Hebron

Project Description

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ExxonMobil Chevron PETRO-CANADA StatoilHydro nalcor energy OIL AND GAS

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1 INTRODUCTION

ExxonMobil Canada Properties (the Operator) on behalf of the Hebron Project Proponents, ExxonMobil Canada Ltd., Chevron Canada Limited (Chevron), Petro-Canada, StatoilHydro Canada Limited (StatoilHydro), and Oil and Gas Corporation of Newfoundland and Labrador (recently named Nalcor Energy – Oil and Gas Inc. [Nalcor]), is leading the development of the Hebron Project. Development of the Hebron Project will include surveys, engineering, procurement, construction, installation, commissioning, development drilling, operations and maintenance, and decommissioning of an offshore oil production system and associated facilities.

This Project Description is meant to address the current and potential future development of facilities required to develop the four Significant Discovery License (SDL) areas (SDL 1006, SDL 1007, SDL 1009 and SDL 1010) incorporated into the Hebron Unit. Initial development in the Hebron Project Area will consist of developing oil resources from the Hebron Field only, and the injection of surplus gas into the West Ben Nevis Field. Further development of resources within the Hebron Project Area is anticipated in the future. It is expected that these future developments will be from the Hebron platform or sub-sea tie backs and utilize ullage from the main facilities installed with the Hebron Project.

1.1 Location of Hebron Project Area

Two Hebron Project areas are discussed in this document for the purpose of environmental assessment. An onshore / nearshore construction area at Bull Arm (located in Trinity Bay, Newfoundland and Labrador) for Gravity Based Structure (GBS) construction, topsides assembly and installation onto the GBS and an offshore area in the Jeanne d'Arc Basin where the completed Hebron Platform will be installed The Jeanne d’Arc sedimentary basin is recognized as the principal oil-producing basin off the east coast of Canada.

1.1.1 Onshore / Nearshore Construction Area

The Bull Arm Site is located 130 km north west of St. John's, Newfoundland and Labrador (Figure 1.1-1). The site is owned and operated by the Bull Arm Site Corporation, wholly owned by Nalcor Energy. The site was later used for the Terra Nova Floating Production, Storage and Offloading (FPSO) facility and some portion of the White Rose topsides fabrication.

The site has more than 12 km of paved roads and is connected to the Province's main highway (Trans Canada Highway). The Bull Arm Site is a fully self-contained facility with capabilities for steel and concrete construction, outfitting, installation, at-shore hook-up and commissioning.

The GBS casting basin site is situated in Great Mosquito Cove. The cove is 1.5 km long and has an average width of 500 m. The GBS casting basin is approximately 16.5 metres deep and has a diameter of 180 metres. The casting basin will be closed by a berm and / or row(s) of sheet piles which will subsequently be removed. The estimated length of the closure required to recreate the GBS casting basin is approximately 200 metres.

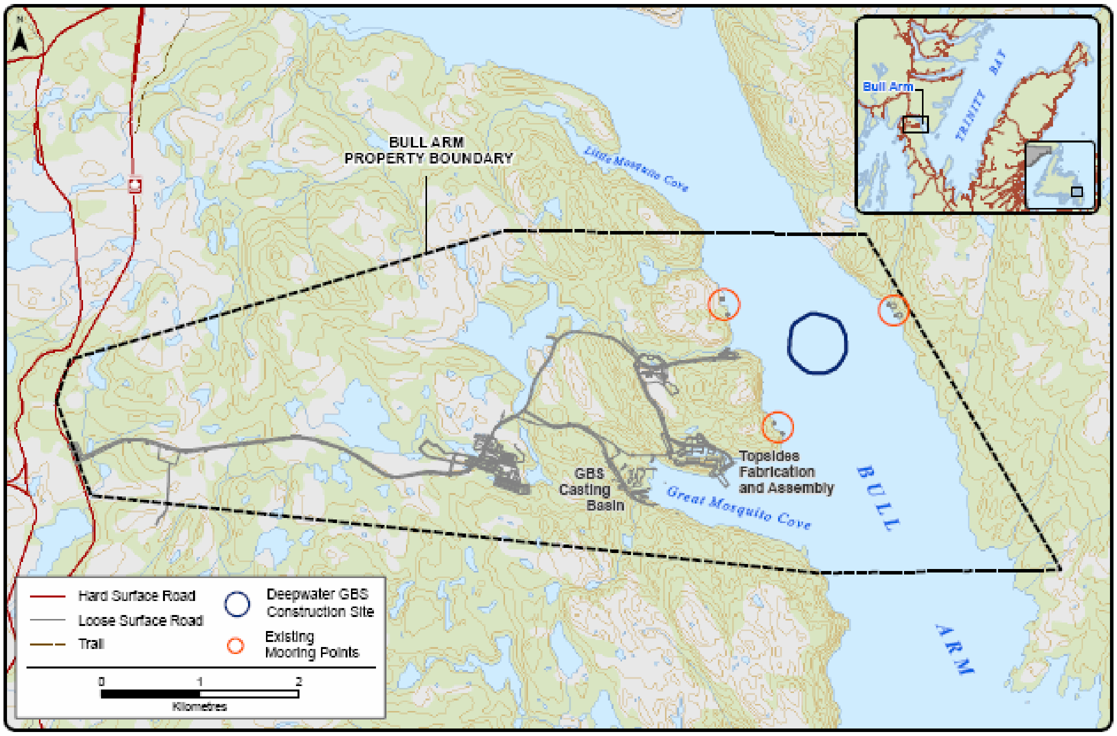

Figure 1.1-1: Onshore / Nearshore Construction Area

The Deep Water GBS Construction Site is located in Bull Arm with a water depth 180 m and is equipped with six mooring points. A study will be conducted to determine if additional and / or strengthened mooring points may be required. The water depth increases towards the mouth of the arm where it reaches approximately 250 metres deep.

The Topsides Fabrication and Assembly area is located on the north side of Great Mosquito Cove. Selected topsides components will be fabricated at the Bull Arm Site; others will be fabricated offsite and will be transported to the Bull Arm Site for assembly. All modules and components will be integrated at the pier. Hook-up and commissioning activities with the fully integrated topsides will begin at the pier prior to floatover and mating with the GBS at the deepwater site and may continue after mating.

1.1.2 Offshore Project Area

The Hebron Offshore Project Area for environmental assessment is located in the Jeanne d'Arc Basin (centered at approximately 46º33'N, 48º30'W), 340 km offshore of St. John's, Newfoundland and Labrador, approximately 9 km north of the Terra Nova Field and 32 km southeast of the Hibernia development (Figure 1.1-2). The water depth ranges from 88 to 102 m. The Hebron Unit (see Figure 1.1-3) contains three discovered fields: the Hebron Field; the West Ben Nevis Field; and the Ben Nevis Field.

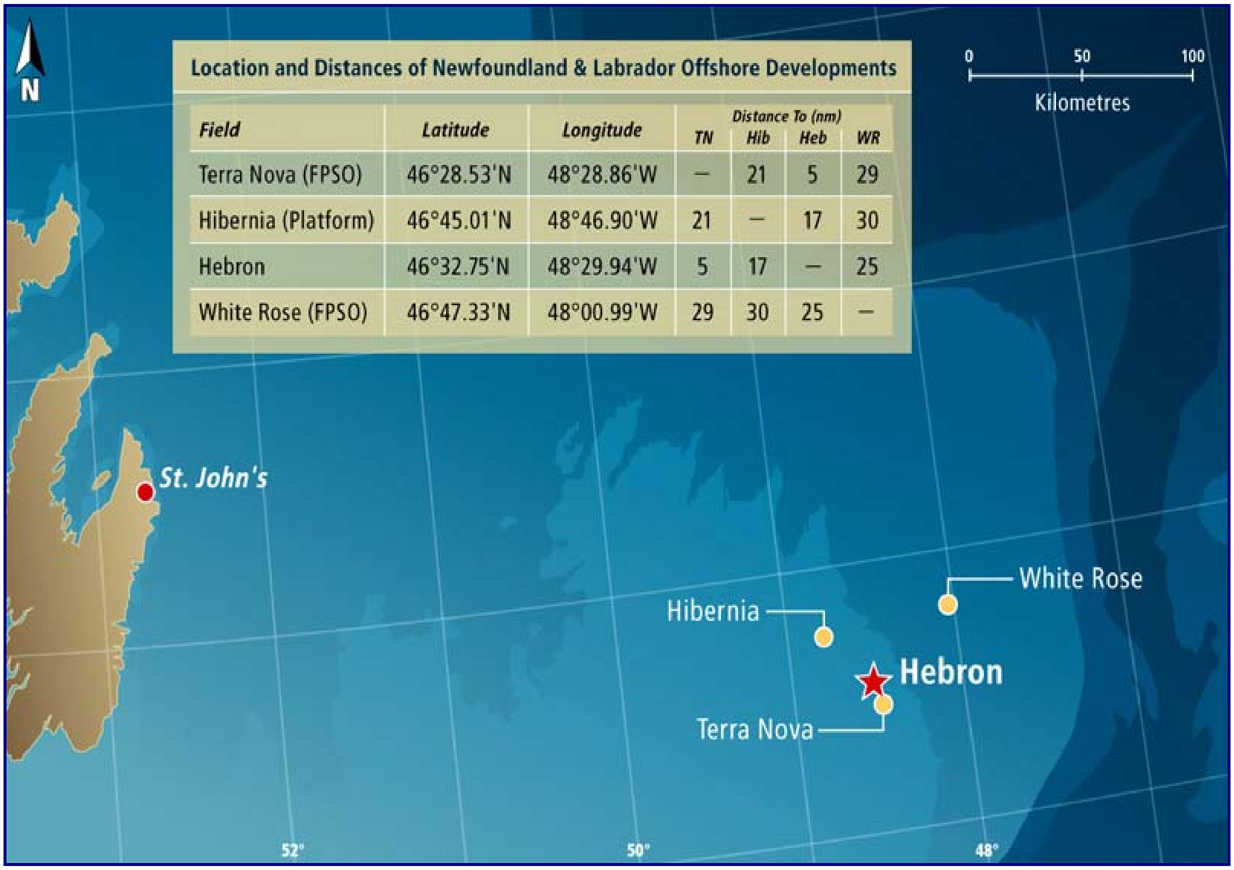

Figure 1.1-2: Hebron Project Location

Note: The distances in the inset table above are in nautical miles (1 nm = 1.85 km)

The Hebron Unit incorporates four Significant Discovery Licenses (SDLs), with ownership varying in each SDL. The four SDLs are: Hebron SDL 1006, Hebron SDL 1007, Ben Nevis SDL 1009 and West Ben Nevis SDL 1010 (Figure 1.1-3). These four SDLs contain the most likely extent of the oil for the delineated pools within the Hebron Unit. The Hebron Unit could be expanded if additional studies, seismic or exploration and / or delineation drilling proves that economically recoverable oil pool accumulations extends beyond the currently envisioned boundaries of the Hebron Unit Area.

Some Project activities (e.g., ice studies, environmental surveys, seismic surveys, vessel support, etc.) may occur within and outside the Hebron Unit indicated. Therefore, the Offshore Project Area as defined in this document will encompass additional areas surrounding the Hebron Unit Area as shown in Figure 1.1-3. This Offshore Project Area extends beyond the Hebron Unit to accommodate the large turning radius required by a seismic vessel.

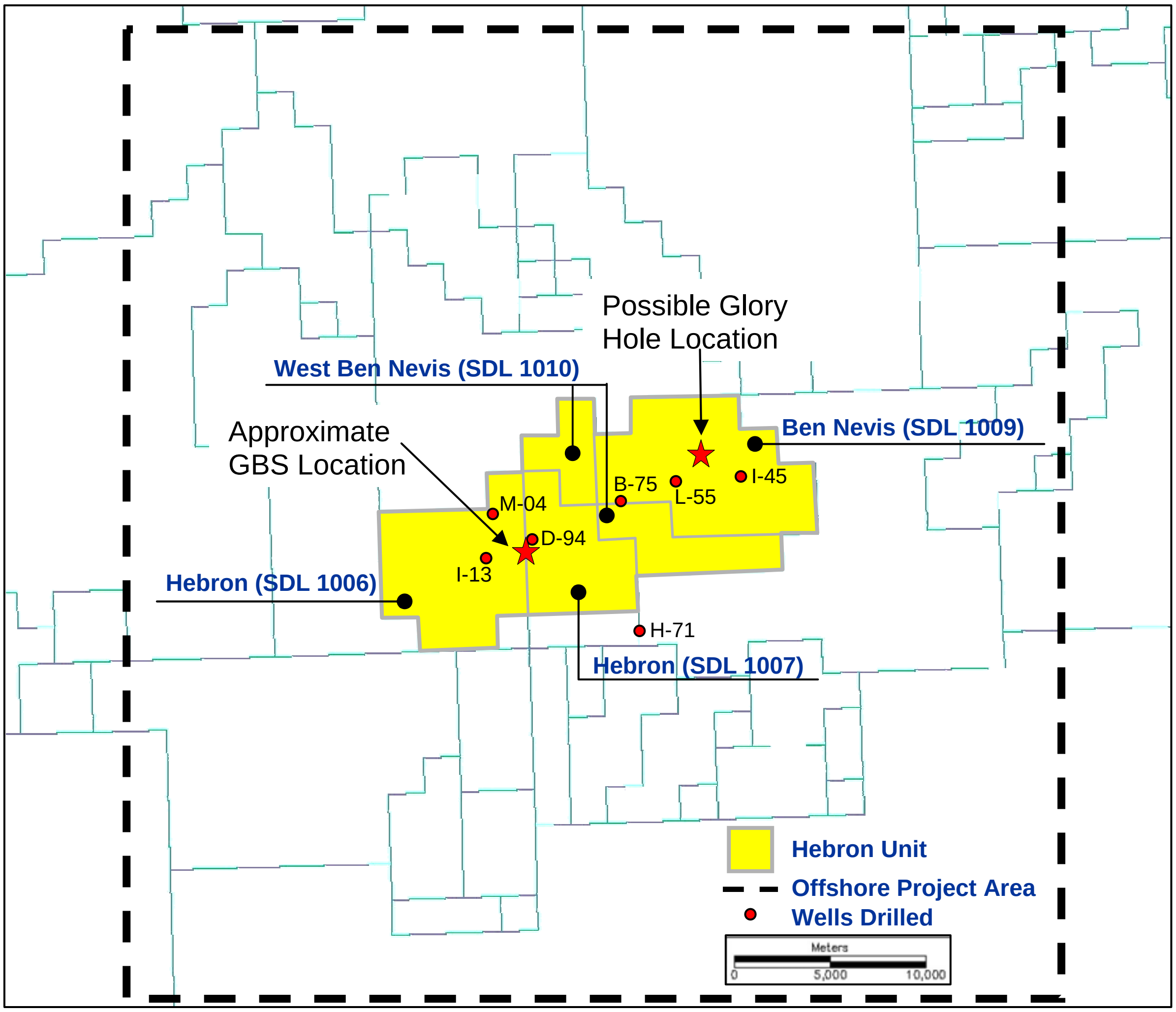

Figure 1.1-3: Hebron Offshore Project Area for Environmental Assessment

The Hebron Unit contains separate oil pools in at least four stratigraphic intervals: the Lower Cretaceous Ben Nevis Reservoir, the Lower Cretaceous Avalon Reservoir, the Lower Cretaceous Hibernia Reservoir and the Upper Jurassic Jeanne d'Arc Reservoir. A schematic cross-section across the Hebron Project area is shown in Figure 1.1-4.

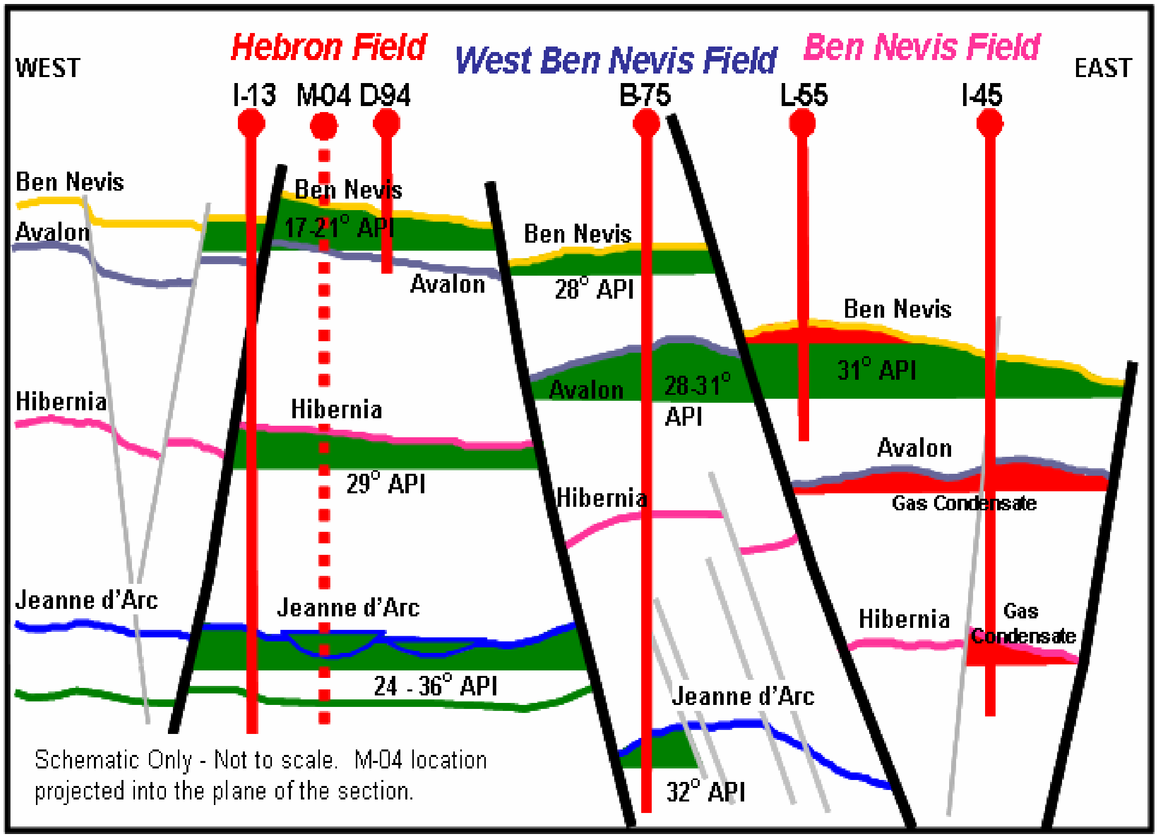

Figure 1.1-4: Schematic Cross-section across the Hebron Project Area

The wells within the Hebron Unit have encountered several hydrocarbon pools. These are:

- Hebron Field, Ben Nevis Reservoir, including the fault block penetrated by the D-94 and M-04 wells, and the fault block penetrated by the I-13 well;
- Hebron Field, Hibernia Reservoir, defined by the I-13 and M-04 wells;
- Hebron Field, Jeanne d'Arc Reservoir, including the isolated B, D, G, and H hydrocarbon bearing sands, defined by the I-13 and M-04 wells;
- West Ben Nevis Field, Ben Nevis Reservoir, penetrated by the B-75 well;
- West Ben Nevis Field, Avalon Reservoir, defined by the B-75 well;
- West Ben Nevis Field, Jeanne d'Arc Reservoir, penetrated by the B-75 well;
- Ben Nevis Field, Ben Nevis Reservoir, defined by the L-55 and I-45 wells
- Ben Nevis Field, Avalon and Hibernia Reservoirs, penetrated by the I-45 well.

1.2 Project Proponents

The Proponents have varying participating interests in the four SDLs comprising the Hebron Unit, but will share the cost of the Hebron Project, as shown in Table 1.2-1.

Table 1.2-1: Owners' Participating Interest

Owners	Share (%)
ExxonMobil Canada Properties	36.0
Chevron Canada Limited	26.7
Petro-Canada	22.7
StatoilHydro Canada Limited	9.7
Nalcor Energy – Oil and Gas Inc.	4.9

The Jeanne d'Arc sedimentary basin is a significant business area for the Hebron Project proponents. ExxonMobil Canada Properties is the Operator of the Hebron Project. The Operator's authority, role, responsibilities and reporting requirements are outlined in the Hebron Ben Nevis and West Ben Nevis Unitization and Joint Operating Agreement (JOA). This agreement was signed on March 31, 2005, retroactively effective to January 1, 2005, and amended on August 20, 2008 to include Nalcor Energy – Oil and Gas Inc.

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1.3 Purpose of the Project Description

This Project Description is being submitted to the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) pursuant to the requirements of the *Canadian Environmental Assessment Act* (CEAA). The document will assist the C-NLOPB and other Federal Authorities (FAs) in determining the nature of their participation in an environmental assessment of the Hebron Project. It will also allow those FAs identified as Responsible Authorities (RAs) to determine the scope of the environmental assessment to be undertaken.

1.3.1 Regulatory Framework

Offshore oil and gas exploration and development activities in the Newfoundland and Labrador offshore area are regulated under the *Canada-Newfoundland Atlantic Accord Implementation Act* (S.C. 1987, c.3) and *the Canada-Newfoundland and Labrador Atlantic Accord Implementation Newfoundland and Labrador Act* (R.S.N.L. 1990, c. C-2) (the Atlantic Accord Acts). Pursuant to the CEAA the C-NLOPB and other RAs are required to conduct an environmental assessment of a proposed project before the requisite permits and licenses can be issued. The *Comprehensive Study List Regulations* under CEAA prescribe a comprehensive study level of environmental assessment for an offshore oil and gas development project. The development approval process under the Atlantic Accord Acts requires that an Environmental Impact Statement (EIS) be submitted as part of a Development Application (DA). Therefore an environmental assessment of the Hebron Project will be undertaken to address the requirements of both CEAA and the Atlantic Accord Acts.

The C-NLOPB and the Canadian Environmental Assessment Agency (the Agency) have established a single harmonized process for addressing the environmental assessment requirements for the Hebron Project. Upon commencement of the environmental assessment process, the Agency will appoint a Federal Environmental Assessment Coordinator to coordinate with other Federal Agencies and departments. The relevant RAs and FAs will be determined through the Federal Coordination Regulations (FCRs) process.

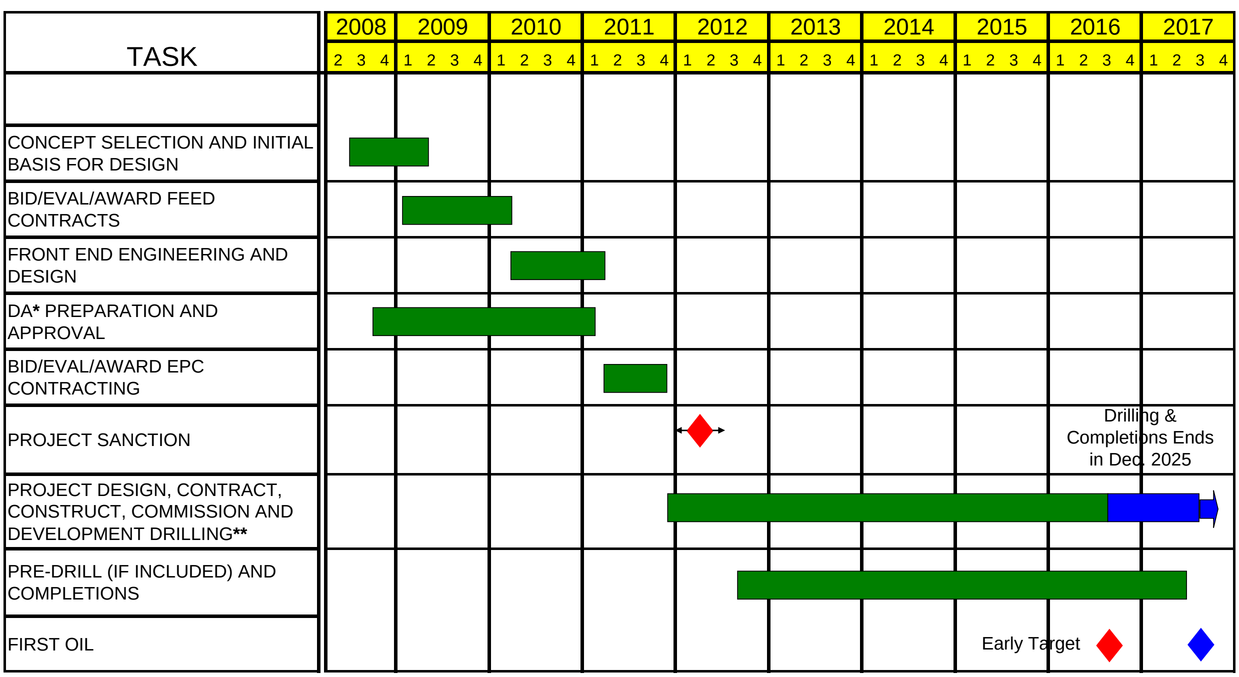
In addition to the C-NLOPB, the other RAs may include the Department of Fisheries and Oceans (DFO), Environment Canada, Transport Canada and Industry Canada. As development of the Hebron Project may have potential effects on fish habitat within the Project Area, DFO may require an Authorization for Works or Undertakings Affecting Fish Habitat under Section 35(2) of the *Fisheries Act*. A Section 35(2) authorization is a Law List trigger under CEAA; therefore, DFO may be an RA with respect to the environmental assessment of the Hebron Project. Construction and subsequent removal of a berm at the Bull Arm Site, and possible clearance dredging for towing the platform to the offshore location, are potential ocean disposal "triggers" for

Environment Canada under the *Canadian Environmental Protection Act* (CEPA). Transport Canada may also have a role as an RA with respect to the requirements of the Navigable Waters Protection Act (NWPA). The radio equipment on the production installation may require approval pursuant to Section 5(1)(f) of the *Radio Communications Act* and therefore, Industry Canada may also be an RA.

Other federal agencies may provide expert advice on specific aspects of the proposed Hebron Project. These Federal Authorities could include Natural Resources Canada, Transport Canada, Health Canada, Department of National Defence (DND) and the Canadian Coast Guard. Provincial departments that could be consulted by the RA include the Newfoundland and Labrador Departments of Environment and Conservation, Fisheries and Aquaculture, and Natural Resources.

1.3.2 Hebron Project Schedule

The Hebron Project Development Schedule (Figure 1.3-1) reflects a preliminary timeline (subject to change) for various activities required to achieve first oil from the Hebron Project area before the end of 2017.



Notes:

** DA - Development Application includes Development Plan, Benefits Plan, EIS / SEIS and other supporting documents as determined by the C-NLOPB.*
*** This is the initial development schedule (base case) and does not include additional drilling/development needed for future developments.*

Figure 1.3-1: Hebron Project Development Schedule

1.4 Hebron Project Area Depletion Planning

A depletion strategy for each of the reservoirs in the Hebron Project Area is under development. The depletion strategy should provide a reasonable balance of economic value, risk mitigation and overall development flexibility to allow the reservoirs to be effectively managed over the life of the field. All reservoirs within the Hebron Unit are being evaluated with respect to risked production performance.

At this juncture, the initial depletion plan consists of developing crude oil resources from the Ben Nevis, Hibernia and Jeanne d'Arc H and B reservoirs within the Hebron Field and gas storage in the Ben Nevis reservoir of the West Ben Nevis Field. Water injection is planned as the primary drive mechanism for the Hebron Field to improve overall oil recovery. The estimated oil recovery for the base development is estimated at approximately 90,000,000 m^3. The total number of wells for the base case Project is expected to be approximately 35 to 45, of which approximately 13 could be pre-drilled to assist with production ramp-up. In addition to the base case development, there is opportunity for the development of additional pools in the Hebron Project Area, depending on the drilling results, production performance (of wells from the initial development), studies, possible delineation wells, new seismic data or some combination of these. For example, the Ben Nevis reservoir in the Ben Nevis Field could be part of an optional later phase of development subject to filing a supplemental development plan. Therefore, this Project Description generally describes the activities and facilities (e.g., drill centres, wells, flowlines, etc.) for inclusion in this environmental assessment. Depending on the aforementioned results and future studies, the number of wells, including potential platform and subsea based wells, could potentially expand to include approximately 70 or more in total.

The Ben Nevis Pool within the Hebron Field is the core of the Hebron Project, and is anticipated to produce about 80 percent of the Hebron Project's crude oil. However, the reservoir quality is expected to be of a lower quality when compared to other producing fields in the Jeanne d'Arc Basin (e.g., Hibernia field or Terra Nova field) and the medium 20ºAPI crude in this pool presents production challenges as the viscosity can be 10 to 20 times higher than that of water.

The Jeanne d'Arc and Hibernia Pools within the Hebron Field are also part of the Hebron Project. Relative to the Hebron - Ben Nevis Pool, the Jeanne d'Arc and Hibernia Pools are characterized as having higher oil quality, poorer reservoir quality, lower recovery factors, and higher development costs.

The Hebron Field fluids have relatively low gas-to-oil ratio oil, but it is expected that excess gas will exist beyond what is needed to facilitate oil production. A gas management plan is being developed in conjunction with the field depletion plan that will take into account a number of considerations including:

- utilization of gas for artificial lift in the oil producing wells;
- injection of excess produced gas into Project Area reservoirs that are secondary oil reservoirs (e.g., West Ben Nevis – Ben Nevis Pool);
- potential need to produce back injected gas (gas storage) later in field life;
- gas injection into primary producing intervals as a means of improving oil recovery (e.g., Water Alternating Gas injection).

Productive life of the Hebron Project is currently estimated at 30 years. Future developments could extend Project life beyond 30 years.

2 THE PROPOSED PROJECT

The Hebron Field will be developed using a stand-alone concrete GBS. The GBS will consist of a reinforced concrete structure designed to withstand sea ice, icebergs, and meteorological and oceanographic conditions at the offshore Hebron Project Area (Figure 2.1-1). The preliminary GBS concept has a single main shaft supporting the topsides, encompassing all wells, and may also incorporate an inner, wet shaft to provide direct access to any pre-drilled wells. The GBS concept will be further refined / finalized during FEED and detailed design stages.

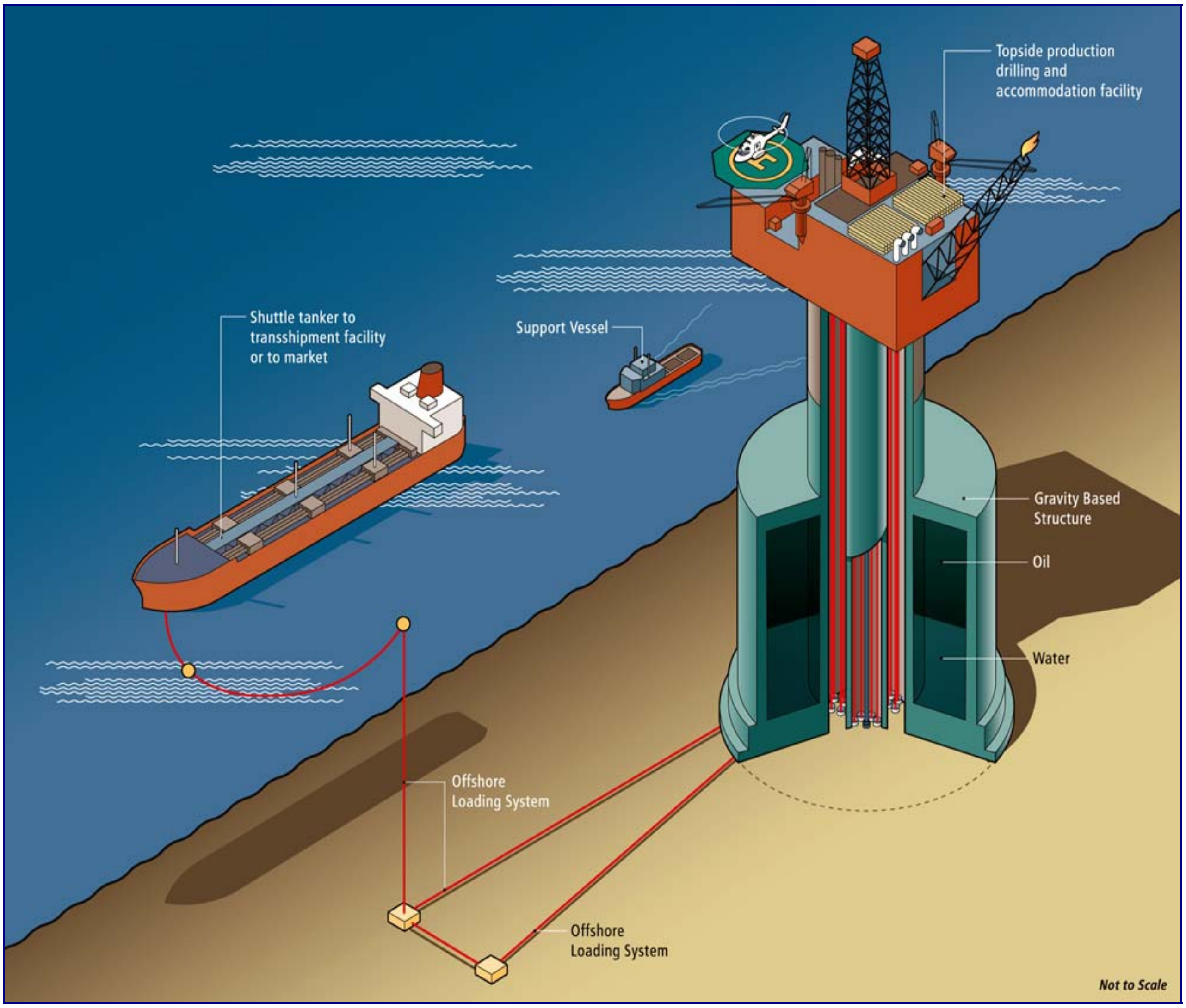


Figure 2.1-1: Stand-alone Gravity-Base Structure Preliminary Development Layout

The following facilities and systems will be mounted on the GBS:

- production facilities for the separation of oil, gas and water, treatment of produced water, compression of gas for use in artificially lifting production from the wellbores and injection of gas for conservation, injection of seawater and potentially produced water to maintain reservoir pressure;
- drilling facilities (single drilling rig) to enable drilling and completion of the post-start up wells, connection and completion of pre-drilled wells (if any) plus ongoing downhole maintenance of all the wells;
- utility systems including power generation and distribution;
- life support and safety systems including personnel accommodation for approximately 140 - 200 (or more) personnel, platform control system, temporary safe refuge, and emergency evacuation and rescue systems.

The topsides will be split into a number of modules. Each of the modules will be fabricated and commissioned (as far as practical) at existing primary fabrication sites per the terms of the Benefits Agreement signed by Hebron Proponents and the Government of Newfoundland and Labrador in August 2008. The modules sourced from different locations, both world-wide and nearby in Newfoundland and Labrador, will be transported to the Bull Arm Site for final assembly, hook-up and commissioning.

When the GBS construction is complete and the topsides are assembled, the two will be mated at the Bull Arm Deepwater GBS Construction Site (Figure 1.1-1). The mated structure will then be towed to the permanent site and installed. Offshore grouting will likely be required. Docking and anchor piles may be required to position the GBS. Drilling would then commence from the platform rig after installation of the GBS. Final commissioning and production start-up will follow based on well availability.

Pre-drilling (prior to platform installation) is being considered to assist with production ramp-up. Based on a preliminary analysis up to approximately 13 of the 35 to 45 total wells planned for the platform could be pre-drilled. If the Project proceeds with this option, a mobile offshore drilling unit (MODU) will be used to drill and partially complete the pre-drilled wells before the arrival of the GBS production facility. If pre-drilling is included, the topsides and GBS structures will be fabricated, assembled, and mated while in-field pre-drilling is ongoing (or pre-drilling could be completed prior to mating). Upon completion of any pre-drilling, the platform will be towed offshore for installation over the pre-drilled wells.

After the platform has been safely installed, any pre-drilled wells will be tied back to the topside drilling facility and production started. The remaining wells will then be drilled by the platform rig in parallel with producing operations to meet the depletion plan objectives.

If pre-drilling is not included, drilling will commence from the platform rig after installation of the GBS. Final commissioning and production start-up will follow based on well availability.

The pre-drilling concept will not utilize a glory hole to mitigate the risk of damage from icebergs. Quantifying this risk and utilizing an ice management plan will be part of the pre-drill concept evaluation studies. Thus, the pre-drilled wells could be exposed to the environment (but still protected by an ice management program) for up to three years before the GBS is installed. The concept of a glory hole was developed to mitigate the risk of ice damage over the life of the wells (e.g., 20 to 40 years). The risk of being "exposed" to potential ice damage for up to three years is significantly lower.

The decision on whether to include pre-drilling in the final concept has not yet been made. It is anticipated this decision will be made during the first half of 2009 based on further analysis of the risks and potential cost-benefits of pre-drilling. During this period the Operator will continue to discuss the opportunities / challenges with the appropriate regulatory agencies.

Further evaluation and risk assessments of the pre start-up process will be performed to ensure that connection to the GBS can be conducted with high reliability.

The GBS production facilities will have the capacity to handle the life of field production stream (30 or more years). Based on the current conceptual reservoir depletion plan, it is expected the facility will be designed to accommodate an estimated production rate of 19,000 to 28,000 m^3/day of oil, with a higher total liquid rate of approximately 30,000 to 50,000 m^3/day to accommodate the high volumes of produced water. The produced water system will be designed to treat roughly 30,000 to 45,000 m^3/day of produced water for overboard disposal as per regulation or possibly re-injection into the sub-surface if feasible. Gas compression will be required to accommodate the re-injection of an estimated 1,500,000 to 2,000,000 m^3/day of produced gas and provide approximately 2,900,000 to 4,900,000 m^3/day of gas lift capability. These design rates may change as the reservoir depletion strategy and plan are finalized.

The GBS will be designed to store approximately 180,000 to 230,000 m^3 of oil in multiple separate storage compartments prior to custody transfer, metering and subsequent shipment.

An offshore loading system (OLS), complete with a looped pipeline and two separate loading points will be installed to offload the oil onto ice-strengthened tankers for transfer to the Newfoundland Transshipment Terminal or for transport directly to market. Several methods could be used for laying the pipelines related to the OLS. The pipeline laying method will be selected as part of the detailed engineering and construction planning effort. These components could be installed during the same season as the GBS installation or during a previous year.

Further development of resources within the four SDLs is anticipated in the future. It is expected that these future developments may be from the platform or tied back using sub-sea flow lines to the GBS and utilize spare capacity. Such future developments may require the addition of one or more drill centre(s) within the Project Area and 'J' tubes will be incorporated into the GBS design to accommodate this tie back option.

2.1 Project Scope

The scope of the Hebron Project is expected to include some or all of the following activities over the life of the Project.

2.1.1 Pre-Construction

Both onshore and nearshore pre-construction activities will occur at the Bull Arm Site to ready the site for actual GBS construction and topsides fabrication and assembly. Some of the key activities associated with the design and site preparation (including site grading, demolition or construction) are shown in Table 2.1-1.

Table 2.1-1: Potential Pre-Construction Activities

<table>
<tr><th>Potential Activities</th><th>Potential Environmental Interactions / Discharges / Emissions / Wastes</th></tr>
<tr><td>Onshore (Bull Arm Construction Site)</td><td rowspan="15">• Air emissions
• Disposal / discharge of stormwater, potable water, fire water and industrial water
• Noise
• Potential surface disturbance
• Site runoff (e.g., soil erosion)
• Solid, construction, hazardous, domestic and sanitary waste disposal
• Wind erosion</td></tr>
<tr><td>Additional onshore surveys (e.g., topographic, geotechnical, environmental, etc.)</td></tr>
<tr><td>Grading of Site</td></tr>
<tr><td>Re-establishment and use of construction camp</td></tr>
<tr><td>Demolition / disposal of unnecessary structures</td></tr>
<tr><td>Construction of new buildings and structures</td></tr>
<tr><td>Repair / upgrade of existing infrastructure (e.g., site roads, buildings, facilities, cranes, topsides pier, etc.)</td></tr>
<tr><td>Continued use of fabrication and laydown yards</td></tr>
<tr><td>Water requirements (potable water, fire water and industrial water)</td></tr>
<tr><td>Waste generated (domestic waste, construction waste, hazardous, sanitary waste)</td></tr>
<tr><td>Quarrying (for concrete aggregate and berm construction) *</td></tr>
<tr><td>Chemical and fuel storage</td></tr>
<tr><td>Bulk material handling (sand, cement, crushed rock, aggregate, etc.)</td></tr>
<tr><td>Road / cutting construction</td></tr>
<tr><td>Blasting</td></tr>
</table>

<table>
<tr><th>Potential Activities</th><th>Potential Environmental Interactions / Discharges / Emissions / Wastes</th></tr>
<tr><td>Management of site traffic</td><td></td></tr>
<tr><td>Nearshore (Great Mosquito Cove and Bull Arm)</td><td rowspan="11">• Air emissions
• Bilge / ballast water
• Deck drainage / onshore site runoff
• Disposal / discharge of stormwater, potable water, fire water, cooling water and industrial water)
• Elevated suspended solids
• Loss of subtidal habitat and organisms
• Noise (including underwater)
• Potential physical impacts (e.g., vibration)
• Potential localized water column contamination
• Sedimentation
• Solid, construction, hazardous, domestic and sanitary waste disposal
• Substrate disturbance</td></tr>
<tr><td>Additional surveys (e.g., topographic, geophysical, geological, geotechnical, environmental, etc.)</td></tr>
<tr><td>Re-establish berm for casting basin
(include sheet pile / driving, potential grouting, ect.)</td></tr>
<tr><td>Dewater casting basin / establish foundation</td></tr>
<tr><td>"Ocean" disposal of berm material in the vicinity of Bull Arm.</td></tr>
<tr><td>Potential diving activities</td></tr>
<tr><td>Vessel traffic (e.g., supply, support, tow, diving support, barge, etc.)</td></tr>
<tr><td>Water requirements (potable water, fire water and industrial water)</td></tr>
<tr><td>Waste generated (domestic waste, construction waste, hazardous, sanitary waste)</td></tr>
<tr><td>Blasting, dredging</td></tr>
<tr><td>Welding and x-ray inspections</td></tr>
<tr><td>Offshore Location</td><td rowspan="15">• Air emissions
• Bilge / ballast water
• Chemical management
• Deck drainage
• Disposal / discharge of stormwater, potable water, fire water, cooling water and industrial water
• Drilling fluids and cuttings disposal (WBM and NAF) **
• Elevated suspended solids
• Loss of benthic habitat and organisms
• Marine / Underwater noise
• Navigation Safety
• Potential water column contamination
• Seawater discharges (e.g., cooling water)
• Sedimentation
• Solid, construction, hazardous, domestic and sanitary waste disposal
• Substrate disturbance</td></tr>
<tr><td>Offshore surveys (Some of these surveys could occur during other Project stages)</td></tr>
<tr><td>Geophysical
(may include Vertical Seismic Profiling [VSP], 2D, 3D, multibeam echosounder, sidescan sonar, subbottom profiler, and streamer and seabed seismic surveys)</td></tr>
<tr><td>Geological</td></tr>
<tr><td>Geotechnical</td></tr>
<tr><td>Environmental baseline</td></tr>
<tr><td>Iceburg shape survey</td></tr>
<tr><td>Water requirements (potable water, fire water and industrial water)</td></tr>
<tr><td>Waste generated (domestic waste, construction waste, hazardous, sanitary waste)</td></tr>
<tr><td>Pre-drilled wells (also see drilling section)</td></tr>
<tr><td>Installation of template on seafloor (piles could be driven or drilled/grouted)</td></tr>
<tr><td>Drill ~13 wells using Mobile Offshore Drilling Unit</td></tr>
<tr><td>Chemical management (e.g., Water-base and Non-Aqueous Fluid additives, cement, well treatment fluids, BOP fluids, etc.)</td></tr>
<tr><td>Drilling fluid and cuttings management</td></tr>
</table>

Potential Activities	Potential Environmental Interactions / Discharges / Emissions / Wastes
Chemical/fuel storage	
Managment of drilling fluids and cuttings (reconditioning, discharge or injection) **	
Cementing and completing wells	
Flaring and well testing	
Vessel traffic (e.g., supply, support, tow, barge, etc.)	
Notes: **All or some of the material may be obtained onsite or it may be trucked or barged from other existing or new quarries.* ***Water-base muds (WBMs) and cuttings will be discharged overboard. The Operator in compliance with regulatory agencies will evaluate best available cuttings management technology and practices to identify a waste management strategy for spent Non-Aqueous Fluids (NAFs) and NAF cuttings.*	

2.1.2 Construction

All shore-based construction activities are planned to take place (as far as practical) at established facilities. No new onshore facilities are planned; however, some of those existing facilities at the Bull Arm or other sites may need to be refurbished or expanded.

The first stage of GBS construction will be in the existing GBS casting basin facility at Bull Arm. The GBS will be transferred to the Bull Arm deepwater site for completion. Figure 2.1-2 illustrates some generic construction steps for a GBS.

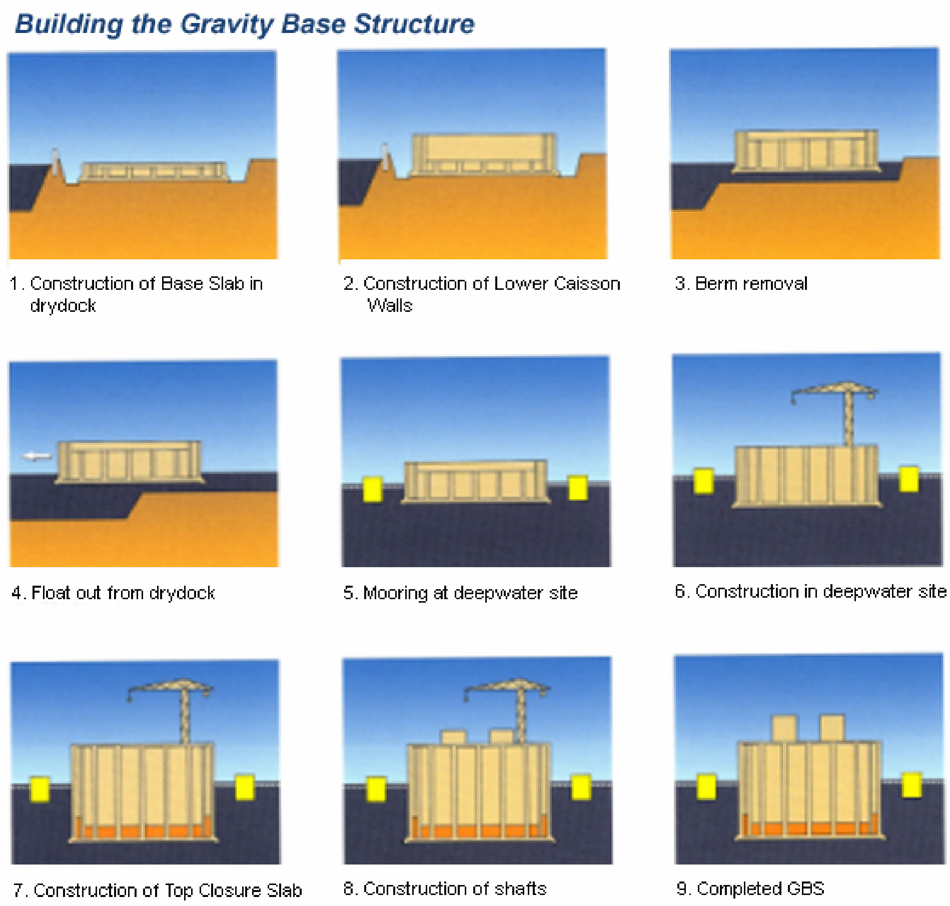


Figure 2.1-2: Building of the Gravity Base Structure (Example of Hibernia GBS Construction)

Both onshore and nearshore construction activities will likely occur at the Bull Arm Site. Some of these key activities associated with the engineering design, construction, and installation of an integrated GBS production platform and offloading system are listed in Table 2.1-2 for the onshore / nearshore location and in Table 2.1-3 for the offshore location.

Table 2.1-2: Potential Construction Activities Associated with the Bull Arm Construction Site

<table>
<tr><th>Potential Activities</th><th>Potential Environmental Interactions / Discharges / Emissions / Wastes</th></tr>
<tr><td>Onshore (Bull Arm Construction Site)</td><td rowspan="4">Air emissions
Bilge / ballast water
Deck drainage / onshore site runoff
Disposal / discharge of stormwater, potable water, fire water and industrial water
Elevated suspended solids</td></tr>
<tr><td>Concrete production</td></tr>
<tr><td>Operation of construction camp and related facilities</td></tr>
<tr><td>Transportation (e.g., vehicle, barge, etc.) of materials, equipment, topsides components, modules and personnel</td></tr>
</table>

Potential Activities	Potential Environmental Interactions / Discharges / Emissions / Wastes
Chemical / fuel storage	• Loss of subtidal habitat and organisms • Noise (including underwater) • Potential water column contamination • Seawater discharges • Sedimentation • Solid, construction, hazardous, domestic and sanitary waste disposal • Substrate disturbance
Water requirements (potable water, fire water and industrial water)	
Waste generated (domestic waste, construction waste, hazardous, sanitary waste)	
Use of existing, refurbished or new sewage treatment plant.	
Continued use of fabrication and laydown yards	
Quarrying (for concrete aggregate and berm construction) *	
Rock crushing	
Bulk material handling (sand, cement, crushed rock, aggregate, etc.)	
Construction of new buildings / facilities	
Chemical and fuel storage	
Construction of GBS, fabrication of topsides, integration of modules and commissioning of topsides	
Welding and x-ray inspections	
Nearshore (Great Mosquito Cove and Bull Arm)	• Air emissions • Bilge / ballast water • Deck drainage • Disposal / discharge of stormwater, potable water, fire water, cooling water and industrial water • Elevated suspended solids • Loss of benthic habitat and oranisms • Noise (including underwater) ** • Potential contamination of environment • Sedimentation • Shoreline Runoff (e.g., erosion) • Solid, construction, hazardous, domestic and sanitary waste disposal • Substrate disturbance
Re-establish and possibly create new moorings at Bull Arm deepwater site	
Mooring chain laying and connection	
Mooring of GBS	
Mooring of barges	
Potential diving activities	
Removal of berm and disposal of material (blasting dredging)	
Inshore solid ballasting (which may include disposal of water containing fine material)	
GBS water ballasting and de-ballasting	
Water requirements (potable water, fire water and industrial water)	
Waste generated (domestic waste, construction waste, hazardous, sanitary waste)	
Tow-out of GBS to Bull Arm deepwater site (may include clearance dredging of selected shallow area) **	
Concrete production	
Power generation	
Slipforming	
Rebar facility	

Potential Activities	Potential Environmental Interactions / Discharges / Emissions / Wastes
Complete GBS construction and install topsides at Bull Arm deepwater site	
Additional hook-up and commissioning of topsides	
Operation of helicoptors, supply, support, standby, mooring and tow vessels / barges / Remotely Operated Vehicles (ROVs)	
Tow Platform (GBS and Topsides) to Offshore location (Clearance dredging may be needed based on outcome of future studies)	
Welding and x-ray inspection	
Notes: * *All or some of the material may be obtained onsite or it may be trucked or barged from other existing or new quarries.* *****Clearance dredging could potentially include blasting if hard bottom substrate is encountered.***	

Table 2.1-3: Potential Construction Activities Associated with Construction and Installation Activities at the Offshore Location

Potential Activities	Potential Environmental Interactions / Discharges / Emissions / Wastes
Offshore Location	
Clearance surveys (e.g.,sidescan sonar, etc.) prior to installation of platform, offloading system, glory holes or pipelines / flowlines)	• Air emissions • Bilge / Ballast water • Deck drainage • Disposal / discharge of stormwater, potable water, fire water, cooling water and industrial water • Elevated suspended solids • Marine / underwater noise (may include blasting) • Potential loss of benthic habitat and organisms • Potential substrate disturbance • Potential water column contamination • Sedimentation • Solid, construction, hazardous, domestic and sanitary waste disposal
Tow-out / Offshore Installation	
Possible clearance dredging	
Seafloor leveling for GBS installation	
Placement of GBS at offshore site location	
Underbase grouting	
Possible offshore solid ballasting	
Placement of rock scour on seafloor around final GBS location	
Installation of docking piles, mooring points and installation of pre-drill template (if pre-drill to occur)	
Operation of helicoptors, supply, support, standby and tow vessels / Barges	
Installation of offloading system (May require dredging to bury offloading flowlines)	
Diving Activities	
Operation of ROVs	
Possible construction of a number of drill centres	
Operation of dredger for glory hole construction	
Installation of flowine(s) from Drill Centre(s) to Platform	

Potential Activities	Potential Environmental Interactions / Discharges / Emissions / Wastes
Buried via dredging, concrete matresses or rock cover	
Tie-ins to Platform	
Additional hook-up, production testing and commissioning	
Hydrostatic test fluid (OLS and Flowlines)	
Ocean disposal of dredge material	
Possible flaring during production testing	
Possible use of corrosion inhibitors or biocides (OLS or flowlines) *	
Water requirements (potable water, cooling water, fire water and industrial water)	
Waste generated (domestic waste, construction waste, hazardous, sanitary waste)	
Chemical/fuel storage	
Note: **The Operator will evaluate the use of biocides other than chlorine.*	

2.1.3 Drilling and Completions

Table 2.1-4 lists the type and possible number of wells that may be drilled over the life of the Hebron Project.

Table 2.1-4: Potential Activities Associated with Drilling and Completing Wells at the Offshore Location

		Number of Wells *		
Potential Drilling Activities at the Offshore Location	**Drill Centres**	**Range**	**Total**	**Potential Environmental Interactions / Discharges / Emissions / Wastes**
Mobile Offshore Drilling Unit (MODU) Pre-Drilling		~13	13	• Air emissions (including potential incinerator) • Bilge / Ballast water • Changes to water quality in receiving environment • Deck drainage / Open drains • Disposal / discharge of stormwater, potable water, fire water, cooling water and industrial water • Drilling fluids and cuttings (WBM and NAF) disposal *** • Sedimentation • Solid , construction, hazardous, domestic and sanitary waste disposal
GBS Drilling **			32	
With Pre-Drilling		22 to 32		
Without Pre-Drilling		35 to 45		
Potential MODU Drilling	0 to 4	~5	20	
Possible Delineation Well(s)		1 to 2	2	
TOTAL WELLS			67	
Water requirements (potable water, firewater, cooling and industrial water)				
Waste generated (domestic waste, construction waste, hazardous, sanitary waste)				
Power generation				

		Number of Wells *		
Potential Drilling Activities at the Offshore Location	**Drill Centres**	**Range**	**Total**	**Potential Environmental Interactions / Discharges / Emissions / Wastes**
Operation of derrick				• Substrate disturbance • Wildlife • Underwater noise
Chemical / fuel management and storage				
Preparation and storage of drilling fluids				
Managment of drilling fluids and cuttings (reconditioning, discharge or injection) ***				
Cementing and completing wells				
Flaring and well testing				
Management and storage of BOP fluids and well treatment fluids				
Operation of helicoptors, supply, support, standby and tow vessels / Barges / ROVs				

Notes:

** The well counts shown are for environmental assessment purposes only and may vary based on future subsurface definition.*

*** The GBS will be designed to accommodate a total of 46 to 54 well slots (the 35-45 slots associated with the base case Project and an additional 9-19 slots for possible future development). The total GBS well count will include waste injection wells or annular disposal.*

**** Water-Based Drilling fluids and cuttings will be discharged overboard. The Operator will evaluate best available cuttings management technology and practices to identify a waste management strategy for spent NAF and NAF cuttings.*

2.1.4 Operations

Table 2.1-5 lists some of the key operational activities associated with the operation, maintenance, (and modification) of an integrated GBS production platform including the offloading system. It also includes those activities associated with the transportation of produced crude to the Newfoundland Transshipment Terminal or directly to market.

Table 2.1-5: Potential Production-Related Activities at the Offshore Platform Location

Potential Activities	Potential Environmental Interactions / Discharges / Emissions / Wastes
Offshore Platform Location	• Air emissions (including waste incinerator) • Bilge / ballast water • Changes to water quality in receiving environment • Deck drainage • Disposal / discharge of stormwater, potable water, fire water, cooling water, and industrial water
Maintenance activities	
Power generation and flaring	
Welding and x-ray inspection	
Normal platform and OLS operational activities	
Operation of seawater systems (cooling, firewater, etc.)	
Operation of Oil Storage / Storage Displacement Water	

Potential Activities	Potential Environmental Interactions / Discharges / Emissions / Wastes
(SDW) system	• Drilling fluids and cuttings (WBM and NAF) disposal * • Elevated TSS levels • Navigation safety • Noise (including underwater noise) • Possible substrate disturbance • Possible loss of fish habitat • Potential contamination of receiving environment • Potential cumulative impacts • Produced water injection or discharge • Seawater / Firewater • Sedimentation, • Solid, construction, hazardous, domestic and sanitary waste disposal • Storage Displacement Water (SDW) System Discharges (similar to Hibernia) • Well treatment fluids • Wildlife concerns
Water requirements (potable water, fire water, cooling water, and industrial water)	
Waste generated (domestic waste, construction waste, hazardous, sanitary waste)	
Operation of Produced Water Re-injection / Treatment / Disposal System**	
Operation of Utilities Systems	
Corrosion Protection System	
Use of corrosion inhibitors or biocides (e.g., hypochlorite) in OLS or other flowlines and pipelines***	
Sewage Disposal Lines	
Chemical / fuel management and storage	
Operation of helicoptors, supply, support, standby and tow vessels / Barges / ROVs	
Continued use of survey vessels and sampling	
Offloding and tranportation of produced crude	
Well workovers (e.g., drilling, completing, testing, etc.)	
Preparation and storage of drilling fluids	
Managment of drilling fluids and cuttings (reconditioning, discharge or injection)	
Management and storage of BOP fluids and well treatment fluids	
Cementing and completing wells	
Operation of possible disposal well(s) on GBS	
Operaation of Corrosion Protection Systems	
Oil processing systems	
Seawater Injection System (to maintain reservoir pressure)	
Gas injection systems	
Artificial Lift (gas lift, electric submersible pumps or a combination	
Oily water treatment †	
Vent and Flare System ††	
Diving Activities	
Operation of ROVs	

Note:

**Water-Based Drilling fluids and cuttings will be discharged overboard. The Operator will evaluate best available cuttings management technology and practices to identify a waste management strategy for spent NAF and NAF cuttings.*

***Produced water will be discharged in compliance with applicable regulations. During pre-FEED the Operator will*

Potential Activities	Potential Environmental Interactions / Discharges / Emissions / Wastes
evaluate the feasibility and impact of full re-injection of produced water into the subsurface reservoir. ****The Operator will evaluate the use of biocides other than chlorine. The discharge from the hypochlorite system will be treated to meet a limit approved by the C-NLOPB's Chief Conservation Officer.* *[†]Water will be treated prior to being discharged to the sea in accordance with OWTG (NEB et al. 2002) or injected into the subsurface. Water from the open drains will also either be disposed overboard in accordance with OWTG or injected into the subsurface.* *[††]Small amounts of fuel gas will be used for flare pilots and may also be used to sweep the flare system piping. "Pilotless" flares will be evaluated during Pre-FEED.*	

2.1.5 Abandonment / Decommissioning

The Operator will decommission and abandon the Hebron production facility according to C-NLOPB requirements and the *Newfoundland and Labrador Offshore Production and Conservation Regulations*. The GBS infrastructure will be decommissioned and the wells will be plugged and abandoned. The GBS structure will be designed for removal at the end of its useful life, although the decision as to whether this will be required will be made at that time. The decision to remove or abandon in place the pipeline and other subsea equipment will be made after a thorough analysis and in compliance with all applicable regulations.

2.2 Potential Environmental Interactions, Discharges, Emissions and Wastes

The potential environmental interactions, discharges emissions and wastes associated with Project activities during pre-construction, construction and installation, development drilling (pre-drilling and GBS drilling), operations and maintenance phases are listed in (Tables 2.1-1 to 2.1-5).

The key guidance pertaining to emissions and offshore discharge, disposal and treatment is contained in the Offshore Waste Treatment Guidelines [OWTG] (NEB et al. 2002). These guidelines were first published in 1996 and subsequently updated in 2002 and are expected to be reviewed again in the near future. The Operator will fully comply with these guidelines as adopted in the Environmental Protection Plan (EPP) approved by the Chief Conservation Officer (CCO). A comprehensive waste management plan similar to those used by the other Grand Banks operators will be developed and implemented for the Hebron Project.

It is anticipated that an Environmental Effects Monitoring (EEM) program will be developed where appropriate to assess the effects of these discharges and emissions.

2.3 Potential Future Development

The Hebron Project proponents may decide that additional drilling will be required in the future to further develop possible economically recoverable hydrocarbon resources. These resources will most likely be developed with subsea tie-back(s) to the GBS. The most likely future glory hole location (subsea drill centre) for such a development is shown in relation to the GBS in Figure 1.1-3. The notional flowline route would be between the GBS and drill centre / glory hole location. Final locations will be adjusted based upon future engineering work and geotechnical and geohazard surveys. Both the well configuration and flowline configuration described for this future Hebron development can be considered tentative and subject to further review before the final design is determined. These possible future developments may involve, but may not be limited to, the following activities:

- Construction, installation, operation, maintenance, modification, abandonment and decommissioning of a number of drill centres within glory holes (up to approximately 70 m x 70 m x 10 m in size) that contain the equipment necessary to support the extraction of petroleum resources. Each of the drill centres could contain a number of injection or production wells. Each glory hole will be of sufficient depth (~10 m) to ensure protection of subsea equipment from iceberg scour. Glory holes will be excavated using proven construction methods for the Grand Banks. Subject to confirmation of soil conditions by a geotechnical survey, a trailing suction hopper dredge, or acceptable alternate dredging technology (e.g., clam dredge), may be used to excavate the glory hole.
- Glory hole dredge spoils disposal in one or more approved areas.
- Construction, installation, operation, maintenance, modification, abandonment and decommissioning of subsea flowlines/umbilicals and associated equipment (inclusive of water and oil flowlines) tied back to the Hebron GBS. This includes any associated seabed trenching, excavation, covering and/or soil deposition. Concrete mattresses positioned over the flowlines near the GBS will be installed by a diving support vessel (DSV) or another vessel of opportunity. The measures (if any) deemed necessary to ensure protection of flowlines from iceberg scour will be identified. Well tie-ins may be performed by an installation vessel and / or a MODU (with ROV support) during the subsea construction program. Trees, templates, and manifolds may be installed by a MODU, whereas pipeline-to-manifold tie-ins may be made by divers.
- Additional topsides equipment located on the Hebron GBS - master control station, topsides umbilical termination assembly, hydraulic power unit, electrical power unit, chemical injection skid, methanol injection skid, and cantilevered decks.
- Drilling and completion of subsea wells (including workovers).

- Vertical seismic profiling and/or checkshot profiling.
- Geophysical / geotechnical investigations such as well site geohazard surveys.
- Operation of support craft associated with the above activities including but not limited to vessels for glory hole excavation, offshore drilling platforms, supply vessels, standby vessels and helicopters.

The drill centres which contain the subsea wellheads could be located in glory holes to protect them from iceberg scour. The location and layout of subsea equipment will provide ease of access for inspection, testing, repair, replacement, or removal. The drill centres and associated glory holes may be situated at any location within the Hebron Project Area at any point in time over the duration of the Project. The exact configuration of the wells in each of the drill centres is not presently known and will likely vary between drill centres.

2.4 Logistics and Other Support

Four key areas of logistical support required during the operation and maintenance of the Project are shorebase support, personnel movements, vessel support and iceberg management.

- Shorebase support: The Project will be managed and operational decisions will be made from offices in St. John’s, Newfoundland and Labrador. A shorebase contractor will provide marine base facilities to support Project activity and to the extent necessary it is anticipated that the St. John’s Port Authority or other acceptable facility could provide the appropriate wharfage for support vessels. Existing port facilities are capable of servicing multiple operations with the existing infrastructure including office space, crane support, bulk storage, consumable (fuel, water) storage and delivery capability.
- Warehouse facilities will be provided by a contracted warehouse provider and Project contractors as required.
- Operation and coordination of voice and data communication services from offshore installations and vessels could be provided from a central communications facility in St. John’s. The primary communications link between the offshore installation(s) and the Project operations office in St. John’s will be via a dedicated C-Band satellite service or other appropriate technologies.

- Personnel movements: Helicopters will be the principal method for transferring personnel between St. John's and the offshore Project facilities, some 340 km offshore. Alternatively, personnel may also be transferred using supply vessels. The Operator will consider and discuss possible shared services with other Grand Banks operators with a view to optimizing the fleet configurations of all operations and providing the safest and most efficient and effective service.
- Supply vessel support: Supply vessels will be required to service the operational needs of the platform and the drilling units in the Hebron Field. Supply vessels will also be required to conduct components of the EEM program and for oil spill response support, training, and exercising. The Operator will consider and discuss possible synergies with other Grand Banks operators with a view to optimizing the fleet configurations of all operations and providing the safest and most efficient and effective service.
- Stand-by vessel support: The requirement for standby vessels will be assessed. The Operator will consider and discuss possible synergies with other Grand Banks operators with a view to optimizing the fleet configurations of all operations and while providing the safest and most efficient and effective service.
- Ice management: Reliable systems for the detection, monitoring and management of icebergs, pack ice, including towing techniques, have been developed for the Grand Banks area. The existing Grand Banks Ice Management Plan has been developed by existing operators and the Hebron Project is expected to participate in this program. This program provides operations personnel sufficient early warning of any need to remove personnel or disconnect drilling units from their moorings and risers.

The Hebron Project may require additional logistical and other support onshore. Current plans are to leverage existing sites and facilities. The existing onshore base will likely include the following:

- Administrative buildings;
- Personnel accommodations;
- Warehousing;
- Heliport;
- Docking facility;
- Maintenance support facilities;
- Catering support facilities;
- Motor pool;

- Fuels, oils, and lubricants storage;
- Medical facility;
- Fire station;
- Waste disposal facility;
- Diving and inspection support services.

2.5 Communications

The Hebron Project will likely rely on multiple, redundant radio and satellite communication systems for both the Bull Arm Site and the offshore Project Area. Primary and backup communications systems will provide reliable 24-hour contact between all components of the Hebron Project (e.g., the GBS platform, onshore facilities, vessels, and helicopters) and ensure continuous communications capability amongst all facilities in all environmental conditions. Flight and vessel tracking services will also be used to monitor the safe movement of personnel. These communication systems will be developed and selected in subsequent design stages.

2.6 Shipping/Transportation

The existing tanker fleet operating in the Grand Banks will likely be used to transport the Hebron crude oil to the Newfoundland Transshipment Terminal or direct to market. If transported to the Newfoundland transshipment terminal, the traffic will not exceed the original assessed maximum (Canship Limited 1999) under the Technical Review Process of Marine Terminal Systems and Transshipment Sites (TERMPOL Review Process).

All vessels will use existing international shipping lanes (Figure 2.6-1).

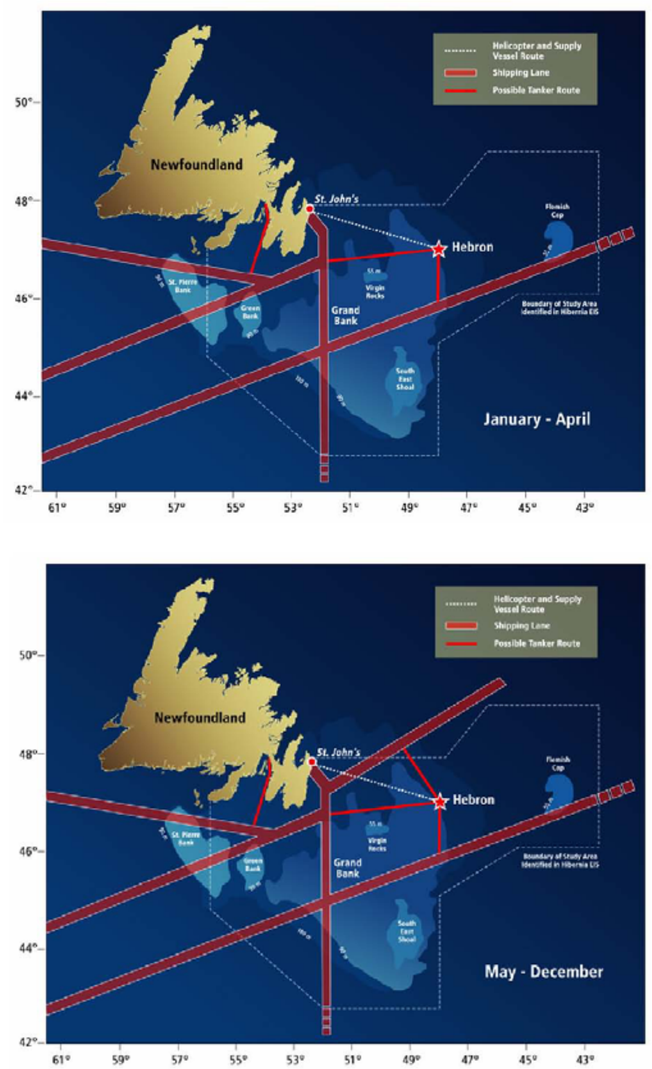


Figure 2.6-1: Transportation Routes Relevant to the Hebron Field

2.7 Onshore Facilities

Aside from office space, it is not anticipated that new on-shore facilities will be required to support the above activities. It is currently planned to use existing onshore industrial sites for construction and fabrication activities (as far as practical). The Operator will conduct an assessment of existing onshore facilities capabilities.

The production platform and all associated offshore activities will require onshore support for docking, warehouse space, helicopter operations and product transshipment. It is anticipated that these activities will be carried out at existing worksites, with an emphasis on synergy with other operators and projects.

2.8 Accidental Events

Two of the main types of accidental events that could occur during the life of the Hebron Project that would result in a discharge to the marine environment are well blowouts and single-event/batch spills of oil. A blowout is a continuous release of oil which could last for a measurable period of time, while a single-event oil spill is an instantaneous or limited duration occurrence. The environmental assessment of the Hebron Project will thoroughly examine the likelihood, control and implications of both types of events.

The Operator is committed to minimizing any adverse effects to the environment due to accidental events and plans to accomplish this goal by: i) incorporating oil and chemical spill prevention into the design, construction and operation of the Hebron Project; and ii) ensuring that the necessary contingency planning has taken place to respond effectively in the event of an incident, iii) institute comprehensive world class Facility Integrity Management System (FIMS) and equipment Maintenance and Reliability (M and R) programs.

A comprehensive Oil Spill Response Plan will be developed for the Hebron Project, which will include access to the Operator's worldwide emergency response resources (e.g., through participation in a mutual aid agreement). Regular training and drills will be undertaken and the Hebron Project will coordinate closely with other operators on the Grand Banks regarding spill response issues and resources. An appropriate level of oil spill and emergency response preparedness will be maintained during all phases of the Hebron Project. The Operator’s definitions of the levels of response to an incident within its emergency response plans are outlined in Table 2.8-1.

Table 2.8-1: Oil Spill Response Plan Spill Level of Response

Response Level	Responsibility	Key Notes
Tier 1	Platform OIM/field response teams, with limited onshore Emergency Operations Centre (EOC) support	• A release has occurred, small and under control • Impact area confined • The incident can be managed within the Hebron Field or Bull Arm Site utilizing field resources and capabilities • Limited onshore support required
Tier 2	Local onshore EOC with support from regional Emergency Support Group (ESG)	• The release is moderate and under control • Impact area migrates beyond the field • Support/response requirements exceed field capability • Response contractor mobilized • Mutual aid agreements may be activated • Corporate North America Regional Response Team (NARRT) may be mobilized
Tier 3	Local onshore EOC with support from regional ESG, Corporate NARRT, and Business Unit	• The release is large and not under control • Impact area beyond the field and may be extensive • Local , regional and potentially international response Contractors mobilized • Mutual aid agreements activated • Corporate NARRT will be mobilized • Business Unit ESG is activated • Response will likely continue for a protracted period of time
**** Note**: Depending upon the nature of the release, escalation from one Tier to another is a possibility and will be considered by response leadership*		

3 ENVIRONMENTAL SETTING

3.1 Physical Environment Setting

3.1.1 Bull Arm Construction Site and Surrounding Area

Bull Arm is an inlet approximately 6 km long and 0.3 km wide running north-south from the body of Trinity Bay, on the Avalon Peninsula of Newfoundland and Labrador. The town of Sunnyside lies at the head of Bull Arm. The Bull Arm construction site (the Bull Arm Site) was originally constructed (1990 - 1993) for the Hibernia Project, and it underwent an environmental assessment at that time. The site is accessed by paved road to the Trans Canada Highway, south of the town of Come By Chance.

The area has highly varied relief with hills up to a maximum of 220 m above sea level. The shores of Bull Arm are barren consisting of exposed bedrock or rock concealed by a thin layer of soil or vegetation. Glacial till soils are restricted to small patches where the material usually occurs as a thin veneer over bedrock. The principal rock type on the west side of Bull Arm is mainly igneous whereas rock types on the east side include sandstones, siltstones and conglomerates. A major fault, the Long Beach Fault, runs in a southwest to northeast direction through the head of Bull Arm near Sunnyside. Another fault runs almost north to south through Centre Bay, just east of Sunnyside (Mobil Oil Canada 1990). There are no major rivers draining in to Bull Arm. Groundwater yields in both the surficial and bedrock aquifers are typically very low to moderate.

Bull Arm is deep with water depths of up to 100 m in the middle and 150 to 180 m near the mouth. Landfast ice is common in Bull Arm between mid January and March. Offshore pack ice can fill Bull Arm as well, in years of easterly spring winds. The nearshore of Bull Arm slopes fairly gradually along the shoreline to depths ranging from 9 to 27 m. This area encompasses Little Mosquito Cove, which is only 10 m deep. The coastline approaching Great Mosquito Cove drops sharply to depths of 30 to 88 m. The maximum tidal variation is about 1 m at the entrance to Bull Arm and a probable variation of 1.5 m at the head of the Arm. The outer portion of Bull Arm is subject to 1.5 m waves generated by southeasterly to easterly winds, but exposure decreases in the Arm.

In Great Mosquito Cove, depths increase dramatically from 13 to 33 m at only 300 m from shore. At the mouth of Great Mosquito Cove the water is deep, ranging from 51 to 132 m near the centre of Bull Arm. The north and south nearshore slopes of Great Mosquito Cove are generally steep with water depths increasing to 10 m within 5 to 10 m of the shoreline. From these nearshore boulder and bedrock slopes, the water depths increase more gradually with a maximum depth contour of 45 m in the middle of Great Mosquito Cove. The western nearshore bedrock slope in the area of the dry dock is much more gradual. Substrates are predominately gravel and sand mix at depths beyond 10 m. Fjord ice or drifting ice is the prevailing ice condition during the winter period; however, it is unlikely to disrupt Project activities. Pack ice intrusion is possible in the period from middle of March to May.

3.1.2 Regional Offshore Overview

The climate of the Grand Banks is dynamic and influenced by maritime, Arctic and tropical air masses. The area typically has cold and dry winters (with respect to humidity) and cool and moist summers. Weather systems are often intense, and include a wide range of precipitation types, particularly in fall and winter. Many of the storms that traverse North America from west to east at mid-latitudes pass near Newfoundland, Labrador, and the Hebron Project Area as they move out into the North Atlantic. In winter, spring and fall, the dominant winds in the area are westerly and in summer, southwesterly. Winter storms are considerably more intense and frequent than those in the summer. The associated winds reach gale force several times in a typical year, and sometimes attain hurricane force. From wind data collected from offshore drilling platforms in the Terra Nova and Hibernia area since 1972, 22 percent of January observations were of gale force or greater, while only 3 percent of July observations recorded winds of gale force or greater (Petro-Canada 1995).

Air temperatures in the vicinity of the Hebron Project Area are generally lower in summer and higher in winter compared to St. John’s because of the oceanic environment. February is the coldest month and August is the warmest month both onshore and offshore. Daily maxima are lower and minima are higher offshore (except from November to January) because of the greater influence of the ocean at the offshore location.

The Grand Banks region is the wettest in eastern Canada, with over 1,000 mm of precipitation per year. The occurrence of precipitation is highest in January and lowest in July. Rainfall is most likely in autumn, with moderate to heavy rainfall occurring most frequently from September to January. Snow is most likely to occur in January through March. Moderate to heavy snowfall is most likely to occur in January and February. Fog frequently occurs in the Hebron Project Area, with the foggiest period occurring between May and July. In July, the foggiest month, visibility is often reduced to less than 1 km.

The water in the Hebron Project Area originates mainly from the Labrador Current, with some influence by water from the south and east. The major offshore branch of the Labrador Current is 50 to 60 km to the east. Water depth in the area is in the range of 88 to 102 m. The highest waves occur from December to February. Up-to-date information on the physical environment on the Grand Banks will be provided in the environmental assessment prepared for this Project.

3.2 Biological Environment Setting

3.2.1 Bull Arm Construction Site and Surrounding Area

There are no scheduled salmon rivers running into Bull Arm. The area is not considered good habitat for moose, caribou or black bear, but each species can be found in the area. Other large furbearing animals in the area include beaver, mink, otter and fox.

Nearshore rocky habitats are typically covered with kelp and coralline algae. Mussels, periwinkles, whelks, urchins, brittle stars, hermit crabs, rock crabs and sea stars are the most common macro-invertebrate species. Common finfish species are gunnels, shannies and cunners. American lobsters are commercially fished from these habitats.

At water depths beyond 10 m on soft substrates, winter flounder, and various sculpin species are common. Atlantic cod may also be present. Vegetation decreases with increasing depth, but patches of kelp and filamentous algaes may occur. The most common macro-invertebrates are sea urchins, sand dollars, rock crabs, and possibly sea scallop. Commercial fisheries in these habitats may include capelin, herring, mackerel, winter flounder, lumpfish and lobster.

Great Mosquito Cove is locally known as a spawning ground for herring (Mobil Oil Canada 1990). Herring typically use dense kelp beds in shallow water to deposit their eggs.

3.2.2 Regional Offshore Overview

The components of the marine ecosystem on the Grand Banks are phytoplankton, zooplankton (including ichthyoplankton), benthos, macroinvertebrates (scallop, crab, and shrimp), fish, marine birds, and marine mammals and reptiles (sea turtles). These components of the Grand Banks ecosystem have been described extensively in various documents (Mobil Oil Canada 1985; Petro-Canada 1995; Husky Oil 2000). The description of the biological environment at the Hebron Project Area that follows makes preferential use of site-specific information when this information is available; otherwise, a summary of information available for the Grand Banks ecosystem as a whole is provided.

Up-to-date information on the biological environment on the Grand Banks will be provided in any environmental assessment prepared for this Project.

3.2.2.1 Fish and Fish Habitat

Phytoplankton are the most important primary producers on the Grand Banks (Petro-Canada 2003b). Peak abundance of phytoplankton on the Grand Banks usually occurs in late April to early May, within the top 30 to 50 m of the water column (Pepin and Paranjape 1996). The spring bloom is dominated by diatoms. An autumn phytoplankton peak is also characteristic of the northern Grand Banks but an obvious peak may not occur on the southern Grand Banks (Myers et al. 1994). Dinoflagellates and other microflagellates dominate the fall bloom.

Zooplankton are an important link between primary production and higher trophic levels (e.g., fish, crustaceans) and many harvested species including crab, shrimp, and a number of fish species have planktonic eggs and larvae. Zooplankton in the northwest Atlantic are dominated by copepods (Myers et al. 1994), whose abundance rises sharply in spring and, to a lesser degree, in fall in response to phytoplankton abundance. Ichthyoplankton, or fish eggs and larvae, constitute a portion of the zooplankton community. On the northeast Grand Banks, during late summer and early fall, the ichthyoplankton may include Atlantic cod, American plaice, sand lance, redfish (*Sebastes* spp.), jellyfish, squid (*Illex illecebrosus*), lanternfish (*Myctophum* spp.), alligatorfish (*Aspidophoroides monopterygius*), sculpins (unidentified), blennies, seasnails, white hake (*Urophycis tenuis*), haddock (*Melanogrammus aeglefinus*), wolffish (unidentified), witch flounder (*Glyptocephalus cynoglossus*), yellowtail flounder (*Limanda ferruginea*) and Greenland halibut (*Reinhardtius hippoglossoides*) (Dalley et al. 2000).

Benthic communities in the vicinity of the offshore Hebron Project locationare dominated by polychaetes and vary in relation to sediment particle size. Site-specific information on sediment particle size and benthic communities is available for the Hebron Project Area. A total of 20 stations were sampled for sediment particle size, benthic community structure analysis, sediment chemistry (metals and hydrocarbon) analysis and sediment toxicity testing. As is the case for Terra Nova (Petro-Canada 2002; 2003a), the substrate in the vicinity of the Hebron Project is predominantly sand (on average 95 percent of substrate is sand) with a varying amount of gravel, silt and clay. Silt and clay make up less than 1.5 percent of the substrate. Gravel content is lower in the southern half of the Hebron Project Area (1.4 percent gravel) than in the northern portion (6.2 percent gravel). Polychaetes account for 74 percent of organisms in the southern area and 84 percent of organisms in the northern area. Remaining components of the benthic community include bivalves, amphipods, echinoderms (sand dollars and starfish), and Tunaidacea.

With respect to bottom dwelling fish and macroinvertebrates, 17 species of finfish and a number of invertebrates were collected during the Hebron Project Area reconnaissance survey, which was conducted in late June/early July 2001. Sand lance was the most abundant fish species, followed by capelin, mailed sculpin (*Triglops ommatistius*) and American plaice. The most abundant invertebrates were shrimp (*Pandalus borealis*), sea urchin (*Strongylocentrotus pallidus*) and sand dollar. Other invertebrates, found in relatively low abundance, included soft-shelled clams (*Mya arenaria*), snow crab (*Chionoectes opilio*), toad crab (*Hyas* spp.), Iceland scallop (*Chlamys islandica*) and sea stars. Differences in species composition between the southern and northern areas were noted. Catches of American plaice and clams were substantially higher (by approximately one order of magnitude) in southern area, and catches of sand lance, sea urchin, and spatulate sculpin (*Icelus spatula*) were substantially higher in the northern area. These differences could likely reasonably be attributed to differences in substrate and benthic community types between the two areas.

None of the species listed above will be expected to be unique to the Hebron Project Area. In general, the Hebron Project Area does not support high biomass of demersal fish relative to other areas on the Grand Banks. Historically, the most abundant species in the vicinity of the Hebron Project were American plaice and cod, but these species were also widely distributed throughout the Grand Banks.

Fish species at risk that could occur near the Hebron Project include wolffish (three species: Atlantic (*Anarhichas lupus*), northern (*Anarhichas denticulatus*) and spotted (*Anarhichas minor*)), Atlantic cod (*Gadus morhua*) (Newfoundland and Labrador population), cusk (*Brosme brosme*), porbeagle shark (*Lamna nasus*), shortfin mako shark (*Isurus oxyrinchus*), blue shark (*Prionace glauca*) and white shark (*Carcharodon carcharias*).

3.2.2.2 Marine Birds

The Grand Banks provides important habitat for millions of marine birds. Over 60 species have been reported. Approximately 19 of these species are pelagic and could occur in the Hebron Project Area. In the spring and summer, the most common species include the northern fulmar (*Fulmarus glacialis*), shearwaters (*Puffinus sp.*), storm-petrels (*Oceanites oceanicus*), jaegers (*Stercorarius sp.*), black-legged kittiwake (*Rissa tridactyla*), gulls (*Larus spp.*), skuas (*Catharacta skua*) and dovekies (*Alle alle*). The only marine bird species at risk likely to occur near the Hebron Project is the Ivory Gull (*Pagophila eburnea*).

3.2.2.3 Marine Mammals

Marine mammals found on the Grand Banks include whales, dolphins, porpoises and seals. Many mammal species are mostly summer residents or transients or both. There are only a few permanent residents, including the Atlantic pilot whale (*Globicephala melaena*) (Nelson and Lien 1996; Waring et al. 2004). Several species of whales may be found on the Grand Banks including humpback (*Megaptera novaeanliae*), minke (*Balaenoptera acutorostrata*), blue (*B. musculus*), fin (*B. physalus*), sei (*B. borealis*), Atlantic pilot, sperm (*Physeter catadon*), killer (*Orcinus orca*) and northern bottlenose

(*Hyperoodon ampullatus*) (Petro-Canada 1995; Wiese and Montevecchi 1999). Fin whales can occur during winter, spring and summer in the area. Humpback and minke whales are common in inshore waters near the Avalon Peninsula during summer, and also frequent areas further offshore. Seals occur year-round in waters off Newfoundland and Labrador, including populations of grey (*Halichoerus grypus*), harp (*Phoca groenlandica*) and hooded (*Cystophora cristata*) seals.

Marine mammals species at risk found on the Grand Banks include blue (*Balaenoptera musculus*), fin (*Balaenoptera physalus*) and North Atlantic right whales (*Eubalaena glacialis*) and harbour porpoise (*Phocoena phocoena*).

3.2.2.4 Sea Turtles

Three species of sea turtles are known to occur near the Hebron Project Area: leatherback (*Dermochelys coriacea*), loggerhead (*Caretta caretta*) and Kemp's ridley (*Lepidochelys kempii*). The Kemp's ridley turtle has been listed as endangered and the loggerhead turtle has been listed as threatened by the United States National Marine Fisheries Service (NMFS) and United States Fish and Wildlife Service (FWS). The leatherback turtle is listed as a Schedule 1 (Endangered) species under Species at Risk Act (SARA), is listed as endangered by Committee on the Status of Endangered Wildlife in Canada [COSEWIC] (2005), and has been listed as endangered by NMFS and FWS.

4 SAFETY, HEALTH, ENVIRONMENT AND SECURITY (SHE&S) MANAGEMENT

The Operator is committed to conducting its business in a responsible and ethical manner that protects the safety and health of employees, others involved in its operations, its customers and the public. Furthermore it is committed to conducting business in a manner that is compatible with the balanced environmental and economic needs of the communities in which it operates. This commitment requires compliance with all applicable laws and regulations, facilities that are designed and operated to a high standard and the systematic identification and management of safety, health, security, and environmental risks.

These commitments are documented in the safety, health, environmental, product safety and security policies of the Operator. These policies are put into practice through a disciplined management framework called Operations Integrity Management System (OIMS). The OIMS framework establishes common worldwide expectations for controlling Operations Integrity risks inherent in its businesses. Operations Integrity addresses all aspects of the Hebron Project business, including security, which can impact safety, health and environmental performance.

The OIMS is a standard framework to manage Safety, Health, Environmental and Security (SHE&S) risks to achieve consistent, reliable and incident free results. OIMS includes 11 elements, each with an underlying principle and a set of expectations:

- Management Leadership, Commitment, and Accountability;
- Risk Assessment and Management;
- Facilities Design and Construction;
- Information/Documentation ;
- Personnel and Training ;
- Operations and Maintenance;
- Management of Change;
- Third Party Services;
- Incident Investigation and Analysis;
- Community Awareness and Emergency Preparedness;
- Operations Integrity Assessment and Improvement.

The Hebron OIMS, as well as regulatory requirements, will require that numerous plans, programs, systems, and attendant processes and procedures be put in place to manage safety, health, environment and security issues. These plans will include (but not be limited to):

- Risk Management Plan (during design phase);
- Contractor SHE&S Management Plan;
- Safety Management Plan;
- Health Plan;
- Environmental Management Plan;
- Security Management Plan;
- Regulatory Compliance Plan;
- Competency Assurance System;
- Facility Integrity Management System;
- Maintenance and Reliability Program;
- Wellbore Management Plan;
- Waste Management Plan;
- Emergency Response Plan;
- Emergency Communications Plan;
- Oil Spill Response Plan;
- Environmental Effects Monitoring Plan;
- Ice Management Plans;
- Marine Incident Plan;
- Abandonment / Decommissioning Plan.

The Operator's policy is to:

- design and maintain facilities, establish management systems, provide training and conduct operations in a manner that safeguards people and property;
- respond quickly, effectively, and with care to emergencies or accidents resulting from its operations, in cooperation with industry organizations and authorized government agencies;
- comply with all applicable laws and regulations, and apply responsible standards where laws and regulations do not exist;
- work with government agencies and others to develop responsible laws, regulations, and standards based on sound science and consideration of risk;

- conduct and support research to extend knowledge about the safety effects of its operations, and promptly apply significant findings and, as appropriate, share them with employees, contractors, government agencies, and others who might be affected;
- stress to all employees, contractors, and others working on its behalf their responsibility and accountability for safe performance on the job and encourage safe behavior off the job;
- undertake appropriate reviews and evaluations of its operations to measure progress and to foster compliance with this policy.

The Hebron Project Team is committed to designing, building, installing and commissioning a production facility that supports world-class SHE&S performance.

Plans for ice management, waste management, oil spill response and contingency plans for emergency events will be developed and will build on those programs currently in place for the Grand Banks. The Operator will comply with all federal and provincial legislation.

5 PUBLIC CONSULTATION

The Operator recognizes the importance of communications with federal, provincial and municipal governments, regulatory agencies, stakeholders and the public and is developing a communications / stakeholder plan to management these activities. The Hebron Project has already met with representatives from each of these groups and will continue to expand its contact list to ensure affected and interested individuals are provided with timely Project information and have an opportunity to provide feedback.

The Project Team will undertake a public outreach program in support of the CEAA process and also in preparation of its Development Application.

In support of the CEAA process, the Operator has commenced engagement with relevant regulatory agencies including the C-NLOPB, Environment Canada, DFO and others. The Operator will proactively engage local non-government environmental organizations including, but not limited to the Natural History Society; World Wildlife Fund; One Ocean; Fish, Food and Allied Workers (FFAW) and the Seafood Producers' Association. The Operator will respond to other parties that express an interest in the environmental aspects of the proposed Project.

The Operator intends to conduct open houses in the Province likely starting in the May-June 2009 timeframe. The purpose of the open houses will be to present the key components of the proposed development of the Hebron Field and solicit the public’s comments. The open houses will be advertised in local newspapers, on local radio stations and the planned project website (discussed below) to encourage maximum participation. The Operator will meet with the local leaders in the communities that could potentially be affected by the Hebron Project to get first hand information regarding their interests and concerns.

Stakeholder workshops (on Canada-Newfoundland and Labrador benefits, socio-economic issues, the environment, fisheries, and other appropriate subjects) will be arranged to discuss interests and concerns of local communities and stakeholders. The meetings and conversations will be fully documented and concerns will be addressed in regulatory documents filed by the Operator with regulatory authorities.

The Hebron Project website, which is under development, will be a valuable and effective communication tool that will be used to help foster open communication with the Hebron Project stakeholders. It will contain a broad description of all elements of the Hebron Project and contain a toll-free number where people throughout Newfoundland and Labrador can contact Hebron Project representatives for more information or to provide ideas and suggestions. It is the Operator's intention to maintain open lines of communication with the public, government, regulators, communities and other stakeholders throughout the Hebron Project.

Through formal and informal meetings and gatherings, the Operator will introduce the Hebron Project and its merits to the public and key stakeholders and provide them with an opportunity for input. The Operator will help identify key issues and concerns and facilitate constructive dialogue.

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7 GLOSSARY, ABBREVIATIONS AND ACRONYMNS

Word	Definition
Abandonment	The decommissioning of facilities, including the plugging of wells, and removal of offshore structures following production of reserves
The Agency	Canadian Environmental Assessment Agency
API	American Petroleum Institute
Benthos	Marine plants and animals that live on or near the ocean bottom
BOP	Blow-out Preventer
Borehole	The hole in the earth made by the drill; the uncased drill hole from the surface to the bottom of the well
CCO	Chief Conservation Officer
CEAA	Canadian Environmental Assessment Act
C-NLOPB	Canada-Newfoundland and Labrador Offshore Petroleum Board
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DA	Development Application
Delineation Wells	Wells drilled after the initial exploration well to give a better understanding of the extent and performance of the reservoir
DFO	Department of Fisheries and Oceans
DND	Department of National Defence
DSV	Diver Support Vessel
Downdip	A direction towards a lower elevation from a given point on a structure or surface
EA	Environmental Assessment
EEM	Environmental Effects Monitoring
EIS	Environmental Impact Statement
EOC	Emergency Operations Centre
EPCM	Engineering, Procurement, Construction and Management
EPP	Environmental Protection Plan
ESG	Emergency Support Group
FA	Federal Authority
FCR	Federal Coordination Regulations
FEED	Front-end Engineering and Design
FFAW	Fish, Food and Allied Workers
FIMS	Facility Integrity Management System
FPSO	Floating Production, Storage and Offloading [facility]
FWS	United States Fish and Wildlife Service
GBS	Gravity-base Structure
Hebron Unit	Comprises the four Hebron Significant Discovery Licences (SDL 1006, SDL

Word	Definition
	1007, SDL 1009 and SDL 1010)
JOA	Joint Operating Agreement
km	Kilometre
m	Metre
m3/day	Cubic Metre per Day
mg/L	Milligrams per Litre
mm	Millimetre
M and R	Maintenance and Reliability
MODU	Mobile Offshore Drilling Unit
Manifolds	A piece of equipment where the fluids from several wells are received and combined
NAF	Non-Aqueous Fluid used for drilling (e.g., **SBM** or **OBM**)
NARRT	North America Regional Response Team
NEB	National Energy Board
NMFS	United States National Marine Fisheries Service
OBM	Oil-Based Mud or drilling fluid
OIMS	Operations Integrity Management System
OLS	Offshore Loading System
OWTG	Offshore Waste Treatment Guidelines
Pelagic Species	Animals which live within the water column
Plankton	Plant (phytoplankton) and animal (invertebrate (zooplankton) and fish eggs and larvae (ichthyoplankton)) organisms that drift with ocean currents
Pool	A unique accumulation of petroleum whose limits are established by subsurface geologic factors
RA	Regulatory Authority
Reservoir	A subsurface rock body in which gas or oil has accumulated; most reservoir rocks are porous and permeable, usually limestones, sandstones or dolomites (or a combination)
Resource	An initial volume of oil and gas that is estimated to be contained in a reservoir
Riser	A section of pipe involving vertical or near-vertical flow
ROV	Remote Operated Vehicle
RRT	Regional Response Team
SARA	Species at Risk Act
SBM	Synthetic-based Mud
SDL	Significant Discovery License – The document of title by which lands are held within a **Significant Discovery Area**. Ownership of a Significant Discovery License must be homogeneous; therefore, there may be several Significant Discovery Licenses comprising a **Significant Discovery Area** if ownership of the **Significant Discovery Area** is multi-partied
SDW	Storage Displacement Water

Word	Definition
SHE&S	Safety, Health, Environment and Security
Significant Discovery Areas	The area deemed to be evaluated by an exploration well drilled on an Exploration License that has encountered and tested significant hydrocarbons. Lands within a Significant Discovery Area continue to be held by the exploration company after the Exploration License has been converted to an SDL or a Production Licence
Template	A design pattern with built-in guides for equipment and structures to ensure their usefulness
The Agency	Canadian Environmental Assessment Agency
Topside Facilities	All the oil and gas separation, treatment and production equipment and related equipment such as compressors, flares and accommodations located on top of an offshore facility
Tree	a) An arrangement of valves placed on top of a well to control flow from the well b) An arrangement of valves and fittings attached to the tubing head to control flow and provide access to the tubing string [also referred to a an Christmas tree]
TSS	Total Suspended Solids
Ullage	Unused capacity usually in reference to a pipeline.
VSP	Vertical Seismic Profiling
WBM	Water-based Mud
Wellbore	The hole drilled by the drill bit
Well Completion	The final sealing-off of a drilled well from the **borehole** with valving, safety and flow-control devices, following final cementing and perforation of the casing at the production zone and removal of the drilling apparatus from the **borehole**
Wellhead	The equipment installed at the top of the **wellbore** used to support the casing strings and upon which the **tree** is installed; it controls the rate of flow of liquid and gas from the well
Well Workover	A program of work performed on an existing well; may involve re-evaluating the production **reservoir**, clearing sand from producing zone, jet lifting, replacing downhole equipment, deepening the well, acidizing or fracturing, or improving the drive mechanism
***Note:* Bolded words within a definition are themselves defined.**	