODUCTION															
Production Platforms	-	-	-	-	-	-	DPL	2 DPL	3 DPL	3 DPL + 1 SPL	3 DPL + 1 SPL	3 DPL + 1 SPL	3 DPL + 1 SPL	3 DPL + 1 SPL	21 DPL + 5 SPL
Offshore Pipeline	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	OM	OM	8 OM
Onshore Pipeline	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	OM	OM	8 OM

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S/DPL - Single/Double Platform

PHYSICAL PLAN

SIMULATION A.1.4. - MINIMUM GAS ON SCOTIAN SHELF

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Total
EXPLORATION															
Rig Years - Scotian Shelf	2	3	4	4	6	7	5	3	1	-	-	-	-	-	35
- Gulf of St. Lawrence	1	1	1	1	-	-	-	-	-	-	-	-	-	-	4
- Grand Banks	1	2	2	2	1	-	-	-	-	-	-	-	-	-	8
- Total	4	6	7	7	7	7	5	3	1	-	-	-	-	-	47
CONSTRUCTION															
Exploration Rigs	-	1 NS	1 NB	-	-	-	-	-	-	-	-	-	-	-	2
Production Platforms - Imported	-	-	2 CO	2 CO	2 MI	2 MI + 2 DD	2 DD + 2 PR	2 PR	-	-	-	-	-	-	4
- Region	-	-	-	-	1 CO-NS + 1 CO-NB	-	2 MI	2 DD	2 PR	-	-	-	-	-	2
Supply Vessels	-	3 NS	-	3 NF	-	-	-	-	-	-	-	-	-	-	6
Other Vessels (Tugs)	-	-	-	1 NB + 1 NS	1 NS + 1 PEI	1 NB	-	-	-	-	-	-	-	-	5
Offshore Pipeline	-	-	-	-	PLC	PLC	PLC	-	-	-	-	-	-	-	-
Onshore Pipeline	-	-	-	-	PLC	PLC	-	-	-	-	-	-	-	-	-
Onshore Gas Plant	-	-	-	-	-	1 NS	-	-	-	-	-	-	-	-	1
PRODUCTION															
Production Platforms	-	-	-	-	-	-	DPL	2 DPL	3 DPL	3 DPL	3 DPL	3 DPL	3 DPL	3 DPL	21 DPL
Offshore Pipeline	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	OM	OM	8 OM
Onshore Pipeline	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	OM	OM	8 OM
Onshore Gas Plant	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	OM	OM	8 OM

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PR - Production

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OM - Operation & Maintenance (of Pipeline or Gas Plant)
S/DPL - Single/Double Platform

PHYSICAL PLAN

SIMULATION A.1.5. - MAJOR GAS ON SCOTIAN SHELF

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Total
EXPLORATION															
Rig Years - Scotian Shelf	2	3	6	8	10	13	15	15	12	9	6	3	1	0	103
- Gulf of St. Lawrence	1	1	1	1	1	1	-	-	-	-	-	-	-	-	6
- Grand Banks	1	2	2	2	2	1	-	-	-	-	-	-	-	-	10
- Total	4	6	9	11	13	15	15	15	12	9	6	3	1	0	119
CONSTRUCTION															
Exploration Rigs	-	1 NS +1 NB	1 NF	1 NF +1 NB	1 NS +1 NF	-	-	-	-	-	-	-	-	-	7
Production Platforms - Imported	-	-	2 CO	2 CO	2 MI	2 CO +2 MI +2 DD	2 PR +2 DD	2 PR +2 MI	2 DD +2 PR	-	-	-	-	-	6
- Region	-	-	-	-	-	1 CO-NS +1 CO-NB	-	1 CO-NS +2 CO-NB +1 CO-NF +2 MI	2 DD	4 MI +2 PR	4 DD	4 PR	-	-	6
Supply Vessels	3 NS	3 NS	3 NB +3 NF	3 NS	3 NB	-	-	-	-	-	-	-	-	-	18
Other Vessels (Tugs)	-	-	-	1 NS	1 NB +1 PEI	1 NS +1 NF	1 PEI	-	-	-	-	-	-	-	6
Onshore Pipeline	-	-	-	-	PLC	PLC	-	-	-	-	-	-	-	-	-
Offshore Pipeline	-	-	-	-	-	PLC	PLC	PLC	-	-	-	-	-	-	-
Onshore Gas Plant	-	-	-	-	-	1 NS	-	-	-	-	-	-	-	-	1
PRODUCTION															
Production Platforms	-	-	-	-	-	-	1 DPL	2 DPL	2 DPL	4 DPL	4 DPL	6 DPL	6 DPL	6 DPL	31 DPL
Offshore Pipeline	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	OM	OM	8 OM
Onshore Pipeline	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	OM	OM	8 OM
Onshore Gas Plant	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	OM	OM	8 OM

NS - Nova Scotia
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CO - Construction Ordered
MI - Mobilized & Installed
DD - Development Drilling
PR - Production

PLC - Pipeline Construction
OM - Operation & Maintenance (of Pipeline or Gas Plant)
S/DPL - Single/Double Platform

PHYSICAL PLAN

SIMULATION A.2.1. - MINIMUM OIL IN GULF OF ST. LAWRENCE

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Total
EXPLORATION															
Rig Years - Gulf of St. Lawrence	1	2	4	4	4	3	2	1	-	-	-	-	-	-	21
- Scotian Shelf	2	2	1	1	-	-	-	-	-	-	-	-	-	-	6
- Grand Banks	1	2	2	2	1	-	-	-	-	-	-	-	-	-	8
- Total	4	6	7	7	5	3	2	1	-	-	-	-	-	-	35
CONSTRUCTION															
Exploration Rigs	-	1 NS	1 NB	-	-	-	-	-	-	-	-	-	-	-	2
Production Platform - Imported	-	1 CO	-	1 MI	1 DD	1 PR	-	-	-	-	-	-	-	-	1
Supply Vessels	3 NS	1 NB	-	-	-	-	-	-	-	-	-	-	-	-	4
PRODUCTION															
Production Platform	-	-	-	-	-	SPL	SPL	SPL	SPL	SPL	SPL	SPL	SPL	SPL	9 SPL

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OM - Operation & Maintenance (of Pipeline or Gas Plant)
S/DPL - Single/Double Platform

PHYSICAL PLAN

SIMULATION A.2.2. - MEDIUM OIL IN GULF OF ST. LAWRENCE

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Total
EXPLORATION															
Rig Years - Gulf of St. Lawrence	1	2	4	5	7	8	9	9	5	2	2	-	-	-	54
- Scotian Shelf	2	2	1	1	1	1	1	-	-	-	-	-	-	-	9
- Grand Banks	1	2	2	2	2	2	1	-	-	-	-	-	-	-	12
- Total	4	6	7	8	10	11	11	9	5	2	2	-	-	-	75
CONSTRUCTION															
Exploration Rigs	-	1 NS	1 NB + 1 NF	1 NS	1 NB	-	-	-	-	-	-	-	-	-	5
Production Platforms - Imported	-	1 CO	-	1 MI	1 DD	1 PR	-	-	-	-	-	-	-	-	1
- Region	-	-	-	1 CO-NS + 1 CO-NB	-	2 MI	2 DD	2 PR	-	-	-	-	-	-	2
Supply Vessels	-	3 NB	3 NS	2 NB	2 NF	-	-	-	-	-	-	-	-	-	10
Offshore Pipeline	-	-	-	-	-	-	PLC	PLC	-	-	-	-	-	-	-
PRODUCTION															
Production Platforms	-	-	-	-	-	SPL	SPL	SPL + DPL	SPL + DPL	SPL + DPL	SPL + DPL	SPL + DPL	SPL + DPL	SPL + DPL	9 SPL + 7 DPL
Offshore Pipeline	-	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	OM	7 OM

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PR - Production

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S/DPL - Single/Double Platform

PHYSICAL PLAN

SIMULATION A.2.3. - MAJOR OIL IN THE GULF OF ST. LAWRENCE

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Total
EXPLORATION															
Rig Years - Gulf of St. Lawrence	1	2	6	8	10	13	15	15	12	9	6	3	1	-	101
- Scotian Shelf	2	2	1	1	1	1	-	-	-	-	-	-	-	-	8
- Grand Banks	1	2	2	2	2	1	-	-	-	-	-	-	-	-	10
- Total	4	6	9	11	13	15	15	15	12	9	6	3	1	-	119
CONSTRUCTION															
Exploration Rigs	-	1 NS + 1 NB	1 NS	1 NB + 1 NF	1 NS + 1 NB	-	-	-	-	-	-	-	-	-	7
Production Platforms - Imported	-	-	2 CO	2 CO	2 MI	2 MI + 2 DD	2 DD + 2 PR	2 PR	-	-	-	-	-	-	4
- Region	-	-	-	-	1 CO-NS + 1 CO-NB	1 CO-NB	2 MI	1 MI + 2 DD	1 DD + 2 PR	1 PR	-	-	-	-	3
Supply Vessels	1 NB	3 NS	3 NB + 3 NF	3 NS + 3 NB	3 NF	1 NB	-	-	-	-	-	-	-	-	20
Other Vessels (Tugs)	-	-	-	1 NB	1 NB + 1 PEI	1 NB + 1 PEI	-	-	-	-	-	-	-	-	5
Offshore Pipeline	-	-	-	-	PLC	PLC	PLC	PLC	PLC	-	-	-	-	-	-
Onshore Pipeline	-	-	-	-	PLC	PLC	-	-	-	-	-	-	-	-	-
PRODUCTION															
Production Platforms	-	-	-	-	-	-	DPL	2 DPL	3 DPL	3 DPL + 1 SPL	3 DPL + 1 SPL	3 DPL + 1 SPL	3 DPL + 1 SPL	3 DPL + 1 SPL	21 DPL + 5 SPL
Offshore Pipeline	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	OM	OM	8 OM
Onshore Pipeline	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	OM	OM	8 OM

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S/DPL - Single/Double Platform

PHYSICAL PLAN

SIMULATION A.2.4. - MINIMUM GAS IN GULF OF ST. LAWRENCE

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Total
EXPLORATION															
Rig Years - Gulf of St. Lawrence	1	2	4	4	6	7	5	3	1	-	-	-	-	-	33
- Scotian Shelf	2	2	1	1	-	-	-	-	-	-	-	-	-	-	6
- Grand Banks	1	2	2	2	1	-	-	-	-	-	-	-	-	-	8
- Total	4	6	7	7	7	7	5	3	1	-	-	-	-	-	47
CONSTRUCTION															
Exploration Rigs	-	1 NS	1 NB	-	-	-	-	-	-	-	-	-	-	-	2
Production Platforms - Imported	-	-	-	2 CO	2 CO	2 MI	+2 MI 2 DD	+2 DD 2 PR	2 PR	-	-	-	-	-	4
- Region	-	-	-	-	-	+1 CO-NS 1 CO-NB	-	2 MI	2 DD	2 PR	-	-	-	-	2
Supply Vessels	-	3 NB	-	3 NB	-	-	-	-	-	-	-	-	-	-	6
Other Vessels (Tugs)	-	-	-	2 NB	+1 NB 1 PEI	1 NB	-	-	-	-	-	-	-	-	5
Offshore Pipeline	-	-	-	-	-	PLC	PLC	PLC	-	-	-	-	-	-	-
Onshore Pipeline	-	-	-	-	-	PLC	PLC	-	-	-	-	-	-	-	-
Onshore Gas Plant	-	-	-	-	-	-	1 NB	-	-	-	-	-	-	-	-
PRODUCTION															
Production Platforms	-	-	-	-	-	-	-	DPL	2 DPL	3 DPL	3 DPL	3 DPL	3 DPL	3 DPL	18 DPL
Offshore Pipeline	-	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	OM	7 OM
Onshore Pipeline	-	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	OM	7 OM
Onshore Gas Plant	-	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	OM	7 OM

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DD - Development Drilling
PR - Production

PLC - Pipeline Construction
OM - Operation & Maintenance (of Pipeline or Gas Plant)
S/DPL - Single/Double Platform

PHYSICAL PLAN

SIMULATION A.2.5. - MAJOR GAS IN GULF OF ST. LAWRENCE

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Total
EXPLORATION															
Rig Years - Gulf of St. Lawrence	1	2	6	8	10	13	15	15	12	9	6	3	1	-	101
- Scotian Shelf	2	2	1	1	1	1	-	-	-	-	-	-	-	-	8
- Grand Banks	1	2	2	2	2	1	-	-	-	-	-	-	-	-	10
	4	6	9	11	13	15	15	15	12	9	6	3	1	-	119
CONSTRUCTION															
Exploration Rigs	-	1 NB +1 NS	1 NB +1 NF	1 NS +1 NF	1 NS +1 NB	-	-	-	-	-	-	-	-	-	8
Production Platforms - Imported	-	-	2 CO	2 CO	2 MI	2 CO +2 MI +2 DD	2 PR +2 DD	2 PR +2 MI	2 DD	2 PR	-	-	-	-	6
- Region	-	-	-	-	-	1 CO-NS +1 CO-NB	-	2 CO-NB +1 CO-NS +1 CO-NF +2 MI	2 DD	4 MI +2 PR	4 DD	4 PR	-	-	6
Supply Vessels	2 NB	3 NS	3 NB +3 NF	3 NS	3 NB	-	-	-	-	-	-	-	-	-	17
Other Vessels (Tugs)	-	-	-	1 PEI	1 NS +1 NB	1 PEI +1 NB	1 NS	-	-	-	-	-	-	-	6
Offshore Pipeline	-	-	-	-	-	PLC	PLC	PLC	-	-	-	-	-	-	-
Onshore Pipeline	-	-	-	-	PLC	PLC	-	-	-	-	-	-	-	-	-
Onshore Gas Plant	-	-	-	-	-	1 NB	-	-	-	-	-	-	-	-	-
PRODUCTION															
Production Platforms	-	-	-	-	-	-	DPL	2 DPL	2 DPL	4 DPL	4 DPL	6 DPL	6 DPL	6 DPL	31 DPL
Offshore Pipeline	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	OM	OM	8 OM
Onshore Pipeline	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	OM	OM	8 OM
Onshore Gas Plant	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	OM	OM	8 OM

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S/DPL - Single/Double Platform

PHYSICAL PLAN

SIMULATION A.3.1. - MINIMUM OIL ON GRAND BANKS

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Total
EXPLORATION															
Rig Years - Grand Banks	1	3	5	5	5	3	2	1	-	-	-	-	-	-	25
- Scotian Shelf	2	2	1	1	-	-	-	-	-	-	-	-	-	-	6
- Gulf of St. Lawrence	1	1	1	1	-	-	-	-	-	-	-	-	-	-	4
- Total	4	6	7	7	5	3	2	1	-	-	-	-	-	-	35
CONSTRUCTION															
Exploration Rigs	-	1 NS	1 NB	-	-	-	-	-	-	-	-	-	-	-	2
Production Platform - Imported	-	1 CO	-	1 MI	1 DD	1 PR	-	-	-	-	-	-	-	-	1
Supply Vessels	-	3 NS	1 NB	-	-	-	-	-	-	-	-	-	-	-	4
PRODUCTION															
Production Platform	-	-	-	-	-	SPL	SPL	SPL	SPL	SPL	SPL	SPL	SPL	SPL	9 SPL

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OM - Operation & Maintenance (of Pipeline or Gas Plant)
S/DPL - Single/Double Platform

PHYSICAL PLAN

SIMULATION A.3.2. - MEDIUM OIL ON GRAND BANKS

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Total
EXPLORATION															
Rig Years - Grand Banks	1	3	5	6	8	9	9	9	5	2	2	-	-	-	59
- Scotian Shelf	2	2	1	1	1	1	1	-	-	-	-	-	-	-	9
- Gulf of St. Lawrence	1	1	1	1	1	1	1	-	-	-	-	-	-	-	7
- Total	4	6	7	8	10	11	11	9	5	2	2	-	-	-	75
CONSTRUCTION															
Exploration Rigs	-	1 NS +1 NF	1 NB	1 NS +1 NF	-	-	-	-	-	-	-	-	-	-	5
Production Platforms - Imported	-	1 CO	-	1 MI	1 DD	1 PR	-	-	-	-	-	-	-	-	1
- Region	-	-	-	1 CO-NS +1 CO-NB	-	2 MI	2 DD	2 PR	-	-	-	-	-	-	2
Supply Vessels	-	3 NF	3 NS	3 NF	3 NB	-	-	-	-	-	-	-	-	-	12
PRODUCTION															
Production Platform	-	-	-	-	-	SPL	SPL	SPL +DPL	SPL +DPL	SPL +DPL	SPL +DPL	SPL +DPL	SPL +DPL	SPL +DPL	9 SPL +7 DPL

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PHYSICAL PLAN

SIMULATION A.3.3. - MAJOR OIL ON GRAND BANKS

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Total
EXPLORATION															
Rig Years - Grand Banks	1	3	7	9	11	13	15	15	12	9	6	3	1	-	105
- Scotian Shelf	2	2	1	1	1	1	-	-	-	-	-	-	-	-	8
- Gulf of St. Lawrence	1	1	1	1	1	1	-	-	-	-	-	-	-	-	6
- Total	4	6	9	11	13	15	15	15	12	9	6	3	1	-	119
CONSTRUCTION															
Exploration Rigs	-	1 NS + 1 NB	1 NF + 1 NS	1 NB + 1 NF	1 NS + 1 NB	-	-	-	-	-	-	-	-	-	8
Production Platforms - Imported	-	-	2 CO	2 CO	2 MI	2 DD + 2 MI	2 PR + 2 DD	2 PR	-	-	-	-	-	-	4
- Region	-	-	-	-	2 CO-NF	1 CO-NF	2 MI	2 DD + 1 MI	2 PR + 1 DD	1 PR	-	-	-	-	3
Supply Vessels	3 NS	3 NF	3 NB + 3 NF	3 NS	3 NB + 3 NF	3 NS	-	-	-	-	-	-	-	-	24
Other Vessels (Tugs)	-	-	-	1 NS	1 NF + 1 PEI	1 NB + 1 NF	-	-	-	-	-	-	-	-	5
Offshore Storage	-	-	-	1 CO-NF	-	1 MI	-	-	-	-	-	-	-	-	1
PRODUCTION															
Production Platforms	-	-	-	-	-	-	DPL	2 DPL	3 DPL	3 DPL + 1 SPL	3 DPL + 1 SPL	3 DPL + 1 SPL	3 DPL + 1 SPL	3 DPL + 1 SPL	21 DPL + 5 SPL

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PHYSICAL PLAN

SIMULATIONS A.3.4. AND A.3.5. - MINIMUM AND MAJOR GAS ON THE GRAND BANKS (SEE ASSUMPTIONS)

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Total
EXPLORATION															
Rig Years - Grand Banks	1	3	7	9	11	13	15	15	12	9	6	3	1	-	105
- Scotian Shelf	2	2	1	1	1	1	-	-	-	-	-	-	-	-	8
- Gulf of St. Lawrence	1	1	1	1	1	1	-	-	-	-	-	-	-	-	6
- Total	4	6	9	11	13	15	15	15	12	9	6	3	1	-	119
CONSTRUCTION															
Exploration Rigs	-	1 NS + 1 NB	1 NS + 1 NF	1 NB + 1 NF	1 NS + 1 NB	-	-	-	-	-	-	-	-	-	8
Production Platforms - Imported	-	-	-	2 CO	2 CO	2 MI	2 CO + 2 MI + 2 DD	2 DD + 2 PR	2 MI + 2 PR	2 DD	2 PR	-	-	-	6
- Region	-	-	-	-	1 CO-NB + 1 CO-NF	1 CO-NB + 1 CO-NF	1 CO-NB + 1 CO-NF + 2 MI	2 MI + 2 DD	2 MI + 2 DD + 2 PR	2 DD + 2 PR	2 PR	-	-	-	6
Supply Vessels	3 NS	3 NB + 3 NF	3 NS	3 NB	3 NF	-	-	-	-	-	-	-	-	-	18
Other Vessels (Tugs)	-	-	-	-	1 NF	1 NS + 1 PEI	1 NF + 1 NB	1 PEI	-	-	-	-	-	-	6
Offshore Pipeline	-	-	-	-	-	-	PLC	PLC	PLC	-	-	-	-	-	-
Onshore Pipeline	-	-	-	-	-	-	PLC	-	-	-	-	-	-	-	-
Onshore Gas Plant	-	-	-	-	-	-	1 NF	-	-	-	-	-	-	-	-
PRODUCTION															
Production Platforms	-	-	-	-	-	-	-	DPL	3 DPL	5 DPL	6 DPL	6 DPL	6 DPL	6 DPL	33 DPL
Offshore Pipeline	-	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	OM	7 OM
Onshore Pipeline	-	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	OM	7 OM
Onshore Gas Plant	-	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	OM	7 OM

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PHYSICAL PLAN

SIMULATION A.4. - EXPLORATION BUT NO DEVELOPMENT

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Total
EXPLORATION															
Rig Years - Scotian Shelf	2	2	2	2	1	1	-	-	-	-	-	-	-	-	10
- Gulf of St. Lawrence	1	1	2	2	1	1	1	-	-	-	-	-	-	-	9
- Grand Banks	2	2	3	3	2	-	-	-	-	-	-	-	-	-	12
- Total	5	5	7	7	4	2	1	-	-	-	-	-	-	-	31

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PHYSICAL PLAN

SIMULATION C - MULTIPLE SIMULATION

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Total
EXPLORATION (Rig Years)																		
Scotian Shelf	2	3	4	4	3	3	2	2	1	1	3	4	4	3	3	2	1	45
Grand Banks	1	2	2	2	1	3	6	9	11	13	15	15	12	9	6	3	1	111
Gulf of St. Lawrence	1	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-	7
Total	4	6	7	7	5	7	9	11	12	14	18	19	16	12	9	5	2	163
CONSTRUCTION																		
Exploration Rigs	-	1 NS	1 NB	-	-	1 NS + 1 NB	1 NS + 1 NF	1 NB + 1 NF	1 NS + 1 NB	-	1 NB + 1 NS	-	-	-	-	-	-	12
Production Platforms - Imported	-	1 CO	-	1 MI	1 DD	1 PR	-	2 CO	2 CO	2 MI	3 CO + 2 MI + 2 DD	2 PR + 2 DD	2 PR + 3 MI	3 DD	3 PR	-	-	
- Region	-	-	-	-	-	-	-	-	1 CO-NB + 1 CO-NF	1 CO-NB + 1 CO-NF	1 CO-NB + 1 CO-NF + 2 MI	2 DD + 2 MI	2 PR + 2 DD + 2 MI	2 PR + 2 DD	2 PR	-	-	6
Supply Vessels	-	3 NS	1 NB	-	3 NS	3 NB + 3 NF	3 NS	3 NB	3 NF	-	3 NS	-	-	-	-	-	-	25
Other Vessels (Tugs)	-	-	-	-	-	-	-	-	1 NF	1 NS + 1 PEI	1 NF + 1 NB	1 PEI	-	-	-	-	-	6
Offshore Pipeline	-	-	-	-	-	-	-	-	-	PLC	PLC	PLC	PLC	-	-	-	-	-
Onshore Pipeline	-	-	-	-	-	-	-	-	-	PLC	PLC	-	-	-	-	-	-	-
Gas Plant Onshore	-	-	-	-	-	-	-	-	-	-	1 NF	-	-	-	-	-	-	1
PRODUCTION																		
Production Platforms	-	-	-	-	-	SPL	SPL	SPL	SPL	SPL	SPL	SPL + DPL	SPL + 3 DPL	SPL + 4 DPL	2 SPL + 6 DPL	2 SPL + 6 DPL	2 SPL + 6 DPL	15 SPL + 26 DPL
Offshore Pipeline	-	-	-	-	-	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	6 OM
Onshore Pipeline	-	-	-	-	-	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	6 OM
Gas Plant Onshore	-	-	-	-	-	-	-	-	-	-	-	OM	OM	OM	OM	OM	OM	6 OM

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S/DPL - Single/Double Platform

(e) Analysis of Spending by Province

Table 22 indicates, by simulation, the total spending over the entire life of each simulation, the breakout of total spending by province for the simulation, and the percentage distribution by province of that spending.

It is interesting to note that the three major gas simulations are the largest spenders, with expenditures ranging from $3.6 billion in the Gulf of St. Lawrence (A.2.5) to $4.0 billion on the Shelf (A.1.5), and $4.2 billion on the Grand Banks (A.3.5). Much of this is pipeline cost, but only regional spending on a pipeline is included in these figures. By contrast, the no strike simulation (A.4) is roughly one-tenth the size.

The major gas simulations in each area are significantly larger than the major oil simulations. On the Scotian Shelf, the major oil simulation spends $3.0 billion compared to $4.0 billion for the major gas simulation. In the Gulf of St. Lawrence, the major oil simulation is $2.8 billion while the major gas is $3.6 billion, and on the Grand Banks the difference between the two is some $1.2 billion.

The percentage spent in Nova Scotia is greater for the Scotian Shelf simulations, and likewise to New Brunswick and to Prince Edward Island for the Gulf of St. Lawrence simulations, and Newfoundland for the Grand Banks simulations. It should also be observed that even in the Gulf of St. Lawrence and the Grand Banks simulations, Nova Scotia, relatively speaking, tends to do slightly better than the other provinces. This is due to the earlier and larger participation of that Province in all appropriate simulations of capital construction activities.

It would also appear that the larger the simulation in terms of spending, the larger will be the percentage going to the province of petroleum activity. Thus, on the Shelf, simulations A.1.5 (major gas) and A.1.3 (major oil) have 82.5% and 86.2% respectively going to Nova Scotia, while the three smaller simulations have been 71.4% and 79.6%. The equivalent two large simulations on the Grand Banks have 90.4% and 88.3% of their spending in Newfoundland, but the two smaller simulations have significantly lower percentages. The pattern is not quite so sharp in the Gulf of St. Lawrence, as both New Brunswick and Prince Edward Island share the main spending.

TABLE 22

TOTAL SPENDING IN SIMULATIONS BY DOLLARS AND

BY PER CENT: PROVINCIAL DISTRIBUTION

SIMU-LATION	TOTAL SPENDING OVER ENTIRE LIFE	SPENDING BY PROVINCE				DISTRIBUTION BY PROVINCE			
		NS	NB	PEI	NFLD	NS	NB	PEI	NFLD
	$000	$000	$000	$000	$000	%	%	%	%
A.1.1.	630,122	449,608	44,233	24,411	111,870	71.4	7.0	3.9	17.8
A.1.2.	1,645,359	1,309,873	97,805	47,032	190,649	79.6	5.9	2.8	11.6
A.1.3.	3,000,079	2,586,119	169,934	45,119	198,907	86.2	5.7	1.5	6.6
A.1.4.	1,940,211	1,449,569	338,457	30,853	121,332	74.7	17.4	1.6	6.2
A.1.5.	3,969,041	3,275,546	423,949	45,339	224,207	82.5	10.7	1.1	5.6
A.2.1.	620,493	101,295	213,575	193,753	111,870	16.3	34.4	31.2	18.0
A.2.2.	1,602,702	192,628	641,208	566,933	201,933	12.0	40.0	35.4	12.6
A.2.3.	2,834,736	203,151	1,314,879	1,135,750	180,956	7.2	46.4	40.1	6.4
A.2.4.	1,729,006	112,366	887,029	617,741	111,870	6.5	51.3	35.7	6.8
A.2.5.	3,639,902	227,196	1,788,890	1,440,050	183,766	6.2	49.1	39.6	5.0
A.3.1.	655,400	101,295	41,275	24,410	488,420	15.4	6.3	3.7	74.5
A.3.2.	1,670,002	192,628	97,805	47,032	1,332,537	11.5	5.8	2.8	79.8
A.3.3.	2,961,948	191,322	113,910	41,971	2,614,745	6.4	3.8	1.4	88.3
A.3.5.	4,161,503	180,357	171,200	45,780	3,764,166	4.3	4.1	1.1	90.4
A.4.	423,035	135,785	59,450	59,449	168,341	32.1	14.0	14.0	39.8
C.	5,348,491	968,911	264,558	51,761	4,063,261	18.1	4.9	1.0	76.0

(f) Analysis of Spending by Type of Activity

Table 23 indicates, by simulation, the breakout of spending between the exploration, capital construction and production phases.

It appears that exploration is a significantly larger percentage of total spending in the oil simulations than it is for the gas simulations. On the Shelf, the three oil simulations have 75.5%, 70.4% and 64.4% of their total spending in exploration whereas the two gas simulations have between 35.5% and 48.6%. Similar large differences occur in the other two areas.

With the exception of only one gas simulation (A.1.4 threshold gas on the Shelf), the percentage of total spending in exploration is consistently greater than on the capital construction and production. Indeed, in all oil simulations, it is greater than the other two combined. In spite of the fact that these simulations cover only a fourteen year period, and that production activities are spread over the latter half of the period, or a little longer in some cases, the data in Table 23 emphasizes that the real spending impact of an off-shore play is not in production activities. The impact lies, first, in exploration, and secondly, in capital construction activities, regardless of whether a small or a large simulation is involved or whether it is an oil or a gas play. This is especially noticeable in the envelope simulation (c), when production has only 5.9% of the spending, and exploration over half (54.1%).

(g) Direct Employment by Province

Table 24 indicates, by number and per cent, the interprovincial distribution of man years of direct employment created in each simulation.

The major gas simulations provide the greatest direct employment with an average of some 2,900 to 3,600 jobs over the fourteen year life of the simulation. The equivalent figures for the small oil simulations are 625 to 650 jobs. These are not particularly high figures, given the volumes of spending. However, the largest contributors to employment are capital construction projects, especially rigs, platforms and pipelines. In the simulations, this active construction period coincides with maximum rates of exploration drilling.

TABLE 23

TOTAL SPENDING IN EACH SIMULATION BY DOLLARS

AND PER CENT: BY TYPE OF ACTIVITY BLOCK

SIMULATION	TOTAL SPENDING OVER ENTIRE LIFE	SPENDING DISTRIBUTION BY TYPE					
		EXPLORATION EXPENDITURES		CAPITAL EXPENDITURES		PRODUCTION EXPENDITURES	
	$000	$000	%	$000	%	$000	%
A.1.1	630,122	475,888	75.5	67,063	10.6	87,171	13.8
A.1.2.	1,645,359	1,157,619	70.4	257,434	15.6	230,306	14.0
A.1.3.	3,000,079	1,930,719	64.4	584,367	19.5	484,993	16.2
A.1.4.	1,940,211	688,560	35.5	766,118	39.5	485,533	25.0
A.1.5.	3,969,041	1,930,719	48.6	1,188,395	29.9	849,927	21.4
A.2.1.	620,493	468,466	75.5	67,063	10.8	84,964	13.7
A.2.2.	1,602,702	1,100,424	68.7	275,830	17.2	226,448	14.1
A.2.3.	2,834,736	1,815,803	64.0	539,727	19.0	479,206	16.9
A.2.4.	1,729,006	656,646	38.0	629,033	36.4	443,329	25.6
A.2.5.	3,639,902	1,789,689	49.2	1,094,816	30.1	755,397	20.8
A.3.1.	655,400	499,384	76.2	68,083	10.4	87,933	13.4
A.3.2.	1,670,002	1,184,175	70.9	255,798	15.3	230,029	13.8
A.3.3.	2,961,948	1,979,412	66.8	502,131	17.0	480,405	16.2
A.3.5.	4,161,503	1,979,414	47.6	1,357,554	32.6	824,535	19.8
A.4.	423,025	423,025	100.0	-	-	-	-
C.	5,348,491	2,891,023	54.1	2,139,673	40.0	317,795	5.9

TABLE 24

PROVINCIAL DISTRIBUTION OF DIRECT EMPLOYMENT

BY SIMULATION, NUMBER AND PER CENT

SIMULATION	TOTAL MAN YEARS OF DIRECT EMPLOYMENT IN SIMULATION	BY PROVINCE, NUMBER				BY PROVINCE, PER CENT			
		NS	NB	PEI	NFLD	NS	NB	PEI	NFLD
		No.	No.	No.	No.	%	%	%	%
A.1.1.	8,762	5,525	1,335	390	1,512	63.2	15.2	4.4	17.2
A.1.2.	20,626	13,704	3,006	682	3,234	66.4	14.6	3.3	15.7
A.1.3.	37,516	26,419	6,178	727	4,192	70.4	16.5	1.9	11.2
A.1.4.	20,199	12,386	5,528	461	1,824	61.3	27.4	2.3	9.0
A.1.5.	40,874	27,681	8,049	727	4,417	67.8	19.6	1.8	10.8
A.2.1.	9,117	2,395	3,027	2,183	1,512	26.3	33.2	23.9	16.6
A.2.2.	21,134	4,783	8,156	4,886	3,309	22.6	38.5	23.1	15.8
A.2.3.	38,528	6,989	17,151	9,789	4,599	18.1	44.6	25.4	11.9
A.2.4.	19,991	2,445	11,618	4,416	1,512	12.2	58.1	22.1	7.6
A.2.5.	44,701	8,215	20,292	11,224	4,970	18.4	45.4	25.1	11.1
A.3.1.	9,087	2,445	1,386	390	4,866	26.9	15.2	4.3	53.6
A.3.2.	23,388	5,407	3,526	682	13,773	23.1	15.1	2.9	58.9
A.3.3.	40,819	7,071	5,192	797	27,759	17.3	12.7	2.0	68.0
A.3.5.	49,505	6,135	7,857	1,009	34,504	12.4	15.9	2.0	69.7
A.4.	5,869	1,886	861	862	2,260	32.1	14.7	14.7	38.5
C.	56,224	15,642	10,273	1,107	29,202	27.8	18.3	2.0	51.9

Thereafter, only a handful of permanent direct jobs remain. Thus, the industry would make very little impression on unemployment in the region.

The larger share of employment falls in the province which features the most activity. On the Scotian Shelf, the simulation that indicates the largest share of its jobs in Nova Scotia is the major oil simulation (A.1.3.). In the Gulf of St. Lawrence, the simulation with the greatest concentration in New Brunswick and Prince Edward Island is the threshold gas simulation (A.2.4.). On the Grand Banks, the equivalent simulation is the major gas (A.3.5.).

(h) Direct Employment by Type of Activity

Table 25 indicates employment patterns, by simulation, broken out into shares in exploration, capital construction and production. All but a few simulations indicate most employment being created in exploration activities, though capital construction looms large in the major oil and the gas simulations.

Production employment is relatively minor. This again emphasizes the need to maximize capital construction benefits, as the permanent employment involved in production is small.

(i) Spending per Direct Man-Year Created

Table 26 presents the gross spending in each simulation per man-year created.

The average of all simulations is some $82,520 of spending at current prices per man year of direct employment created - 1972 to 1985. This average is not a typical figure, for oil simulations generally spend significantly less per man-year created than do gas simulations. On the Scotian Shelf, for example, the oil simulations spend from $71,920 to $79,970 per man-year created whereas gas simulations spend $96,050 to $97,100. The exploration-no-strike simulation spends $72,080 per man-year created which is very similar to the smaller oil simulations.

The smaller oil simulations generally create a man-year of employment more cheaply than the larger oil simulations. If funds were limited, and if job creation were the only, or the priority, objective, then a series of smaller plays might be preferred to a few larger plays.

TABLE 25

DISTRIBUTION OF DIRECT REGIONAL EMPLOYMENT

BY ACTIVITY TYPE BY NUMBERS AND PER CENT

SIMULATION	TOTAL MAN YEARS OF DIRECT EMPLOYMENT IN SIMULATION	BY TYPE OF ACTIVITY, NUMBER			BY TYPE OF ACTIVITY, PER CENT		
		EXPLORATION	CAPITAL CONSTRUCTION	PRODUCTION	EXPLORATION	CAPITAL CONSTRUCTION	PRODUCTION
	No.	No.	No.	No.	%	%	%
A.1.1.	8,762	6,256	2,335	171	71.4	26.6	2.0
A.1.2.	20,626	12,688	7,501	437	61.5	36.4	2.1
A.1.3.	37,516	19,313	15,735	2,468	51.5	42.0	6.6
A.1.4.	20,199	8,022	8,903	3,274	39.7	44.1	16.2
A.1.5.	40,874	19,313	17,770	3,791	47.2	43.5	9.3
A.2.1.	9,117	6,611	2,335	171	72.5	25.6	1.9
A.2.2	21,134	12,356	8,341	437	58.5	39.5	2.1
A.2.3.	38,528	19,297	18,338	893	50.1	47.6	2.3
A.2.4.	19,991	8,185	9,715	2,091	40.9	48.6	10.4
A.2.5.	44,701	19,298	22,617	2,786	43.2	50.6	6.2
A.3.1.	9,087	6,376	2,540	171	70.2	28.0	1.9
A.3.2.	23,388	12,720	10,231	437	54.4	43.7	1.9
A.3.3.	40,819	19,793	20,133	893	48.5	49.3	2.2
A.3.5.	49,505	19,803	26,581	3,121	40.0	53.7	6.3
A.4.	5,869	5,869	-	-	100.0	-	-
C. (Envelope)	56,224	24,340	30,614	1,270	43.3	54.5	2.2

TABLE 26

TOTAL SPENDING PER MAN-YEAR CREATED,

BY SIMULATION

SIMULATION	TOTAL SPENDING	TOTAL MAN-YEARS NO.	SPENDING PER MAN-YEAR $000
A.1.1.	630,122	8,762	71.92
A.1.2	1,645,395	20,626	79.77
A.1.3.	3,000,079	37,516	79.97
A.1.4.	1,940,211	20,199	96.05
A.1.5.	3,969,041	40,874	97.10
A.2.1.	620,493	9,117	68.06
A.2.2.	1,602,702	21,134	75.84
A.2.3.	2,834,736	38,528	73.58
A.2.4.	1,729,006	19,991	86.49
A.2.5.	3,639,902	44,701	81.43
A.3.1.	655,400	9,087	72.12
A.3.2.	1,670,002	23,388	71.40
A.3.3.	2,961,948	40,819	72.56
A.3.5.	4,161,503	49,505	84.06
A.4.0.	423,025	5,869	72.08
C.	5,348,491	56,224	95.13
Average			82.52

(j) Indirect Employment by Provinces

In this study indirect employment represents the employment created by the oil and gas industry's expenditures on goods and services, plus employment that is generated by the spending of wages and salaries paid to direct employees of the industry. Thus, indirect employment consists of associated employment as shown in Table 21 plus employment created by consumption.

Indirect employment was not calculated for each one of the simulations. It was determined for the five simulations shown below.

TABLE 27

INDIRECT EMPLOYMENT CREATED IN SELECTED SIMULATIONS

Simulations	Total Direct Employment in hundreds of man years	Total Indirect Employment in hundreds of man years	Indirect/ Direct %
Minor Oil Scotian Shelf	88	55	63.2
Minimum Gas St. Lawrence	200	124	61.9
Major Oil Grand Banks	408	254	62.1
Major Gas Grand Banks	495	328	66.2
Exploration No Development	59	37	63.1
AVERAGE	-	-	63.3

TABLE 28

TOTAL MAN YEARS OF INDIRECT EMPLOYMENT CREATED IN EACH SIMULATION BY PROVINCIAL DISTRIBUTION

Simulation	Total Direct Employment in man years	Indirect Employment as a % of	Total Indirect Employment in man years	Total Indirect Employment by Province				Total Direct and Indirect Employment in man years
				Nova Scotia	New Brunswick	Prince Edward Island	Newfoundland	
	No.	%	No.	No.	No.	No.	No.	No.
A.1.1	8,762	63.2	5,538	3,499	842	244	953	14,300
A.1.2	20,626	63.3*	13,056	8,669	1,906	431	2,050	33,682
A.1.3	37,516	63.3*	23,748	16,719	3,918	451	2,660	61,264
A.1.4	20,199	63.3*	12,786	7,838	3,503	294	1,151	32,985
A.1.5	40,874	63.3*	25,873	17,542	5,071	466	2,794	66,747
A.2.1	9,117	63.3*	5,771	1,518	1,916	1,379	958	14,888
A.2.2	21,134	63.3*	13,378	3,023	5,151	3,090	2,114	34,512
A.2.3	38,528	63.3*	24,388	4,414	10,877	6,195	2,902	62,916
A.2.4	19,991	61.9	12,374	1,510	7,189	2,735	940	32,365
A.2.5	44,701	63.3*	28,296	5,206	12,847	7,102	3,141	72,997
A.3.1	9,087	63.3*	5,752	1,547	874	247	3,084	14,839
A.3.2	23,388	63.3*	14,805	3,420	2,236	429	8,720	38,193
A.3.3	40,819	62.1	25,349	4,385	3,219	509	17,236	66,168
A.3.5	49,505	66.2	32,772	4,064	5,211	655	22,842	82,277
A.4	5,869	63.1	3,704	1,189	544	544	1,427	9,573

* This percentage is the average of indirect to direct employment as shown in Table 27.

Using both the actual relationships of indirect to direct employment where available and the average (from Table 27) where not available, indirect employment for each simulation was calculated as shown in Table 28. It was assumed that the distribution between the provinces of the indirect employment would be the same as that of direct employment (see Table 24).

Whilst some of the indirect employment figures in Table 28 are quite high, it must be remembered that they relate to total employment in each simulation, and that the simulations contain the exploration and construction phases. Production employment is a small proportion of the total (see Table 25). Thus, when the exploration and construction phases decline, the loss of employment will be felt in both the direct and indirect sectors.