



**DECISION 2003.02**

**RESPECTING**

**Extension of the Ben Nevis/Avalon Appraisal Period**

**October 2003**

Disponible en français

*ISBN # 0-921569-97-1*

## Table of Contents

	<u>Page</u>
<b>1.0 Summary:</b> _____	<b>1</b>
<b>2.0 Background</b> _____	<b>5</b>
<b>3.0 Proponent's Application</b> _____	<b>9</b>
3.1 Reservoir Performance _____	9
3.2 B-44 'O' Block Appraisal Well _____	14
3.3 Southwest Ben Nevis/Avalon Development Options _____	14
3.4 Original Oil-in-Place _____	15
3.5 Proponent's Geologic Model _____	16
3.6 Proposed Production, Injection & Drilling Plans _____	22
3.7 Northwest Ben Nevis/Avalon Reservoir Area _____	23
3.8 Data Acquisition _____	23
3.9 Appraisal Activities Timeline _____	24
<b>4.0 C-NOPB Review</b> _____	<b>26</b>
4.1 Ben Nevis/Avalon Appraisal Period Considerations _____	26
4.2 Conclusion _____	29

## List of Tables

- Table 1: Ben Nevis/Avalon Production and Injection Volumes up to December 31, 2002 ( Source: C-NOPB )
- Table 2: Ben Nevis/Avalon STOOIP Estimates ( Source: After HMDC )
- Table 3: Ben Nevis/Avalon Proposed Production and Injection from January 2003 to December 2005 ( Source: After HMDC )

## List of Figures

- Figure 1: Ben Nevis/Avalon Reservoir proposed appraisal period wells ( Source: After HMDC 1996 )
- Figure 2: Ben Nevis/Avalon Reservoir current well locations ( Source: After HMDC )
- Figure 3: Ben Nevis/Avalon Reservoir Cumulative Production & Injection ( Source: C-NOPB )
- Figure 4: Ben Nevis /Avalon Reservoir Average Daily Production Rates ( Source: C-NOPB )
- Figure 5: Ben Nevis/Avalon Average Daily Water Injection Rates ( Source: C-NOPB )
- Figure 6: Ben Nevis/Avalon Reservoir “Polygons” ( Source: After HMDC )
- Figure 7: HMDC Barrier Island Model ( Source: After HMDC )
- Figure 8: Paleodepositional Environment, Lower Ben Nevis Unit I ( Source: After HMDC )
- Figure 9: Paleodepositional Environment, Lower Ben Nevis Unit II ( Source: After HMDC )
- Figure 10: Generalized Geologic Cross-section ( Source: After HMDC )
- Figure 11: Cross Section showing key differences in southwest area of Hibernia field ( Source: After HMDC )
- Figure 12: Isopach, Northwest Wedge, Ben Nevis to B-27 Basal, showing potential location ( Source: After HMDC )
- Figure 13: Seismic Section, Northwest Wedge, showing potential location ( Source: After HMDC )
- Figure 14: Ben Nevis/Avalon Reservoir Appraisal Activities Timeline ( Source: After HMDC )

## 1.0 Summary:

Two main reservoirs exist within the Hibernia field, the Hibernia reservoir and the Ben Nevis/Avalon reservoir. The Hibernia Development Plan submitted in 1985 proposed only a limited area of development for the Ben Nevis/Avalon reservoir. The Board rejected the development plan for the Ben Nevis/Avalon reservoir at that time, asking the Hibernia owners to explore ways to exploit the reservoir earlier than proposed. In July 1996, the Hibernia Management and Development Company (the Proponent) submitted a Development Plan Amendment for the Hibernia field, which included a proposed appraisal program for the Ben Nevis/Avalon reservoir. The Proponent's strategy included an appraisal stage designed to resolve uncertainties and acquire information to devise a development plan for the Ben Nevis/Avalon reservoir.

In *The Amendment to the Hibernia Development Plan, Decision 97.01*, the Board approved the Proponent's plan to conduct an appraisal program for the Ben Nevis/Avalon reservoir. In the Amendment, the Proponent committed to submitting a report detailing the results of the Ben Nevis/Avalon appraisal program and an update to the Hibernia Development Plan five years after first oil production (December 2002). This report was to provide a comprehensive development plan for the Ben Nevis/Avalon reservoir.

On December 13, 2002 the Proponent submitted the document *Ben Nevis-Avalon Appraisal Program Update*, and requested an extension of the Ben Nevis/Avalon appraisal period from December 31, 2002 to December 31, 2005. The Proponent noted that while considerable effort has been made to appraise the Ben Nevis/Avalon reservoir, experience to date indicates the reservoir is significantly more complex than originally anticipated. The Proponent states that many of the essential elements necessary for preparation of a comprehensive development plan still remain unknown. The Proponent also requests that while the application for the extension of the appraisal period is being considered, it be permitted to continue with production from the Ben Nevis/Avalon reservoir. The Board approved the latter request.

The Board has determined that approval of the Proponent's request to extend the appraisal period, is a fundamental decision under the *Canada-Newfoundland and Labrador Atlantic Accord Implementation Acts*. In addition, in accordance with the Newfoundland Offshore Area Petroleum Production and Conservation Regulations, the proposed appraisal program is viewed as a "pilot scheme".

The Board has also determined that the proposed extension of the Ben Nevis/Avalon appraisal period does not introduce any new safety, environmental or benefits issues that are not already addressed by current approvals issued by the Board.

Following a review of the information provided, the Board's technical staff requested additional information, which was provided by the Proponent. All documents were

reviewed by the Board's technical staff and the staff met with the Proponent to discuss information submitted in support of the application. The Board's technical staff also monitored production activities from the Ben Nevis/Avalon reservoir and has conducted its own engineering, geological and geophysical assessments.

The Proponent stated in its application that earlier than anticipated gas breakthrough in the Hibernia reservoir has delayed Ben Nevis/Avalon reservoir appraisal and evaluation activities. Also, the Ben Nevis/Avalon reservoir is significantly more complex than was originally anticipated. The Proponent notes that until steady state operations can be established and maintained, long-term performance cannot be assessed. To this end, it is the Proponent's intention to obtain steady state production from the 'I' and 'Q' Blocks. The Board's technical staff agree with these views.

The Proponent outlined the proposed appraisal program and activities schedule to occur during the Ben Nevis/Avalon appraisal extension. Appraisal initiatives that the Proponent plans to undertake in the current producing 'I', 'Q' and 'K' Blocks include:

- Continuing to monitor thermal fracturing processes that occur which are potentially important to long term improvement in injection performance in the Ben Nevis/Avalon reservoir;
- Obtaining further data and experience in mitigating techniques for sand control;
- Understanding scaling tendencies in the Ben Nevis/Avalon reservoir, this cannot be understood until water breakthrough occurs; and
- Continuing with analysis of sweep efficiency, vertical production profiles, relative permeability and reservoir simulation in the Ben Nevis/Avalon reservoir.

The Proponent has tentative plans to drill wells in the 'K', 'O' and 'N' fault blocks. The Proponent also intends to conduct further analysis of the most recent seismic data including angle stacks to re-assess the Murre Fault seal and an analysis of direct hydrocarbon indicators at the northwest wedge location, following which the Proponent will reconsider its strategy to appraise this region in 2004.

The Proponent advises the following staff complement, based in St. John's, is dedicated to supporting the Ben Nevis/Avalon reservoir subsurface activities:

- Ben Nevis/Avalon Co-ordinator;
- Reservoir Engineer;
- Geologist;
- Geophysicist;
- Subsurface Engineer; and,
- Petrophysicist ( about 50% allocated).

Other Proponent staff will provide support on a part time and as needed basis. The Proponent noted that periodically specialized expertise or support from Owner Company

staff or consultants is required. However, in such cases the work would be managed locally by the Proponent.

The Board concurs with the initiatives proposed by the Proponent during the proposed appraisal period extension. However, the Board notes the lack of the Proponent's commitment to drill any new wells during the extended appraisal period. In the application, the Proponent indicates tentative plans to drill an injection well in the 'K' Block, as well as a tentative plan to drill a production and injection well pair in the 'O' or 'N' Blocks during the extended appraisal period. Information from these wells is essential to assessing the commercial viability of developing the Ben Nevis/Avalon reservoir and facilitating development planing. If these wells are not drilled, the appraisal period should not be extended beyond September 30, 2004. If the proposed wells are drilled as scheduled, and no major disruption in production and injection activities occurs, sufficient information should be acquired by June 30, 2005 to assess the development potential of the Ben Nevis/Avalon reservoir and to permit the submission of a development plan to the Board.

A further concern of the Board is that the Proponent has not identified when a delineation well in the northwest area of the Ben Nevis/Avalon reservoir will be drilled. This area represents a large region of the Ben Nevis/Avalon reservoir for which there are several possible geologic interpretations with differing potential for quantity of oil in place. The Board believes that the only way the commercial potential of this area can be evaluated and a comprehensive geologic model of the Ben Nevis/Avalon reservoir constructed is through drilling a delineation well in this area. A plan acceptable to the Board for delineation of the northwest area has therefore been requested by June 30, 2004.

The Board has therefore approved the following:

**Hibernia Development Plan Amendment**  
**Decision 2003.02**

The Board approves the Proponent's Application to extend the Ben Nevis/Avalon appraisal period to:

September 30, 2004, in the event that no well has been drilled in the 'O' and 'N' Ben Nevis/Avalon reservoir fault blocks and in the opinion of the Chief Conservation Officer, drilling activity is not being diligently pursued or

June 30, 2005 in the event that a well has been drilled or is being diligently pursued, in the Ben Nevis/Avalon reservoir 'O' and 'N' fault blocks prior to September 30, 2004.

This approval is subject to conditions 2003.02.01 and 2003.02.02, set out below, and the conditions contained in Decision Reports 86.01, 90.01, 97.01, 2000.01 and 2003.01. The

outstanding conditions are summarized in Appendix A. The Board notes that to continue with production from the Ben Nevis/Avalon reservoir following the appraisal period, an approved development plan is required. The Proponent's stated intention is to have an amendment to the Hibernia Development Plan for the Ben Nevis/Avalon reservoir approved by the Board prior to the end of the appraisal period. In the event that a substantive development plan has been prepared and submitted prior to September 30, 2004 or June 30, 2005 as appropriate, the Board may extend the appraisal period to permit continued production from the Ben Nevis/Avalon reservoir while the application is under review.

**Condition 2003.02.01**

It is a condition of the Board's approval that:

The Proponent submit, by June 30, 2004, the following:

- a) a report detailing the results of relevant analyses of the northwest area of the Ben Nevis/Avalon reservoir including analysis of the seismic data to assess the Murre Fault seal and direct hydrocarbon indicators at the northwest wedge location; and,
- b) a plan acceptable to the Board for delineation of the northwest area of the Ben Nevis/Avalon reservoir.

**Condition 2003.02.02**

It is a condition of the Board's approval that:

The Proponent submit, quarterly, a report to the satisfaction of the Chief Conservation Officer, summarizing the results achieved over the previous three months. The first report should cover the period January 1, 2003 to the effective date of this decision report and be submitted 30 days following the effective date of this decision report.



## 2.0 Background

The Hibernia field is located on the northeastern Grand Banks approximately 315 km southeast of St. John's, Newfoundland, in a water depth of about 80 metres. Two main reservoirs exist within the Hibernia field, the Hibernia reservoir and the Ben Nevis/Avalon reservoir. The Ben Nevis/Avalon reservoir is the shallower reservoir, occurring at depths of 2,100 to 3,000 metres subsea. The Hibernia reservoir is the deeper of the two reservoirs, occurring at depths between 3,300 and 4,030 metres subsea.

The Hibernia Development Plan submitted in 1985 proposed a limited area of development for the Ben Nevis/Avalon reservoir, to maintain the plateau production. Production from the Ben Nevis/Avalon reservoir was to begin eight years after the initiation of production from the Hibernia reservoir. The Board rejected the development plan proposed for the Ben Nevis/Avalon reservoir at that time, stating that it expected the Proponent to continue to evaluate the potential of the Ben Nevis/Avalon reservoir and to consider ways to exploit the reservoir earlier than proposed in the development plan.

Since the 1985 Development Plan submission, the Hibernia partners have represented to the Board that commercial quantities of oil exist in the Ben Nevis/Avalon reservoir in the southwest portion of the Hibernia field. On the basis of the evidence presented, the Board included this area in the commercial discovery declaration for the Hibernia field.

On July 10, 1996, the Proponent submitted a Development Plan Amendment for the Hibernia field, which included, among other items, a proposed appraisal program for the Ben Nevis/Avalon reservoir. The Proponent's strategy for the Ben Nevis/Avalon reservoir development included an appraisal stage designed to resolve uncertainties and acquire the information to devise a comprehensive development plan for the Ben Nevis/Avalon reservoir. The strategy proposed earlier development and a larger development area than was proposed in the 1985 Development Plan. The Ben Nevis/Avalon reservoir well locations that were tentatively scheduled for the appraisal program period, as per *Decision 97.01*, are shown in Figure 1. In the Development Plan Amendment submitted in 1996, the Proponent committed to submitting a Development Plan for the Ben Nevis/Avalon reservoir five years after first oil from the Hibernia field (December, 2002). In its *Decision 97.01* approving the Hibernia Development Plan Amendment, the Board noted that there are two major areas of uncertainty, which need to be addressed in order to prepare a comprehensive development plan for the Ben Nevis/Avalon reservoir. These are the production performance of the reservoir under water flood conditions, and the delineation of the reservoir in the southwest and northwest areas of the Hibernia structure to establish more precisely the extent of the hydrocarbon accumulation and determine reservoir characteristics.

Further, the Board noted in its decision that while the Proponent proposed to drill a well (AOPN5) to probe the southwest area, this well alone would not adequately appraise the

southwest area of the Ben Nevis/Avalon reservoir, and further drilling in the area beyond the present range of extended reach drilling, would be needed. The Board also noted that it believed delineation drilling would be necessary to prepare a comprehensive development plan for the Ben Nevis/Avalon reservoir. The Board accepted the strategy for the Ben Nevis/Avalon development to be followed during the appraisal period but noted that the development plan update to be submitted following the appraisal period must include a firm plan to delineate the northwest and southwest areas of the Ben Nevis/Avalon reservoir. The Board conditionally accepted the Proponent's strategy for Ben Nevis/Avalon development during the appraisal period. In October of 2002 the Proponent drilled a delineation well, HMDC B-44, in the southwest area of the Ben Nevis/Avalon reservoir.

On December 13, 2002, the Proponent submitted the document *Ben Nevis-Avalon Appraisal Program Update*. The Proponent noted that while considerable effort has been made to appraise the Ben Nevis/Avalon reservoir, experience to date indicates that the reservoir is significantly more complex than originally anticipated and many of the essential elements necessary for preparation of a comprehensive development plan still remain unknown. The Proponent, therefore, requests that the current Ben Nevis/Avalon appraisal period be extended to December 31, 2005. The Proponent also requested that while the application is being considered they be permitted to continue with production from the Ben Nevis/Avalon reservoir. The Board approved the latter request.

The Board has determined that approval of the Proponent's request is a Fundamental Decision. The Board has also determined that the proposed extension of the Ben Nevis/Avalon appraisal period does not introduce any new safety, environmental or benefits issues that are not already addressed by current approvals issued by the Board. Also, in accordance with the Newfoundland Offshore Area Petroleum Production and Conservation Regulations, the proposed appraisal program is viewed as a pilot scheme. More specifically, a pilot scheme is defined as follows:

**"pilot scheme" means a scheme that applies existing or experimental technology over a limited portion of a pool to obtain information on reservoir or production performance for the purpose of optimizing field development or improving reservoir or production performance**

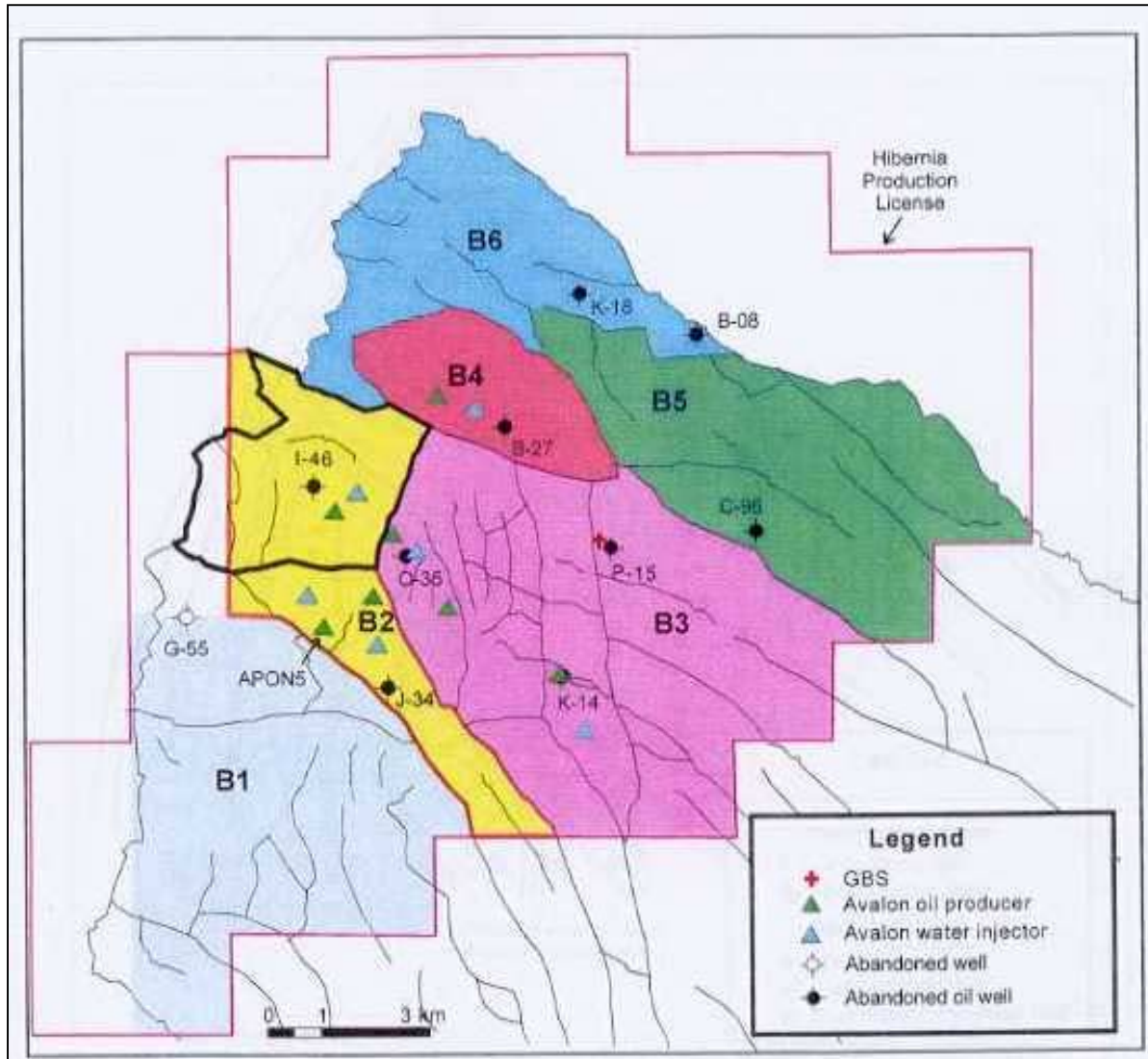
Following a review of the document, *Ben Nevis-Avalon Appraisal Program Update*, additional information was requested, which was supplied by the Proponent in the document *Ben Nevis-Avalon Appraisal Program Update: Supplementary Information Submission #1* and the document *Ben Nevis-Avalon Appraisal Program Update: Supplementary Information Submission #2*. The Proponent also provided the following documents in support of its Application:

- *Andrews/Patten/Burse, A Review of the Trends Observed from Hibernia's Monthly Fluid Sampling Program, 2001 & 2002*
- *Herron, M., Mineralogy and Chemistry Analysis Report: B-16 23, Schlumberger Research, 25 p., 2001*
- *Patten, Chris, Compositional Trends in the Ben Nevis Avalon Reservoir, April 2002*
- *Prasad, M., Petrophysical Measurements of Porosity, Permeability, Velocity Under Elevated Pressures in Hibernia and Ben Nevis Samples, Petrophysical Consulting Inc., 2002*
- *Weatherill, B.D., A Study of the Analogues of Hibernia's Ben Nevis – Avalon Reservoirs, Adams Pearson Associates, 2000*
- *Exxon Mobil Production Company, Central Technology, Ben Nevis – Avalon Appraisal Well Study, 2002*
- *Fugro Jacques Geosurveys Inc., Ben Nevis Avalon Site Survey Grand Banks, Newfoundland, Proposed B-44 and F-39 Drill Locations Volumes 1-4, 2002*
- *Geslin, J.K., Larsen, P., Feldman, H.R., Stratigraphic Architecture of the Ben Nevis / Avalon Interval from Core Analysis and Well-log Correlation, Hibernia Field, Newfoundland, Canada, ExxonMobil Upstream Research, Reservoir Characterization Division, Rpt. URC.2001ES.042, 2001*

On July 3, 2003, the Proponent met with the Board's technical staff to discuss the Application and provided an update on appraisal activities that have occurred since the Application was submitted in December, 2002. During the meeting, the Proponent also provided a geologic and geophysical review of the Ben Nevis/Avalon reservoir. On July 29, 2003 the Proponent submitted the supplementary document *Ben Nevis – Avalon Appraisal – 'I', 'Q' and 'K' Blocks, The Need for Ongoing Appraisal*.

The following section of the report presents an overview of the Proponent's application.

**Figure 1: Ben Nevis/Avalon Reservoir proposed Appraisal period wells**  
( Source: After HMDC 1996 )



### 3.0 Proponent's Application

In the Application, the Proponent noted that the timing of drilling in the Ben Nevis/Avalon reservoir was delayed due to earlier than anticipated gas breakthrough in the Hibernia reservoir gas flood blocks. As a result, drilling resources were dedicated to resolving these problems requiring the deferral of several Ben Nevis/Avalon appraisal initiatives. The Proponent also stated that experience has indicated that the Ben Nevis/Avalon reservoir is more complex than originally anticipated, and considers it premature to submit a development plan for the Ben Nevis/Avalon reservoir at this time. The Proponent requests that the current Ben Nevis/Avalon appraisal period be extended to December 31, 2005.

### 3.1 Reservoir Performance

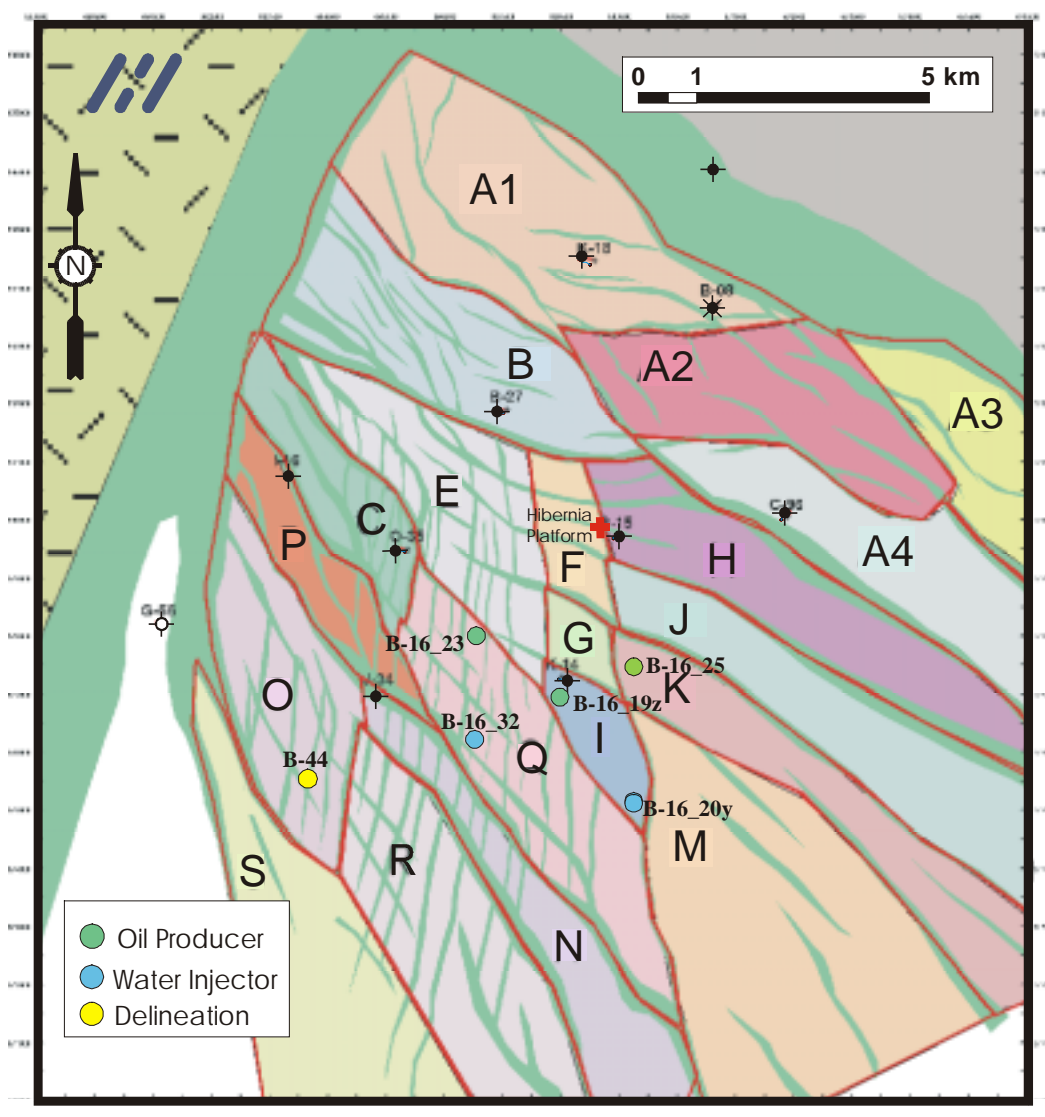
To date, five development wells have been completed in the Ben Nevis/Avalon reservoir. These include producer-injector pairs in the 'I' and 'Q' Blocks and a producer in the 'K' Block. Figure 2 shows the locations of the existing Ben Nevis/Avalon reservoir wells.

The Proponent provided an overview of the reservoir performance to date in each of the three producing fault blocks. As of December 31, 2002 the total volumes of oil production and water injection into the Ben Nevis/Avalon reservoir are 0.905 Million Sm<sup>3</sup> and 0.820 Million Sm<sup>3</sup>, respectively. These volumes are broken down by well in Table 1 below. Figure 3 shows a plot of the cumulative production from and injection into the Ben Nevis/Avalon reservoir, and Figures 4 and 5 show the daily average production and injection rates for each well.

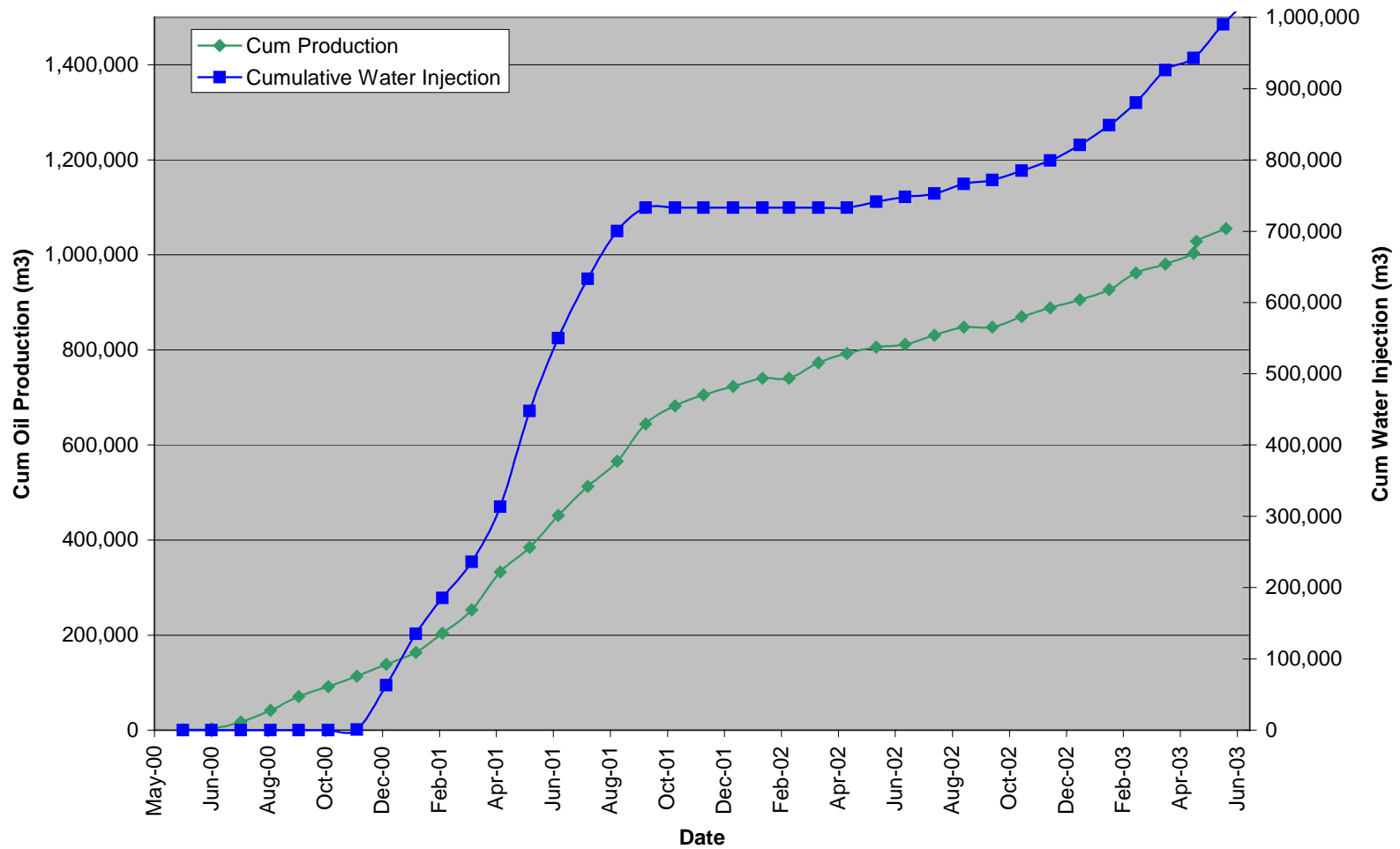
**Table 1: Ben Nevis/Avalon Production & Injection Volumes up to December 31, 2002 ( Source: C-NOPB )**

	<b>Production Millions Sm<sup>3</sup></b>	<b>Injection Millions Sm<sup>3</sup></b>
<b>B-16 19Z</b>	0.642	
<b>B-16 23</b>	0.204	
<b>B-16 25</b>	0.052	
<b>B-16 20Y</b>	0.003	0.747
<b>B-16 32</b>	0.004	0.073
<b>Total:</b>	0.905 <i>(5.69 Million bbls)</i>	0.820 <i>(5.16 Million bbls)</i>

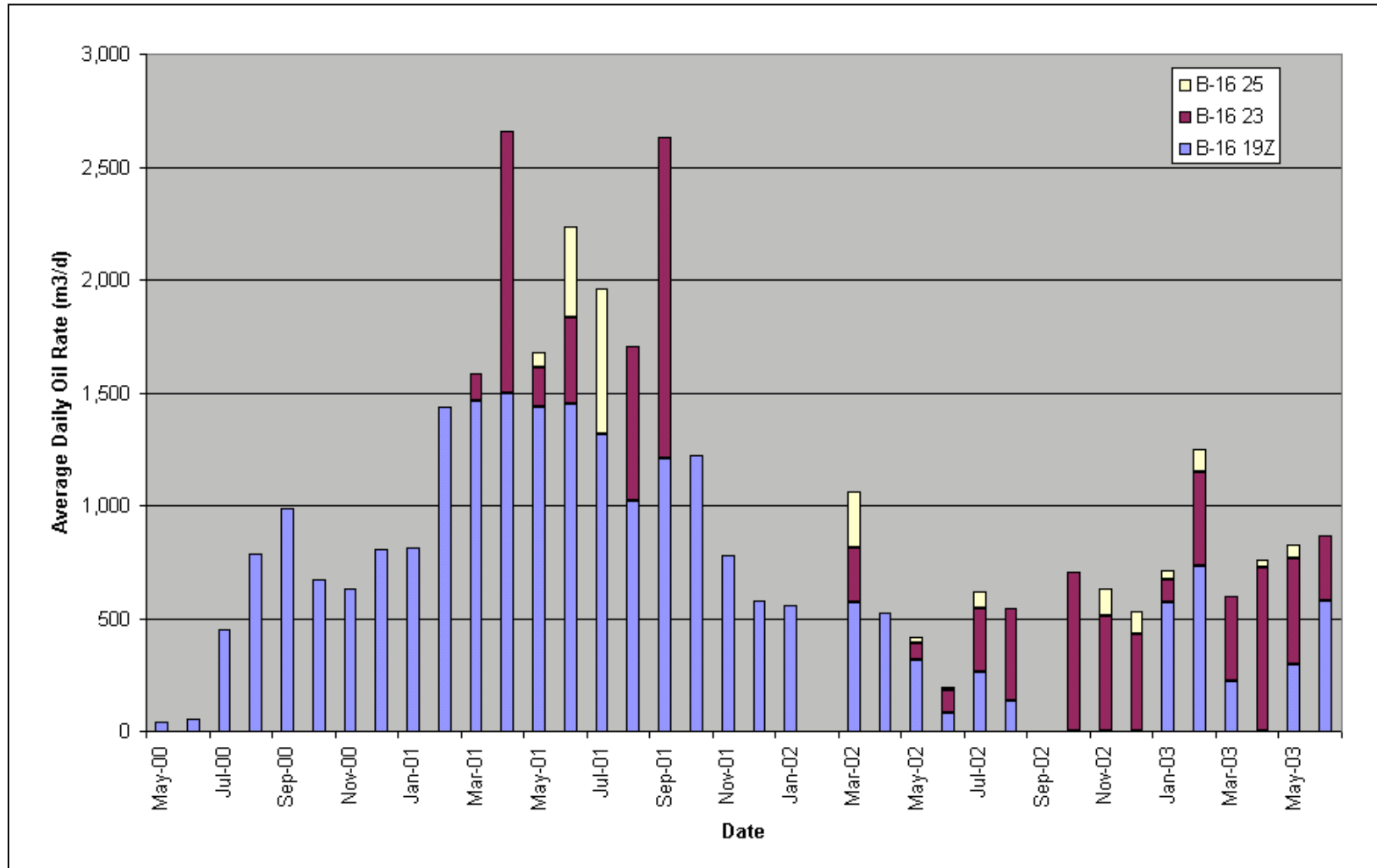
**Figure 2: Ben Nevis/Avalon Current Well Locations ( Source: After HMDC )**



**Figure 3: Ben Nevis/Avalon Cumulative Production & Injection ( Source: C-NOPB )**

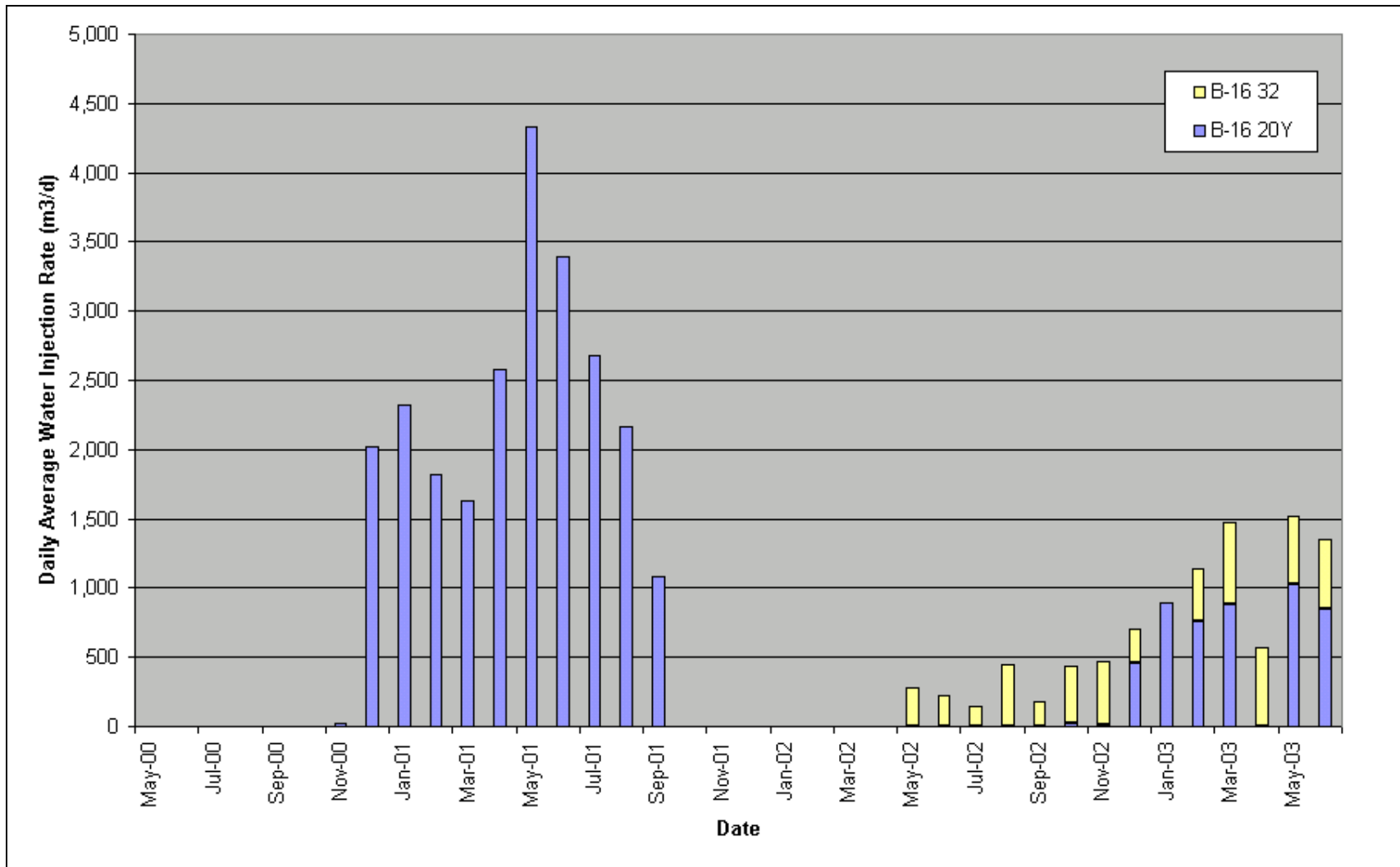


**Figure 4: Ben Nevis/Avalon Average Daily Production Rates ( Source: C-NOPB )**





**Figure 5: Ben Nevis/Avalon Average Daily Water Injection Rates ( Source: C-NOPB )**



In the 'I' Block, the Proponent has encountered problems of limited injectivity in the B-16 20Y injection well. The water injection rates that can be achieved are insufficient to support the higher production rates at the B-16 19Z well. Also, over-pressuring of the B-16 20Y injector in April 2003, caused the well to fracture out of zone resulting in inadequate injection support for the B-16 19Z producer. This delayed the appraisal activities in the 'I' Block since the B-16 20Y injection well had to be shut in for an extended period of time. A well operation was conducted in December 2002, to correct this problem. Recently, the B-16 19Z production well has experienced problems with sand production, and as a result production rates from this well have been reduced to limit sand production. A well work-over operation to clean out the sand was conducted in August 2003.

In the 'Q' Block, the producer-injector pair have only been able to sustain a 500 m<sup>3</sup>/d production rate, due to poor injectivity into the B-16 32 well. It is the Proponent's interpretation that the 'Q' Block acts as an internally baffled system, and that the B-16 23 producer and B-16 32 injector are in separate compartments within the 'Q' Block. The Proponent also states that based on pressure transient analysis, it suspects that the 'I' Block is in communication with the 'Q' Block. Work is ongoing in an attempt to understand this apparent communication.

In the 'K' Block, the B-16 25 well has also had limited production due to the lack of an injection well in this block. The Proponent has tentative plans to drill an injection well in this block in the fourth quarter of 2003.

### **3.2 B-44 'O' Block Appraisal Well**

In October 2002, the Proponent drilled the B-44 appraisal well, in the Ben Nevis/Avalon 'O' Block, in the southwest area of the reservoir. The B-44 well provided critical data as it was the first delineation well drilled in the southwest area of the Ben Nevis/Avalon reservoir. The B-44 well penetrated a full oil-bearing reservoir in the O35 sandstone interval. While the O35 sands encountered were thicker than those in the current producing area, they are significantly thinner than the sands encountered in the nearby G-55 well. The B27 sand encountered was poorer than expected, lacking the B27 Basal unit that is the primary development target to date in the Ben Nevis/Avalon reservoir.

### **3.3 Southwest Ben Nevis/Avalon Development Options**

In the meeting with the Board's technical staff on July 3 2003, the Proponent outlined work that has been completed to investigate the feasibility of various southwest Ben Nevis/Avalon reservoir development options. The options considered were platform development, subsea development and a combination of both. The results of this work concluded that a platform development is technically feasible although it would be challenging because slot constraints would make a large-scale platform development an

unlikely near term opportunity. If a near term development occurs, a full-scale development of the southwest area would have to include a combination of subsea and platform development. The Proponent has indicated that further resource assessment work is required to determine if commercial viability of the southwest area of the reservoir can be established.

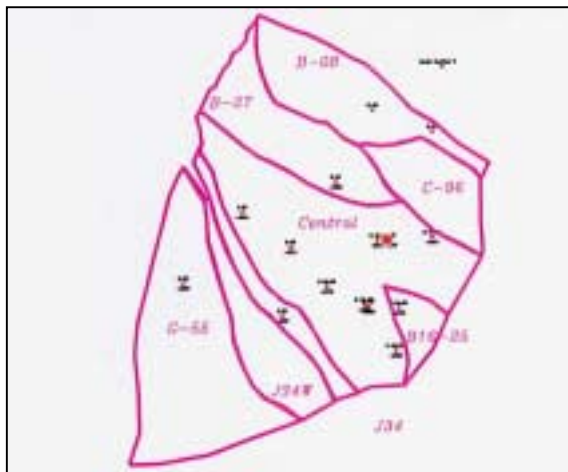
### 3.4 Original Oil-in-Place

The Proponent's current original oil-in-place estimate for the Ben Nevis/Avalon reservoir, documented in the report *Ben Nevis-Avalon Appraisal Well Study, 2002*, is 343 Million Sm<sup>3</sup> (2,158 Million bbls). In this study, the original oil-in-place estimates, summarized in Table 2, were broken down into 8 regions or "polygons" (Figure 6) which were outlined based on Fault Seal Analysis work. The Proponent notes that the geological model is being actively worked to include the results of the B-44 appraisal well and to include the interpretation of the 2001 Hibernia 3D seismic survey. The original oil-in-place estimates will be updated based on this work.

**Table 2: Ben Nevis/Avalon STOOIP Estimates ( Source: After HMDC )**

STOOIP Estimate per Ben Nevis-Avalon Appraisal Well Study 2002 (Million Sm <sup>3</sup> )					
Polygon	Sand				Grand Total
	B27B	B27U	J34	O35B	
<b>B08</b>	9.1	1.5	0.2	3.4	14.2
<b>B-16 25</b>	1.8	4.0	0.9	0.0	6.7
<b>B27</b>	13.0	10.5	0.4	11.6	35.5
<b>C96</b>	5.3	1.7	0.0	0.0	7.0
<b>Central</b>	39.3	54.5	52.0	34.5	180.4
<b>G55</b>	0.6	3.1	0.0	10.8	14.4
<b>J34</b>	3.6	7.4	6.3	12.5	29.8
<b>J34W</b>	7.8	15.7	6.7	24.9	55.2
<b>Grand Total</b>	80 Million Sm <sup>3</sup> (506 MMbbls)	98 Million Sm <sup>3</sup> (619 MMbbls)	67 Million Sm <sup>3</sup> (418 MMbbls)	98 Million Sm <sup>3</sup> (615 MMbbls)	343 Million Sm <sup>3</sup> (2,158 MMbbls)

**Figure 6: Ben Nevis/Avalon Reservoir “Polygons” ( Source: After HMDC 2002 )**

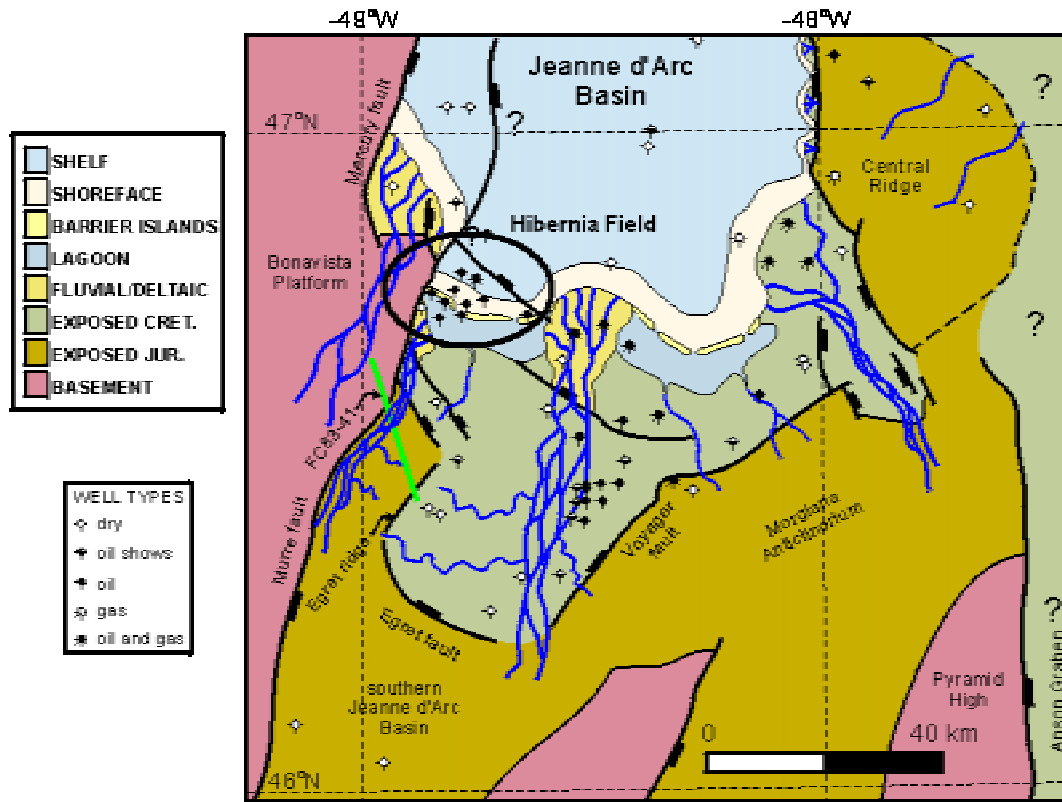


### 3.5 Proponent’s Geologic Model

On July 3, 2003, the Proponent presented to the Board’s technical staff, details of its new sequence stratigraphic based interpretation. The Proponent emphasized that the understanding of the Ben Nevis/Avalon reservoir is still evolving.

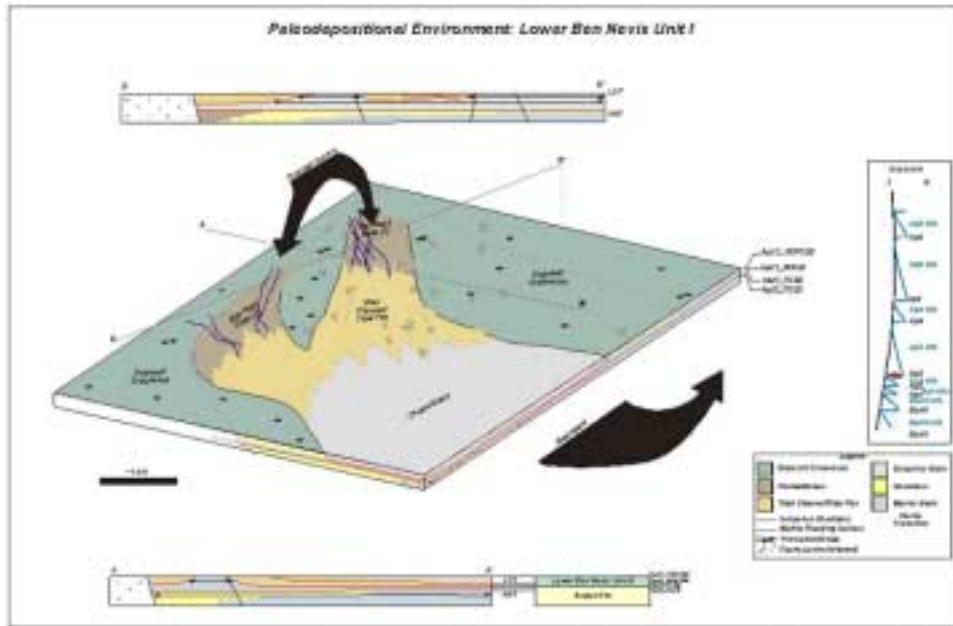
From a regional geology perspective, there is general agreement between this and the previous working model, with the main differences being the interpretation of the primary reservoir intervals. The Proponent’s previous geologic model (HMDC - Sinclair 1988, 1993, 1995) has the primary reservoir sands (B27 Basal) as barrier island deposits in a shoreface environment (Figure 7). As seen in the Figure 7, these were interpreted to trend approximately east west at the Hibernia Field.

**Figure 7: HMDC Barrier Island Model ( Source: After HMDC )**

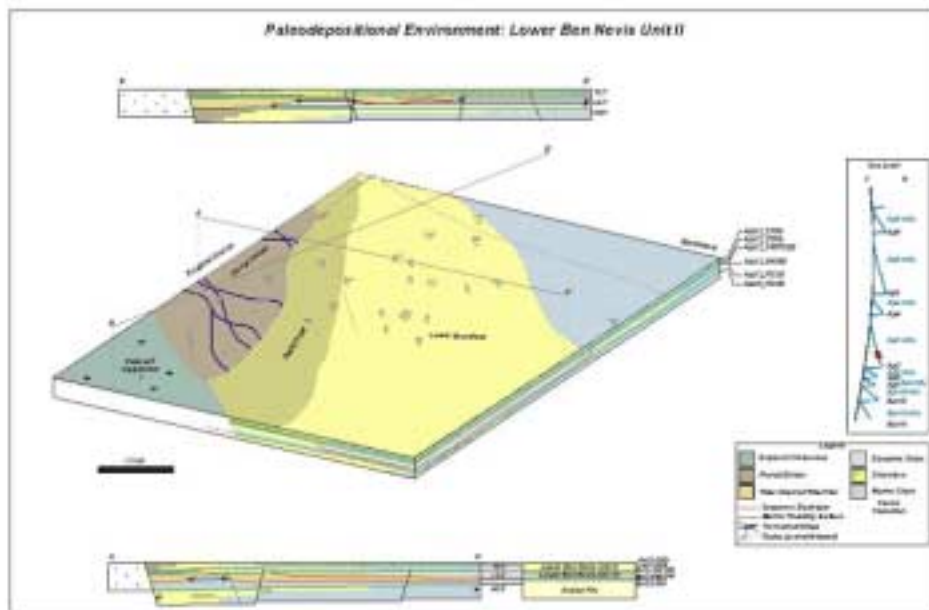


The new interpretation suggests the older primary reservoir intervals may be estuarine sands deposited in incised valleys, sourced from the west, and oriented in a general north to south direction parallel to the Murre Fault. (Figure 8). The younger reservoir intervals proved by the B-44 well are interpreted to be shoreface facies (Figure 9).

**Figure 8: Paleodepositional Environment: Lower Ben Nevis Unit I (formerly B27 Basal Sand) ( Source: After HMDC )**

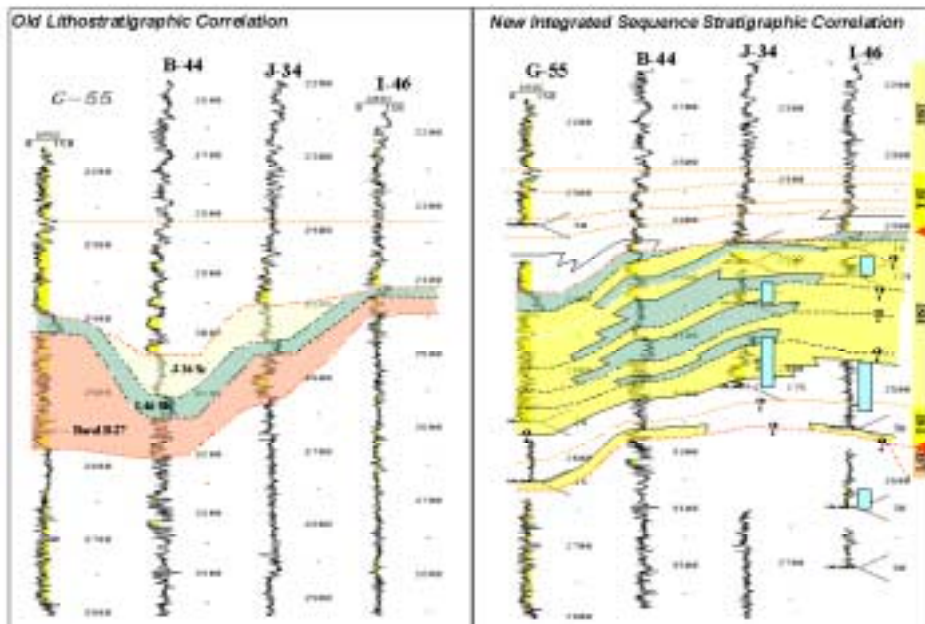


**Figure 9: Paleodepositional Environment: Lower Ben Nevis Unit II (formerly B27 Upper, J34, O35 Sands) ( Source: After HMDC )**





**Figure 11: Cross Section showing the key differences in Southwest area of Hibernia Field ( Source: After HMDC)**

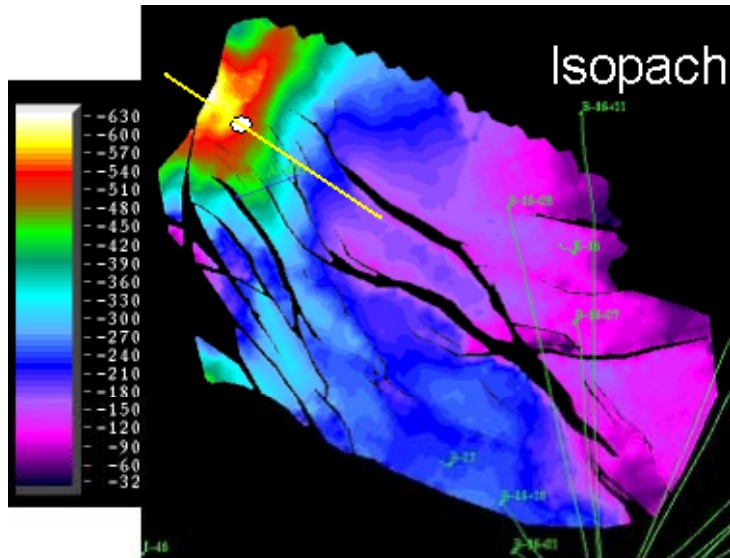


The result is that while the current development wells in the Ben Nevis/Avalon reservoir were drilled in favorable locations with respect to the earlier model, they do not appear to be in optimum locations for reservoir development with respect to the new model, particularly in the upper sand units.

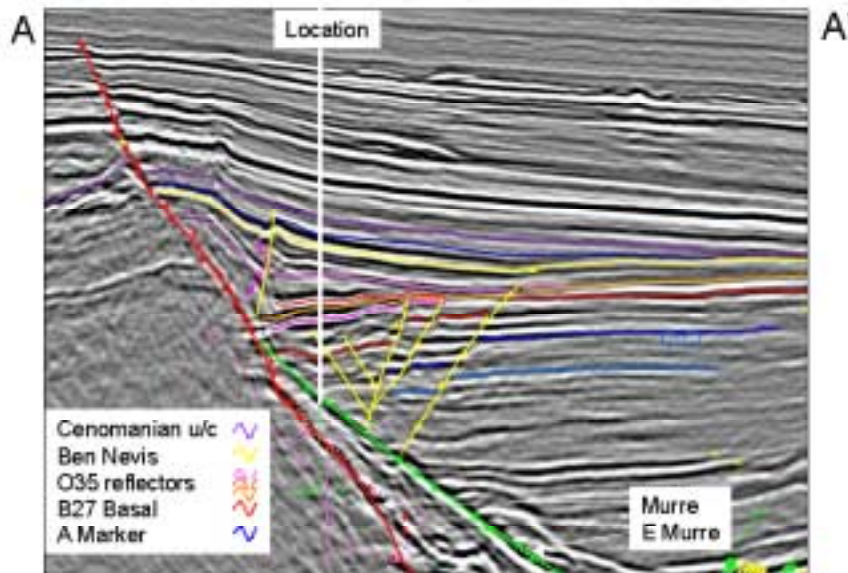
As noted above, these newly interpreted trends suggest that the best reservoir (now identified as O35 sands) may be located along the western edge of the field parallel to the Murre fault. It follows from this that the northwest edge of the Ben Nevis/Avalon reservoir may now be prospective for reservoir and hydrocarbons, whereas it was less prospective in the Proponent's previous model. Seismic mapping shows an isopach thick in this area (Figure 12), with seismic signatures consistent with a clastic fan shed from the basement high to the west (Figure 13). The Proponent has indicated that this wedge is small (1 km by 2 km), and there may not be sufficient fault seal to trap hydrocarbons. However, they indicated that work is progressing on evaluation of a target in this area, with more studies being initiated if current DHI (Direct Hydrocarbon Indicator) reconnaissance work is positive.



**Figure 12: Isopach, Northwest Wedge, Ben Nevis to B27 Basal, showing potential location ( Source: After HMDC )**



**Figure 13: Seismic Section, Northwest Wedge, showing potential location ( Source: After HMDC )**



### 3.6 Proposed Production, Injection & Drilling Plans

The Proponent's intention is to produce the current Ben Nevis/Avalon production wells at the maximum allowable sustainable production rates. The originally targeted plateau production rates from the 'I', 'K' and 'Q' blocks were in excess of 1 000 m<sup>3</sup>/d. Balanced production and injection from the 'I' Block has only been established for less than six months since initial production began from the block. If the problems with sand production in the B-16 19Z well are resolved, a period of stabilized production and injection will be required to assess the overall 'I' Block performance.

The Proponent states that the B-16 23 and B-16 32 wells were positioned relatively close together to obtain data on the rates and characteristics of water breakthrough, which is considered critical to a long-term field development plan. The 'Q' Block has yet to obtain steady state production and injection performance due to injectivity problems in the B-16 32 injection well. Injection rates at the B-16 32 well have not been fully tested, but rates up to 1 200 m<sup>3</sup>/d have been attained for a few hours. It is the Proponent's intention to obtain steady state production from the 'I' and 'Q' Blocks so that long term performance can be assessed.

The Proponent has indicated tentative plans to drill an injection well in the Ben Nevis/Avalon 'K' Block in the fourth quarter of 2003, to allow the B-16 25 well to produce at rates in excess of 1 000 m<sup>3</sup>/d starting in March, 2004.

Other appraisal initiatives that the Proponent plans to undertake in the current producing 'I', 'Q' and 'K' Blocks include:

- Continuing to monitor thermal fracturing processes that occur, which are potentially important to long term improvement in injection performance in the Ben Nevis/Avalon reservoir;
- Obtaining further data and experience in mitigating techniques for sand control;
- Understanding scaling tendencies in the Ben Nevis/Avalon reservoir, this cannot be understood until water breakthrough occurs; and,
- Continuing with analysis of sweep efficiency, vertical production profiles, relative permeability and reservoir simulation in the Ben Nevis/Avalon reservoir.

In the Application, the Proponent has also indicated that it has tentative plans to drill a production and injection well pair from the platform in the southwest Ben Nevis/Avalon reservoir 'O' or 'N' Block in 2004. Primary production could commence from this area in mid 2004 at rates in excess of 1 000 m<sup>3</sup>/d.

The Proponent is also considering opportunities for platform wells in the Ben Nevis/Avalon reservoir 'B' Block in the northwest area of the reservoir, but there are currently no firm plans for a well in this region during the appraisal period.

An estimate of the total volume of Ben Nevis/Avalon oil to be produced during the period from January 2003 to December 2005 is included in Table 3.

**Table 3: Ben Nevis/Avalon Estimated Production & Injection for the period from January 2003 to December 2005 ( Source: After HMDC )**

Block	Prod Rate m <sup>3</sup> /d	InjectionRate m <sup>3</sup> /d	Days	Efficiency/ Risking	Total Forecast Volume Produced During Appraisal Period Extension Million Sm <sup>3</sup>	Total Forecast Volume Water Injected during Appraisal Period Extension, Million m <sup>3</sup>
I	700	1,000	1,095	80%	0.61	0.88
Q	700	1,000	1,095	60%	0.46	0.66
O/N	1,000	1,000	548	90%	0.49	0.49
K	1,000	1,000	304	80%	0.24	0.24
<b>Total</b>					1.81 (11.4 Million bbls)	2.27 (14.3 Million bbls)

### 3.7 Northwest Ben Nevis/Avalon Reservoir Area

The Proponent stated that drilling a subsea appraisal well in the northwest wedge region of the Ben Nevis/Avalon reservoir was considered in 2002, but the investment was determined not to be attractive given the present uncertainties and risk associated with this area of the reservoir. The Proponent intends to conduct further analysis of the most recent seismic data including angle stacks to re-assess the Murre Fault seal and an analysis of direct hydrocarbon indicators at the Northwest Wedge location, following which the Proponent will reconsider its strategy to appraise this region in 2004.

### 3.8 Data Acquisition

The Proponent states in its Application, that it is premature at this time to define details of formation evaluation programs that would be run in any future appraisal or development wells drilled in the Ben Nevis/Avalon reservoir. For each Ben Nevis/Avalon well drilled during the appraisal period the Proponent plans a formation evaluation program that shall consist of:

- Full set of conventional logs (Gamma Ray, Array Resistivity, Neutron-Density and Sonic) over all prospective intervals;
- Wireline pressures; and,
- Fluid samples for new block penetrations.

The Proponent also proposes to supplement this program, where appropriate, with additional formation evaluation activities where such data can be demonstrated to cost effectively reduce future development uncertainty and risk. At the time of submission of a full field development plan for the Ben Nevis/Avalon reservoir, the Proponent would then plan to include a formation evaluation program, which would also include production and injectivity testing and fluid analysis.

### **3.9 Appraisal Activities Timeline**

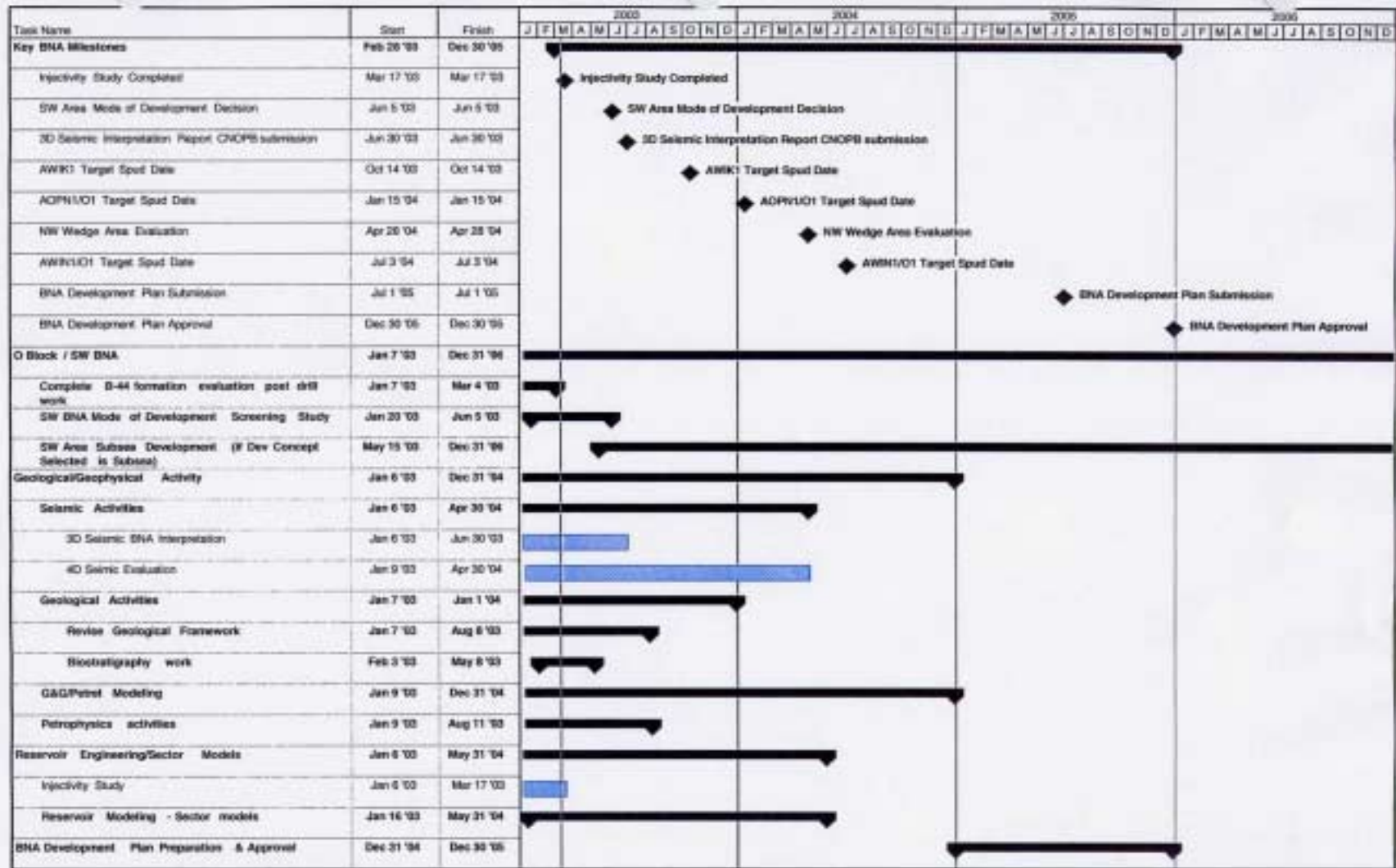
The Proponent states that the need to extend the Ben Nevis/Avalon appraisal period to December 31, 2005, reflects the long-term plan and commitment of resources required to address significant geological and reservoir uncertainties. A planning schedule of key Ben Nevis/Avalon appraisal activities (Figure 14) was presented by the Proponent.

According to the Proponent, the following staff complement, based in St. John's, is dedicated to supporting the Ben Nevis/Avalon reservoir subsurface activities:

- Ben Nevis/Avalon Co-ordinator;
- Reservoir Engineer;
- Geologist;
- Geophysicist;
- Subsurface Engineer; and,
- Petrophysicist ( about 50% allocated).

Other Proponent staff will provide support on a part time and as needed basis. The Proponent noted that periodically specialized expertise or support from Owner Company staff or consultants is required. However, in such cases the work would be managed locally by the Proponent.

**Figure 14: Ben Nevis/Avalon Appraisal Activities Timeline ( Source: After HMDC )**



## **4.0 C-NOPB Review**

### **4.1 Ben Nevis/Avalon Appraisal Period Considerations**

The documents provided by the Proponent were reviewed by the Board's technical staff, and the staff met with the Proponent to discuss the information submitted in support of the application. The Board's technical staff also monitored production activities from the Ben Nevis/Avalon reservoir and conducted engineering, geological and geophysical assessments.

Since the initiation of production at the Hibernia field, the following Ben Nevis/Avalon reservoir appraisal activities have been undertaken:

- Five development wells have been completed in the Ben Nevis/Avalon reservoir;
- A delineation well, B-44, was drilled into the 'O' Block in the southwest area of the reservoir;
- The Proponent implemented a study to investigate the water injectivity problems, and are assessing means to improve injectivity; and,
- During the appraisal period, the Proponent conducted formation evaluation work on the Ben Nevis/Avalon reservoir when the formation was penetrated while drilling Hibernia development wells. The Proponent has an ongoing special core analysis program, which will include comprehensive testing of core cut from the B-16 19Z, B-16 23, B-16 25 and the B- 44 wells.

The Proponent stated in its application, that earlier than anticipated gas breakthrough in the Hibernia reservoir has delayed Ben Nevis/Avalon reservoir appraisal and evaluation activities. Earlier than anticipated gas breakthrough has occurred in the Hibernia reservoir, and drilling resources have been dedicated to solving these problems, therefore delaying several appraisal initiatives. Also, development wells have taken longer to drill than originally projected. According to the Hibernia Development Plan Amendment approved in the Board's Decision Report 97.01, the Proponent predicted 58 development wells would be drilled, 42 in the Hibernia reservoir and 16 in the Ben Nevis/Avalon reservoir by December, 2002. However, as of that date, the Proponent has drilled only 33 development wells, 28 into the Hibernia reservoir and 5 into the Ben Nevis/Avalon reservoir. These factors have delayed appraisal activities.

The Ben Nevis/Avalon reservoir is significantly more complex than was originally anticipated. This is evident from the performance of the development wells in the 'I' and 'Q' Blocks of the reservoir. The Proponent believes the 'Q' Block consists of various faulted zones which act as internal baffles and limit the communication between the B-16

23 producer and the B-16 32 injector. In the 'I' Block, the problem of limited injectivity is believed to be due to restricted stratigraphic continuity between the B-16 19Z producer and the B-16 20Y injector. The reservoir in these areas is complex and the explanation presented by the Proponent for the performance to date is, in the view of the Board's technical staff, reasonable. In its Decisions 86.01 and 97.01 the Board acknowledged the complexity of the Ben Nevis/Avalon reservoir and the need to evaluate the Ben Nevis/Avalon reservoir early to acquire the information to prepare a comprehensive development plan.

Many of the Ben Nevis/Avalon development wells have not been in service on a continuous basis due to operational problems. The limited production activity has provided valued information concerning production and injection performance and has identified further issues, such as sand production that need to be investigated. A continuous period of stable production is necessary to assess long term performance for development wells in the 'I', 'Q' and 'K' block areas. However, the Board's technical staff is not convinced that the appraisal period needs to be extended to December 31, 2005 to acquire the necessary information. The current development wells are located in an area of the Ben Nevis/Avalon reservoir which, according to the Proponent's geologic model, contains thin sands and is highly faulted. The Proponent's geologic model predicts that the reservoir is thicker and of better quality to the west of the current appraisal area. Therefore, while the information acquired through the proposed production and injection activities will be helpful in development of the current appraisal area, it is not expected to be reflective of the production performance in areas of the reservoir with thicker sand development and less faulting, as is projected for the west area of the Ben Nevis/Avalon reservoir.

The Proponent's latest geological interpretation appears to be reasonable. However, there are other possible interpretations, and additional drilling is necessary to acquire the information to confirm the geologic model.

The initiatives proposed by the Proponent during the appraisal period extension appear reasonable but there is a concern that the Proponent has not committed to drill any new wells during the proposed extended appraisal period. In the application, the Proponent indicates tentative plans to drill an injection well in the 'K' Block, as well as a tentative plan to drill a production and injection well pair in the 'O' or 'N' Blocks. The information acquired from drilling and production and/or injection activities from the proposed wells will facilitate assessing the commercial viability of developing the Ben Nevis/Avalon reservoir and facilitate development planning. If these wells are not drilled, the appraisal period should be extended no later than September 30, 2004. If the proposed wells are drilled as scheduled and no major disruption in production and injection activities occur, sufficient information should be acquired by June 30, 2005 to assess the development potential of the Ben Nevis/Avalon reservoir and submit a development plan to the Board. The Board will require the Proponent to submit interim reports to the Chief

Conservation Officer, and the Proponent is also required, in accordance with the applicable legislation, to file a report of the results of the pilot scheme at the end of the appraisal period.

The Board is also concerned with delineation of the northwest area of the Ben Nevis/Avalon reservoir. To date, the Proponent has not drilled a well in this area of the field, and indicates in the Application that it is considering opportunities for a well in this area of the field. The Board noted in its Decisions 86.01 and 97.01 the need for a delineation well in the northwest area of the Ben Nevis/Avalon reservoir. This area represents a large region of the Ben Nevis/Avalon reservoir for which there are several possible geologic interpretations with differing potential for quantity of oil-in-place. The only way the commercial potential of this area can be evaluated and a comprehensive geologic model of the Ben Nevis/Avalon reservoir constructed is through drilling a delineation well in the northwest area of the reservoir. The Proponent intends to conduct further analysis of the most recent seismic data including angle stacks to re-assess the Murre Fault seal and an analysis of direct hydrocarbon indicators at the northwest wedge location. Following this analysis, the Proponent will reconsider its strategy to appraise this region in 2004. The Board will require the Proponent to submit a report of its assessment and a plan for drilling a delineation well in this area of the field.



## 4.2 Conclusion

### **Hibernia Development Plan Amendment Decision 2003.02**

The Board approves the Proponent's Application to extend the Ben Nevis/Avalon appraisal period to:

September 30, 2004, in the event that no well has been drilled in the 'O' and 'N' Ben Nevis/Avalon reservoir fault blocks and in the opinion of the Chief Conservation Officer, drilling activity is not being diligently pursued or

June 30, 2005 in the event that a well has been drilled or is being diligently pursued, in the Ben Nevis/Avalon reservoir 'O' and 'N' fault blocks prior to September 30, 2004.

This approval is subject to conditions 2003.02.01 and 2003.02.02, set out below, and the conditions contained in Decision Reports 86.01, 90.01, 97.01, 2000.01 and 2003.01. The outstanding conditions are summarized in Appendix A. The Board notes that to continue with production from the Ben Nevis/Avalon reservoir following the appraisal period, an approved development plan is required. The Proponent's stated intention is to have an amendment to the Hibernia development plan for the Ben Nevis/Avalon reservoir approved by the Board prior to the end of the appraisal period. In the event that a substantive development plan has been prepared and submitted prior to September 30, 2004 or June 30, 2005 as appropriate, the Board may extend the appraisal period to permit continued production from the Ben Nevis/Avalon reservoir while the application is under review.

#### **Condition 2003.02.01**

It is a condition of the Board's approval that:

The Proponent submit, by June 30, 2004, the following:

- a) a report detailing the results of relevant analyses of the northwest area of the Ben Nevis/Avalon reservoir including analysis of the seismic data to assess the Murre Fault seal and direct hydrocarbon indicators at the northwest wedge location; and,
- b) a plan acceptable to the Board for delineation of the northwest area of the Ben Nevis/Avalon reservoir.

#### **Condition 2003.02.02**

It is a condition of the Board's approval that:

The Proponent submit, quarterly, a report to the satisfaction of the Chief Conservation Officer, summarizing the results achieved over the previous three months. The first

report should cover the period January 1, 2003 to the effective date of this decision report and be submitted 30 days following the effective date of this decision report.

**Appendix A**  
**Outstanding Conditions From**  
**Decisions 2003.01, 2000.01, 97.01, 90.01 and 86.01**

## **A1**

### **Hibernia Development Plan Amendment**

#### **Decision 2003.01**

The Board has reviewed the status of its conditions attached to its Decision 2003.01 approval of the Hibernia Development Plan Amendment. .

#### **Condition 2003.01.01**

It is a condition of the Board's approval that:

The Board's Chief Conservation Officer may at any time reduce the production rate if reservoir performance differs significantly from that predicted in the document entitled "*Technical Support For Hibernia Field Rate Increase Revision 1*", and the Chief Conservation Officer has reason to believe that production at the approved rate may cause waste.

#### **Status:**

Condition 2003.01.01: Ongoing

#### **Condition 2003.01.02**

It is a condition of the Board's approval that:

- (i) The Proponent undertake and submit to the Chief Conservation Officer no later than March 31, 2004 an analysis of the feasibility of produced water re-injection; and
- (ii) The Proponent proceed with produced water re-injection if, in the opinion of the Chief Conservation Officer, it is technically feasible and economically reasonable to do so.

#### **Status:**

Condition 2003.01.02: Ongoing

#### **Condition 2003.01.03**

It is a condition of the Board's approval that:

No later than 6 months prior to seeking approval for anticipated marine discharge of produced water at a daily rate in excess of 24 000 m<sup>3</sup>, the Proponent shall:

- (i) Submit, in a form suitable for public release and acceptable to the Board's Chief Conservation Officer, an assessment of the environmental effects of produced water discharge at the maximum daily discharge rate for which it anticipates seeking approval, including but not limited to:
  - A description of results from modeling of the physical fate of discharged produced water at rates up to the maximum daily rate proposed;
  - An assessment of the potential environmental effects of the aforementioned produced water; and

- An assessment of any resultant changes to the conclusions of the *Hibernia Environmental Impact Statement*; and
- (ii) Submit for the approval of the Chief Conservation Officer revisions to the Environmental Protection Plan components of the *Hibernia Operational Plan* that are necessary in consideration of the assessment described in Condition 2003.01.03(i).

## **A2**

### **Hibernia Development Plan Amendment**

#### **Decision 2000.01**

The Board has reviewed the status of its condition attached to its 2000 approval of the Hibernia Development Plan Amendment. This condition requires a continuing response.

#### **Condition 2000.01.1**

It is a condition of the Board's approval that:

This approval may be suspended or revoked if the Board's Chief Conservation Officer determines that the Proponent's operations depart significantly from those projected in the Application or if reservoir performance differs significantly from that predicted in its document entitled "*Technical Support for Hibernia Field Rate Increase*".

#### **Status:**

Condition 2000.01.1: Ongoing.

## **A3**

### **Hibernia Development Plan Amendment**

#### **Decision 97.01**

The Board has reviewed the status of the five conditions attached to its 1997 approval of the Hibernia Development Plan Amendment. One of these conditions has been fully satisfied. The remaining four conditions, some of which require a continuing response and some of which relate to activities that have yet to occur, have not yet been fully satisfied.

#### **Condition 97.01.1**

It is a condition of approval of the Amendment that:

- (i) Prior to initiating of production from the Hibernia 'A' pools, the Proponent submit its depletion plan therefor for the approval of the Board.

- (ii) The Development Plan update to be submitted following the appraisal period must provide a firm plan for delineation of the northwest and southwest areas of the Avalon reservoir.

**Status:**

Condition 97.01.1(i): Continued.

Condition 97.01.1(ii): Continued. The Proponent drilled a delineation well in the southwest of the Avalon reservoir during 2002. In December, 2002 the Proponent submitted an application for extension of the Avalon appraisal period to December 31, 2005. This request is the subject of this decision report.

**Condition 97.01.2**

It is a condition of approval of the Amendment that:

- (i) Prior to proceeding with the water flood in the Hibernia reservoir 'B5' pool 'H' and 'I' fault blocks the Proponent reassess the depletion schemes for these blocks and obtain the approval of the Chief Conservation Officer for the scheme to be implemented.
- (ii) The oil production rate in the Hibernia reservoir 'G' gas flood block is restricted to a maximum rate of 1190 STm<sup>3</sup>/d per well until such time it can be demonstrated to the Chief Conservation Officer that a higher production rate will not be detrimental to oil recovery.
- (iii) The reservoir pressure in those fault blocks containing a gas cap shall be maintained at least 1000 kPa above the dew point pressure. In other fault blocks, the reservoir pressure shall be maintained at least 500 kPa above the bubble point pressure.

**Status:**

Condition 97.01.2(i): Satisfied.

Condition 97.01.2(ii): Satisfied.

Condition 97.01.2(iii): Ongoing.

**Condition 97.01.5**

It is a condition of approval of the Hibernia Development Plan Amendment that the Proponent evaluate the potential to exploit areas of the Avalon reservoir penetrated by Hibernia reservoir development wells and not proposed for development by re-completing selected wells. The results of the evaluation are to be presented in the Development Plan Update to be submitted to the Board following the Avalon reservoir appraisal period.

**Status:**

Condition 97.01.5(i): Ongoing. In December, 2002 the Proponent submitted an application for extension of the Avalon appraisal period to December 31, 2005. This request is the subject of this decision report.

**A4**  
**Hibernia Development Plan Update**  
**Decision 90.01**

The Board attached four Conditions to its 1990 approval of the Hibernia Development Plan Update. These have all been satisfied.

**A5**  
**Hibernia Benefits Plan**  
**Decision 86.01 Status**

The Board attached five conditions to its 1986 approval of the Hibernia Benefits Plan. The following conditions have not been satisfied:

**Condition #4**

That as the project evolves, the Proponent provide to the Board comprehensive listings of all major contracts and purchase orders anticipated. The Board, in consultation with the Proponent, will determine which of these major contracts and purchase orders will be subject to Board review.

**Status:**

Satisfied/Ongoing.

The Proponent provides this information to the Board in accordance with the C-NOPB's *Procurement Reporting Guidelines*: Hibernia Development Project.

**Condition #5**

That the Proponent provide advance notice of and information on major contracts and purchase orders to enable the Board to conduct its review. The review time required will be determined by the Board, in full consultation with the Proponent.

**Status:**

Satisfied/Ongoing.

The Proponent provides this information to the Board, in accordance with the C-NOPB *Procurement Reporting Guidelines*: Hibernia Development Project.

## **A6**

### **Hibernia Development Plan**

#### **Decision 86.01 Status**

The Board attached seventeen conditions to its 1986 approval of the Hibernia Development Plan. The following conditions have not been satisfied:

#### **Condition #1**

- (i) That the Proponent at a very early stage in the development program, drill a well in the area of the B-08 gas cap, to obtain samples for laboratory analyses and define a gas-condensate-oil regime; and,
- (ii) that the Proponent undertake studies, concurrent with initial development drilling, to establish the feasibility of a miscible flood for the Hibernia reservoir.

#### **Status:**

The Proponent has undertaken to drill a well in the area of the B-08 gas cap early in the development and complete a miscible flood feasibility study.

Condition 1(i): Satisfied.

Condition 1(ii): Continued.

#### **Condition #2**

- (i) That prior to any development of the Avalon Reservoir, the Proponent submit a revised plan for the Board's approval;
- (ii) that during development of the Hibernia Reservoir, the Proponent evaluate the Avalon Reservoir by coring, logging and testing all prospective zones penetrated by wells drilled to the Hibernia Reservoir; and,
- (iii) that during the design of topside facilities, the Proponent give due consideration to sizing equipment and allocating space for production facilities and utilities, sufficient to accommodate additional production from the Avalon Reservoir concurrently with Hibernia production, should there be a requirement to produce the Avalon Reservoir prior to the time contemplated in the Development Plan, and that the Proponent report to the Board on its actions in this regard before the topside facilities design is finalized.

#### **Status:**

Condition 2(i): Satisfied.

The submission of the 1996 Hibernia Development Plan Amendment constitutes a revised plan for development of the Avalon reservoir.

Condition 2(ii): Continued.

Condition 2(iii): Satisfied.



In August 1991, the Board accepted the Proponent's plans for satisfying this condition.

### **Condition #3**

- (i) That the Proponent file for approval by the Board, prior to commencement of development drilling, a specific drilling schedule designed to reduce gas flaring to limits acceptable to the Board;
- (ii) that in the unlikely event that reservoir conditions prevent gas-reinjection, the Proponent present to the Board for approval a plan for gas disposal; and,
- (iii) that the Proponent obtain the Board's approval to flare those small volumes of gas needed for normal operations.

#### **Status:**

Conditions 3(i) and 3(iii): Satisfied.

In August 1996, the Board conditionally approved the Proponent's drilling schedule and volumes of gas to be flared during start-up and transition to steady state operations.

Condition 3(ii): Continued.

The Proponent has informed the Board that it has evaluated the feasibility of gas re-injection, and considers it to be highly feasible. A plan for gas disposal will be necessary only if gas re-injection proves to be detrimental to the resource recovery.

### **Condition #5**

- (i) That the Proponent design the export lines and loading platforms so that they can be flushed of hydrocarbons if there is risk of damage to those facilities; and,
- (ii) that the design iceberg scour depth be determined by the Proponent and approved by the Board prior to the design of subsea well installations.

#### **Status:**

Condition 5(i): Satisfied.

The Proponent designed its facilities so that export lines will be capable of being flushed, and, in a May 1997 submission to the Board, described its proposed procedures for flushing the risers in the offshore loading system. The Board approved the proposed procedures in May 1997.

Condition 5(ii): Continued.

No subsea well installations have yet been proposed.

**Condition #9**

That the Proponent obtain specific approval from the Board for its plans for subsea installations prior to proceeding with the detailed design of these facilities.

**Status:**

Continued.

**Condition #15**

That the Proponent provide periodically to the Board, during the execution of the project, in a form to be prescribed, estimates of the expected capital cost for the project as a whole and for those major components which the Board shall request.

**Status:**

Satisfied/Ongoing.

On a semi-annual basis, the Proponent's Canada-Newfoundland Benefits Department provides capital cost expenditure forecasts and associated estimates of Canada-Newfoundland content levels which are expected to be achieved.

## **Glossary**

**Aquifer**

A porous rock that is water bearing.

**bbls (Barrels)**

1 bbl = 0.15898 m<sup>3</sup>

**Board, the**

In this report, the Canada-Newfoundland Offshore Petroleum Board.

**Bubble point pressure**

The reservoir pressure below which dissolved gas begins to bubble out of the host oil at the prevailing temperature conditions.

**C-NOPB**

Canada-Newfoundland Offshore Petroleum Board

**Certifying Authorities**

Bodies licensed by the Board to conduct examination of designs, plans and facilities and to issue Certificates of Fitness.

**Completion**

The activities necessary to prepare a well for the production of oil and gas or injection of a fluid.

**Delineation well**

Well drilled to determine the extent of a reservoir.

**Development well**

Well drilled for the purpose of production or observation or for the injection or disposal of fluid into or from a petroleum accumulation.

**Fault**

In the geological sense, a break in the continuity of rock types.

**Flooding**

The injection of water or gas into or adjacent to, a productive formation or reservoir to increase oil recovery.

**Injection**

The process of pumping gas or water into an oil-producing reservoir to provide a driving mechanism for increased oil production.

**Logging**

A systematic recording of data from the driller's log, mud log, electrical well log, or radioactivity log.

**m<sup>3</sup>**1 m<sup>3</sup> = 6.2898 bbls**OOIP**

Original oil in place.

**Petrel**

Trademark of Schlumberger product group geologic modeling software.

**Petrophysics**

Study of reservoir properties from various logging methods.

**Pool**

Is a natural underground reservoir containing or appearing to contain an accumulation of petroleum that is separated or appears to be separated from any such other accumulation

**Produced water**

Water associated with oil and gas reservoirs that is produced along with the oil and gas.

**Production platform**

An offshore structure equipped to produce and process oil and gas.

**Production well**

A well drilled and completed for the purpose of producing crude oil or natural gas.

**Recoverable reserves**

That part of the hydrocarbon volumes in a reservoir that can be economically produced.

**Reservoir**

A porous, permeable rock formation in which hydrocarbons have accumulated.

**Reservoir pressure**

The pressure of fluids in a reservoir.

**Sandstone**

A compacted sedimentary rock composed of detrital grains of sand size.

**Seismic**

Pertaining to or characteristic of earth vibration. Also, process whereby information regarding subsurface geological structures may be deduced from sound signals transmitted through the earth.

**STOOIP**

Stock tank original oil in place.