HUSKY WHITE ROSE DEVELOPMENT PROJECT: NEW DRILL CENTRE CONSTRUCTION AND OPERATIONS PROGRAM ENVIRONMENTAL ASSESSMENT ADDENDUM

Prepared by

LGL LIMITED
environmental research associates

for

Husky Energy

LGL Report SA883a
January 2007

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1.0 Introduction

This is a follow-up document to the Husky White Rose Development Project: New Drill Centre Construction and Operations Program Environmental Assessment. It includes a revised Project Description, other revised text relevant to changes in the Project Description and reviewer comments on the EA, and a Table of Concordance in Appendix 1 which contains reviewer comments and their respective responses. References to the reviewer comments in the Table of Concordance are inserted throughout the body of the document to provide context to the reader as to which areas of the EA the comments applied. Numbered comments are inserted *after* the revised text (or response).

Husky Oil Operations Limited (Husky) is proposing the development of up to five new drill centres. The new drill centres would be located in three areas adjacent to the Northern, Central and Southern Drill Centres (NDC, CDC, and SDC, respectively) currently active in the White Rose Field (Figures 1.1 and 1.2) which is located on the Grand Banks offshore Newfoundland approximately 350 km east-southeast of St. John's.

The most southerly of the areas proposed for new drill centres has been designated South White Rose Extension (SWRX) and North Amethyst, each potentially requiring a new drill centre (Figures 1.1 and 1.2). The area adjacent (1.3 to 3 km northwest) to the current Central drill centre and designated as West White Rose Extension (WWRX) could potentially support up to two new drill centres. The most northerly area, located one to three km northeast of the current Northern drill centre, has been designated North White Rose Extension (NWR). NWRX would support one new drill centre.

Current planning calls for the SWRX drill centre to be constructed in the summer of 2007. Pending approval, a second glory hole for North Amethyst may also be constructed in summer 2007. The viability of any or all of the other proposed new drill centres is contingent on successful delineation drilling results during the next three to seven years.

The Project will require authorizations pursuant to Section 138 (1) (b) of the *Canada-Newfoundland Atlantic Accord Implementation Act* and Section 134 (1) (a) of the *Canada-Newfoundland and Labrador Atlantic Accord Implementation Newfoundland and Labrador Act*. Subject to Section 5 (1) (d) of the *Canadian Environmental Assessment Act* (*CEA Act*), the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB, also referred to as "the Board") is a responsible authority (RA) and federal environmental assessment coordinator (FEAC) and must undertake a screening level environmental assessment (EA) of the Project. Also required are habitat alteration, disruption or destruction (HADD) authorization(s) and ocean disposal permit(s) from Fisheries and Oceans and Environment Canada, respectively.

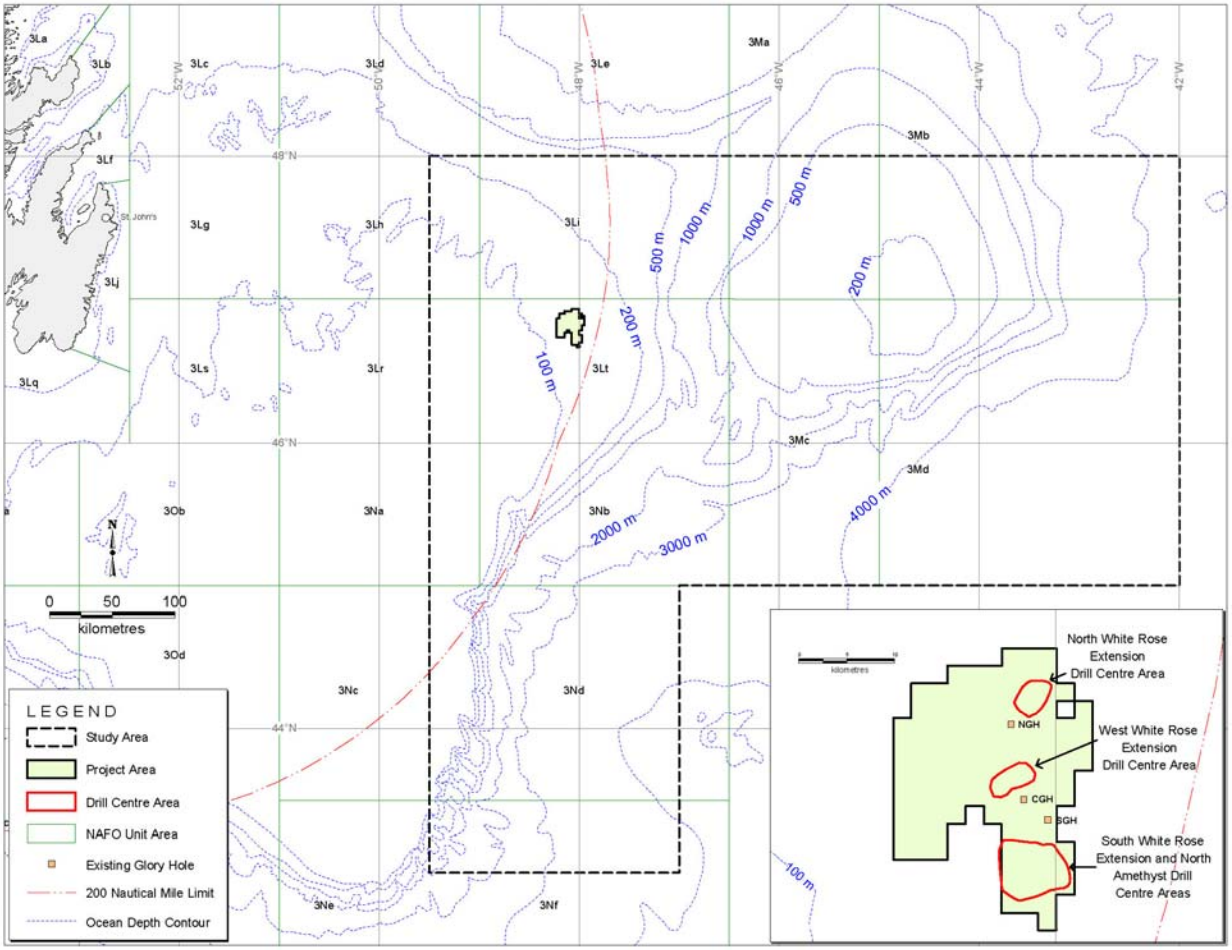

Figure 1.1. Locations of the Project Area, the Study Area and the Three Proposed Drill Centre Areas.

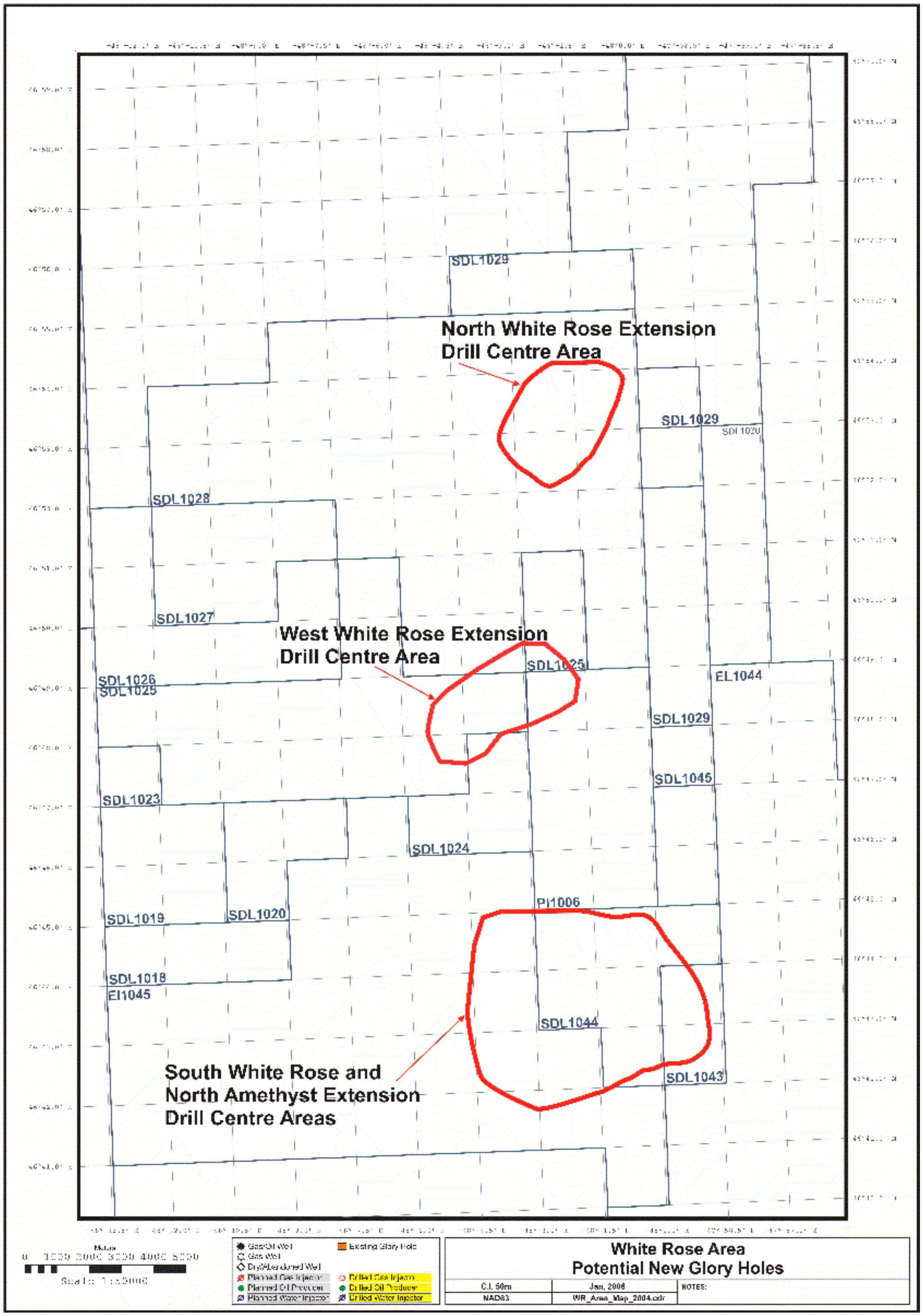

Figure 1.2. General Locations of Proposed Drill Centres (Existing Glory Hole Designations: NGH - Northern Glory Hole, CGH - Central Glory Hole, SGH - Southern Glory Hole).

Legislation that is relevant to the environmental aspects of this Project include

- *Canada-Newfoundland Atlantic Accord Implementation Acts*
- *Canadian Environmental Assessment Act*
- *Oceans Act*
- *Fisheries Act*
- *Navigable Waters Protection Act*
- *Canada Shipping Act*
- *Species at Risk Act*
- *Migratory Birds Convention Act*
- *Canadian Environmental Protection Act*

There is no federal funding for this Project. Federal lands are involved and they are administered by the C-NLOPB, a federal-provincial agency operating under the *Canada-Newfoundland & Labrador Atlantic Accord* acts.

Scoping and technical advice received from the C-NLOPB, other federal agencies, and stakeholders consulted by Husky will guide the preparation of this assessment. The Project Description is an accurate reflection of the Proponent's current level of knowledge.

Comment No. 15: Timing of commencement of glory hole construction

2.0 The Proponent

Headquartered in Calgary, Alberta, Husky Oil Operations Limited (the Operator) is a Canadian-based integrated energy company serving global customers, committed to maximizing returns to its shareholders in an ethical and socially responsible way, through the dedicated effort of its people. It is involved in:

- Exploration and development of crude oil and natural gas,
- Production, purchase, transportation, refining and marketing of crude oil, natural gas and natural gas liquids and sulfur, and
- Transportation and marketing of refined products.

The Operator is the management and operating company for the Operator's seven Significant Discovery Areas (SDA) and ten Exploration Licenses, offshore Newfoundland. The White Rose field, the largest of the Operator's SDA's, is estimated to contain 200-250 million barrels of recoverable reserves.

2.1 Operator Contacts

Operator contacts concerning this application are provided below.

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3.0 Project Description

During the period 2007 to 2015, Husky plans to develop up to five new drill centres in three areas adjacent to the three drill centres currently active in the White Rose Field; the Southern Glory Hole (SGH), the Central Glory Hole (CGH) and the Northern Glory Hole (NGH) (Figures 1.1 and 1.2). Production operations associated with these five new drill centres would occur between 2009 and 2020.

Comment No. 17: Current active drill centres in Figures 1.1 and 1.2

Comment No. 21: Stated duration of period of drilling

3.1 Name and Location of Proposed Project

The official name of the Project is the Husky White Rose Development Project: New Drill Centre Construction & Operations Program. It is located on the northeastern Grand Banks (Figure 1.1). All proposed activities will occur within the defined Project Area (Figure 1.2). The Project is defined as the North, West and South White Rose Extension Drill Centres and the North Amethyst Drill Centre including all related subsea structures (Figure 1.2).

3.2 Alternative Means within Project

Currently all floating production systems on the Grand Banks are designed similarly to the Terra Nova and White Rose systems (i.e., construction of glory holes and installation of drill centres). While individual field analysis of iceberg risk is performed, the results to date have supported placement of the trees, manifold, and subsea controls equipment in recessed areas (glory holes) on the seabed. This approach provides protection against icebergs large enough to be a danger to the seabed equipment. There are no alternative means to glory hole construction to produce the oil out of the ancillary pools.

Alternatives to dredge a new glory hole included the use of a suction hopper versus a clamshell dredging system. For technical reasons, the suction hopper dredge technique for excavating the new glory holes was selected. Husky has also considered long range directional drilling but this method was determined to be inappropriate.

3.3 Canada-Newfoundland and Labrador Benefits

Consistent with the legislative requirements of the *Canada Newfoundland Atlantic Accord Implementation* acts, Husky Oil Operations Limited is committed to enhancing the business opportunities for Canada and Newfoundland and Labrador as outlined in the Company's Canada-Newfoundland and Labrador Benefits G/L outlined in the Benefits Plan. Consequently, Husky will utilize the services of Newfoundland and Labrador and other Canadian companies and personnel wherever possible.

3.4 Personnel

The work associated with this Project Description will be managed by Husky's East Coast Operations Development Manager located in St. John's. The onshore management team that supports the Development Manager includes the Drilling and Completions Manager, Sub-Surface Manager, Production Operations Manager, Logistics Manager, HSEQ Manager and the Regulatory Affairs and Administration Manager.

Offshore, the Management teams will vary by project phase and requirements but will generally consist of the following:

- **Drilling Operations Team** led by the Drill Rig (s) Offshore Installation Manager (s) (OIM) and Offshore Senior Drilling Supervisor reporting to Drilling Superintendent and the Drilling and Completions Manager onshore.

- **Subsea Construction and Installation Team** led by the Subsea Manager and the Subsea Installation Manager onshore will manage the design and construction of the glory holes and the design construction and installation of the subsea drilling templates, well head appurtenances and flow lines connecting the new drill centres to the existing White Rose Development subsea and production infrastructure. The work involved in the construction of the glory holes and the installation of the incremental subsea infrastructure will be carried out by sub-contractors managed by Husky.

- **Production Operations Team** led by the Production Operations Manager will manage production operations once the Project described herein is completed and the operation is fully integrated with the White Rose Production Operation's organization.

Logistical support will be managed through Husky's Logistics Team, made up of a Logistics Lead and supporting Coordinators. The Logistics Coordinator manages supply vessels, helicopters, and materials movement activities for Husky's East Coast operations. The transport of personnel to and from St. John's and the Operating Area will be conducted mainly by helicopter but, in isolated situations, supply vessels may be used.

3.5 Offshore Equipment

3.5.1 Glory Hole Construction/TGB Installation

Dredging, as described in the White Rose Oilfield Comprehensive Study (Husky 2000), is seafloor excavation work generally to lower the "profile of subsea production equipment relative to the surrounding seafloor." A dredge is a vessel equipped with a device for cutting, scraping and/or suctioning the seafloor material and displacing it to another location.

Glory holes in this Project will be dredged using a trailing suction hopper dredging (TSHD) vessel. This type of dredge is a self-propelled ship which fills its hold or hopper during dredging while following a pre-set track. Such dredges are equipped with either single or twin (one on each side) trailing suction pipes. Material is lifted through the trailing pipes by one or more pumps and discharged into a hopper contained within the hull of the dredge. When the hoppers are full the TSHD sails to a disposal area and either dumps the material through doors in the hull or pumps the material out of the hoppers. The largest hopper dredges in the world (subject to revision) are Jan De Nul's Vasco Da Gama (33,000 m^3 hopper, 37,060 kW total installed power) and Boskalis WD FAIRWAY 35,000 m^3 hopper.

The Temporary Guide Base (TGB) is, in principle, a standard drilling technology used for individual wells and in multi-well template configurations for the purpose of providing a precise location to begin a well and re-enter a well. TGBs are generally utilized only for the spudding and surface casing portion of the well. As the wellhead system is "built up", a permanent guide base (PGB) is located above the TGB and becomes the new well entry point.

3.5.2 Drilling

Drilling will be conducted by a mobile offshore drilling unit (MODU). The *GSF Grand Banks*, is an example of a typical MODU that has been used on the East Coast. The *GSF Grand Banks* is a rectangular, twin hull, column stabilized, MODU, constructed to an Aker #3.2 design. There are two 29.5 ft. (9.0 m) diameter corner stability columns plus two 24.3 ft. (7.4 m) diameter intermediate stability columns rising from each hull to support the main deck. The deck is arranged with the drilling mast in the centre and modules on the perimeters, housing the living quarters, equipment, storage area and workshops. The *GSF Grand Banks* or a comparable MODU will be used to execute the proposed Project. Note that no jack up drilling platforms will be used to execute development of the new drill centres. Jack up rigs cannot operate over glory holes due to the nature of their anchoring process and all wells drilled for this project will be placed in glory holes.

Comment No. 18: Use of jack-up drilling rigs

3.5.3 Production Subsea Equipment Installation

Subsea facilities to support the new drill centres will include all equipment necessary for the safe and efficient operation and control of the subsea wells and transportation of production and injection fluids. Procedures for installation of subsea facilities and subsequent operations are anticipated to be the same as those currently employed for the existing White Rose Development. The following equipment will be installed in the new drill centres:

- Wellheads and xmas trees (production and water injection);
- Production and water injection manifolds;

- Subsea distribution units;
- Subsea umbilical termination unit;
- Flowlines (gas lift, production, water injection);
- Jumpers (control, gas lift); and
- Rigid spools (to production and water injection xmas trees.

Iceberg protection measures applied to the current White Rose Project will also be applied to the SWRX, and other drill centers, including placement of wellheads, xmas trees and manifolds in glory holes, with the top of the equipment a minimum of two to three metres below the seabed level and use of flowline weak link technology.

Subsea equipment for the White Rose Project, while standard in design, must be installed quite accurately relative to the seabed and other equipment components. Two types of specialty vessels are required for installation of the subsea equipment; a subsea construction vessel (SCV) and a subsea diving support vessel (DSV).

The SCV work will generally consist of large equipment lifts that require precise placement on the seabed. This work is generally supported by ROV rather than diving operations and may involve several structures such as foundations, piles, manifolds. The flowlines and umbilicals are planned to be installed by a DSV. The lines will be transported on large reels on a heavy lift vessel (HLV) and handled onto the DSV or in a carousel (on the DSV while at the factory). The lines are precisely laid on the seabed, inspected and mapped by ROV. The lines are then connected by divers, displaced to water, pigged and tested.

3.5.4 Production Operations

3.5.4.1 Floating Production, Storage and Offloading Vessel (FPSO)

The FPSO proposed for use at White Rose was described in detail in Section 2.4.1 of the Project Description of the White Rose Oilfield Comprehensive Study (Husky 2000). It is a floating system that contains the necessary equipment to retrieve, produce and store crude petroleum and to moor and transfer oil product to shuttle tankers. The SeaRose FPSO has been operational on the Grand Banks since November 2005. All production from the new drill centres will be processed through the SeaRose FPSO currently operating at White Rose.

3.5.5 Abandonment

The decommissioning and abandonment of all Project facilities will be in accordance with C-NLOPB requirements and *Newfoundland Offshore Petroleum Production and Conservation Regulations* and any other applicable laws (see Section 3.8.6 for further detail).

3.6 Logistic Support

3.6.1 Marine Support Vessels

Husky's existing fleet of Anchor Handling Tug Supply (AHTS) and Supply/Standby vessels will be used to support the offshore construction and installation operations associated with the Project. These vessels are and will be Canadian-flagged and crewed and will be managed from the Contractor's office in St. John's, Newfoundland and Labrador.

3.6.2 Helicopter Support

Cougar Helicopters Inc. (CHI) have been contracted to provide helicopter support for the Project and will have access to a Sikorsky S61, AS-332L Super Puma or other equivalent rated aircraft, pooled with all operators in St. John's to service the Company's requirements. Cougar Helicopter Inc. will also provide all auxiliary flight services including First Response Equipment and technicians, alternate landing site at Long Pond complete with weather station, aviation fuel, and helicopter passenger transportation suits and an aircraft maintenance and passenger handling facility located at the St. John's Airport. Cougar Helicopters Inc. will utilise their internal flight following service using the Blue Sky tracking system.

3.6.3 Shorebase Facilities

The Project will be managed and operational decisions will continue to be made from Husky Oil Operations Limited's existing Regional Office in St. John's at Suite 901, 235 Water Street.

A. Harvey and Company Ltd. will continue to provide marine base facilities to support Project activity and, to the extent necessary, it is anticipated that Pier 17 will provide the appropriate wharfage for the dredge vessel. Existing port facilities are capable of servicing multiple operations with the existing infrastructure including office space, crane support, bulk storage and consumable (fuel, water) storage and delivery capability. The existing infrastructure and activity at the Harvey's facility enables the industry to optimise the utilisation of supply vessels and other logistic assets.

Warehouse facilities will continue to be provided by Husky's contracted warehouse provider (ASCO) and Project contractors as required and will consist primarily of storage for tubular goods, and the equipment belonging to the rig contractor which can be stored onshore.

Operation and co-ordination service of voice and data communication services from offshore installations and vessels will continue to be provided from the central facility Stratos Wireless Communications 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. Details on communications systems are outlined in the Husky East Coast Emergency Response Plan currently on file with the C-NLOPB.

3.7 Information on Consultations

As part of the White Rose Development Plan Application, that included an assessment of development activities such as glory hole construction and well drilling, Husky conducted extensive consultations with numerous organizations (see Appendix 2). These included federal agencies, particularly Fisheries and Oceans and Environment Canada; provincial departments such as Environment and Labour, and Fisheries and Aquaculture; municipal governments in St. John's, Clarenville and Marystown; special interest groups including the Natural History Society; and the general public at various locations. A detailed list of over 100 meetings is contained in the report entitled "White Rose Oilfield Development Public Consultation Report" and summarized in the Comprehensive Study Report. The White Rose Development Plan Application also went through a series of Commission hearings that were open to the public.

In addition, Husky briefed the following parties on the nature of the Jeanne d'Arc Basin exploratory drilling project, including a description of proposed activities, locations and timing.

- Transport Canada (23 April 2002)
- C-NOPB (12 April 2002)
- Transport Canada, C-NOPB, Det Norse Veritas (7 May 2002)
- Environment Canada (May 2002)
- Fisheries & Oceans Canada (May 2002)

For the proposed new drill centre development program, the following organizations have been consulted by Husky during the preparation of the environmental assessment:

- Department of Fisheries and Oceans
- Environment Canada
- Natural History Society
- One Ocean
- Fish, Food and Allied Workers Union (FFAW)
- Association of Seafood Producers
- Fishery Products International
- Groundfish Enterprise Allocation Council
- Clearwater Seafoods Limited Partnership
- Icewater Harvesting

Environmental concerns expressed during some of the meetings on the White Rose Project that could be of relevance to the development of new drill centres included those associated with the discharge of waste including drilling muds and cuttings (more so synthetic based muds as opposed to water based muds), produced water, any oily discharges (particularly accidental oil spills), fishery exclusions, and attraction of several species of seabirds to the rig. The general consensus of the meetings was that offshore oil could be developed on the Grand Banks in an environmentally responsible manner and in coexistence with the fishing industry. These issues were also addressed during the White Rose Development Application review process and have been considered in the environmental assessment together with issues that arose from the specific consultations conducted for the new drill centre development program. Husky will maintain ongoing consultations with the above groups and is available to discuss issues at all times.

3.8 Project Components/Structures/Activities

Five new drill centres are being proposed at the following locations:

- **South White Rose Extension (SWRX)** (one glory hole with drill centre) approximately five kilometres due south of the current Southern Drill Centre in approximately 120 m of water.

- **North Amethyst** (one glory hole with drill centre), approximately five kilometers southwest of the current Southern Drill Centre in approximately 120 m of water.

- **West White Rose Extension (WWRX)** (one or two glory holes with one or two drill centres) approximately 1.5 to 3.0 km northwest of the current Central Drill Centre in approximately 120 m of water.

- **North White Rose Extension (NWRX)** (one glory hole with drill centre) approximately 3.0 km northeast of the current Northern Drill Centre in approximately 125 m of water.

Figure 1.1 depicts the general locations of the new drill centres within the Project Area.

The number of wells that will be drilled in each glory hole has yet to be determined and will depend on the results of delineation drilling. However, for planning purposes it will be assumed that each of the five drill centres could potentially support the following distribution of wells if all the drill centres are constructed over the next eight years:

- South White Rose Extension: maximum 16 wells.
- North Amethyst: maximum 16 wells.
- West White Rose Extension: maximum 18 wells.
- North White Rose Extension: maximum 4 wells.

It is proposed that initial construction operations will start with glory hole excavation at SWRX (and possibly North Amethyst) during the 2007 construction season with drilling and subsea construction operations and tie-ins from these two drill centres to the SeaRose FPSO occurring over the 2007-2009 period. The SWRX drill centre will be comprised of three production wells and two water injection wells with expansion capacity to 16 wells.

3.8.1 Schedule of Activities

The time table for the remainder of the construction, installation and tie back operations is provided in Table 3.1.

Construction of the West White Rose Extension and North White Rose Extension drill centres is subject to successful delineation drilling results and full economic assessment.

Table 3.1. Project Phases and Scheduling.

Project Phases	**Timing**
Glory Hole Excavation & TGB Installation	May to September
Drilling Completions	January to December March to November
Subsea Production Equipment Installation	May to October
Subsea Flowline Installation and Tie-ins	May to October
Production Operations	Continuous
Abandonment	May to October

3.8.2 Glory Hole Construction & TGB Installation

Glory hole construction methods will be the same as those typically employed for development of the South Avalon Pool. However, the glory hole(s) will be larger and deeper than those constructed for the South Avalon Pool. The glory hole(s) needed to support establishment of the drill centre will be excavated to a maximum of minus 11 m below existing seabed level in order to protect the subsea wellheads and templates from iceberg scour. Each glory hole will have a maximum “floor” dimension of 70 m by 70 m with graded sloped sides (each of four sides 70 m x 35 m) as required for stability and the flowline ramps. The greater dimensions result from lessons learned during the original White Rose Development. Specifically:

- Increased depth will allow equipment to be installed on purpose-made blocks to decrease exposure of wellheads and associated equipment to irregularities in excavation and sedimentation in the bottom of the glory hole;

- A larger size will facilitate unimpeded movement of ROVs, easier equipment installation, and to allow for possible installation of a universal subsea tree structure currently being assessed; and

- Graded slope ramps will facilitate placement of flow lines and may enhance removal or movement of sediment out of the glory hole through less obstructed current flow.

As noted previously, glory hole construction will be accomplished by use of a trailing suction hopper dredge operation.

Approximately 155,540 m^3 of seabed sediment per glory hole will be moved and dumped at a previously used dumpsite located approximately three kilometres south-southeast of the current southern glory hole. Husky will submit an application for an Ocean Dumping Permit for the South White Rose Extension Glory Hole early in 2007. A second Ocean Dumping Permit application will be submitted should construction of the North Amethyst glory hole be approved for 2007.

Concrete mattresses or impact resistant plastic sleeves at flow exits from the glory holes will protect the flow lines from drill rig anchor chains. It is not planned to bury flow lines in the seabed.

Construction of glory holes will engender a HADD, pursuant to the federal *Fisheries Act*. To compensate for the loss of fish habitat and its attendant fish productivity, Husky will be required to construct fish habitat in an area of Newfoundland.

3.8.3 Drilling

Husky's current drill rig contractor or a separate contractor will operate a MODU to drill the wells associated with this project.

The drill rig employed will have been constructed to an appropriate design for the operating area and physical environment. The drilling unit will have the necessary capability for drilling in the water depths required and the functional specifications of the well design. The rig will have a valid Certificate of Fitness for Canadian waters issued by the rig contractor's Certifying Authority; a Transport Canada Marine Safety Inspection will be conducted as part of the requirements for a Letter of Compliance issued by that agency.

The rig contractor(s) will have an operations office located in St. John's, Newfoundland. The strategy concerning drilling unit crewing plans will be presented in the associated Canada-Newfoundland Benefits Plan and/or components of the Safety Program update documentation. Any foreign Worker's Permits will be sought as the overall Project crew complement is finalized.

3.8.4 Production Subsea Equipment Installation

The production subsea equipment installation will be done in a similar fashion to the same work previously carried out for the other White Rose drill centers in recent years (i.e., flowlines, umbilicals, and subsea manifolds with control system components).

Development of the new drill centres may entail tying back to the FPSO through existing drill centres via new production flowlines or the new drill centres may be tied back directly to the SeaRose FPSO. In the event that new drill centres are tied back through existing drill centres, it will be necessary to disconnect valves and sections of pipework from the subsurface manifolds in the existing drill centres. Prior to disconnecting the existing manifold pipework, the complete drill centre production flowline system will be depressurized and all production fluids (i.e., oil and gas) will be flushed from the manifold and flowline system using a pig train driven by water from the FPSO. To assist in the removal of oil emulsions from the surface of the flowline and manifold pipework, if necessary, a dilute surfactant may be added to the water during the flushing operation. Any chemicals used during the process will be screened through the Offshore Chemical Management System.

Despite the flushing operations, small amounts of oil may remain trapped in the flowline carcass and manifold piping cavities due to the nature of the flexible flowlines and the intricacies of the manifold pipework. As a result, once the pipework section is removed by divers, a small amount of oily residue may be released to the environment. The pipework will be open for approximately two to four hours until the replacement pipe spools are connected to the exposed manifold flanges. The amount of oily residue released is not anticipated to exceed 0.3 m^3.

Once tie-in is complete, the system will be brought back into service through the existing infrastructure at the FPSO.

As already noted, lessons learned will be incorporated into glory hole design for the new glory holes. Specifically, glory holes will be larger and deeper to reduce the interface of equipment with the seabed.

The umbilical and flowlines utilized for the new drill centres will be of the same design and specifications as those currently used by White Rose. Subsea tie-in work in the new drill centres and the existing drill centres (if new drill centres are tied back to existing ones) will be accomplished using ROV technology as well as divers, when required.

3.8.5 Production Operations

3.8.5.1 Organization

Husky Oil manages the production and maintenance operations of the White Rose oilfield on behalf of itself and Petro-Canada from the Husky Oil office in St. John's, where the management team is located. The day-to-day management and control of all offshore operations is the responsibility of the Offshore Installation Manager (OIM) who is located on the FPSO. Each MODU operating in the field will also be managed and controlled by an Installation Manager. The OIM on the FPSO will, however, take responsibility for routine coordination of all concurrent offshore operations.

3.8.5.2 FPSO

The crew complement for the FPSO is approximately between 80-90 personnel on board (POB). The maximum allowed POB offshore during production is 90. The crew complement on the FPSO is not anticipated to change as result of the development of the new drill centres. Major maintenance will be conducted during production shutdowns.

The offshore operation will be provided with engineering support by the Technical Services Group. This support will be for specific tasks, or investigation and solution of process problems, and will be on an ad hoc basis.

3.8.5.3 MODU

Each drilling vessel will require approximately 85-110 support staff during drilling operations. To provide for rotation, this means a requirement of some 170 to 210 personnel per drilling unit.

3.8.5.4 Operations and Maintenance Procedures

Operations and maintenance procedures and manuals have been prepared specifically for the White Rose development. They make provision for compliance with all regulatory requirements, and personnel are trained to operate in accordance with the manuals and procedures.

3.8.5.4.1 Systems

Systems manuals provide descriptions and drawings of the primary process, ancillary systems, and associated equipment and subsystems. The rationale behind the design is presented. Operating parameters are set out. Operator training manuals are based upon these documents.

3.8.5.4.2 Equipment

Detailed information on each individual piece of equipment and each system and subsystem are assembled and incorporated into data books. Such information is drawn from vendor sources, design specifications and operational record. It includes drawings, specifications, descriptions, materials, installation guidelines, operation and maintenance guidelines, and recommendations on spare parts inventory.

3.8.5.4.3 Reporting Relationships and Procedures

Roles, limits of authority, lines of reporting and accountabilities in production operations are set out in reporting procedures and where applicable bridging manuals. For the current White Rose operations, these clearly identify reporting relationships throughout the organization as well as with external agencies. The reporting procedures will be applied to activities related to the development of the new drill centres.

Similarly, the procedures for record-keeping are set out in the manuals, together with requirements for report generation and distribution and data acquisition. Operating and maintenance records are documented as required by Husky Oil and governing regulations. Requisite reports are produced routinely. The same record-keeping procedures will be applied to activities related to the development of the new drill centres.

Production operating procedures and drilling and production operations environmental protection plans that govern day to day work define the necessary environmental protection, compliance monitoring and internal/external reporting processes required to ensure environmental protection. These procedures will also apply to the activities related to the construction and operation of the new drill centres.

3.8.5.4.4 Maintenance Procedures

Maintenance procedures manuals will be prepared for all equipment installed for the new drill centres. These procedures will be based on design data, recommendations by vendors, operating conditions, and the importance of the equipment to operation of the facility. This latter aspect will be based on the effect of failure of the item of equipment on personnel safety, environmental consequences, operational efficiency, and revenues.

As with existing White Rose operations, the maintenance program for new equipment will be extensively supported by computerized systems, providing detailed information on each item of equipment, including its criticality, maintenance history, and spares to be kept in inventory. The system will also be linked to an inventory control system.

The basic significant features of monitoring, inspection, and maintenance and repair, will be recognized in the program.

3.8.5.4.5 Production and Marine Procedures

The production and marine procedures manual deals with the safe and efficient operation of the FPSO for all facets of production and marine-related activities. It describes in detail how the following activities are carried out or managed:

- process start-up and shutdown;
- routine production;
- operations limits;
- adverse weather conditions;
- crude storage and shipment; and
- marine activities.

The procedures manual will apply to all activities related to the construction and operation of the new drill centres.

3.8.5.4.6 Ice Management Procedures

Husky Oil already has an Ice Management Plan in place for its operations on the Grand Banks. Husky Oil will review and update, or modify, this plan as appropriate for application to the proposed development of additional drill centres at the White Rose field.

Ice management procedures currently set out clearly the steps and responsibilities for ice surveillance, monitoring and reporting. The procedures are structured to include cooperation with other operators and government agencies in their concurrent ice surveillance and management operations on the Grand Banks. All available ice intelligence information sources are used to ensure the well-being of the facilities offshore. The ice management procedures in place for the current White Rose development will be employed for construction and operation of the new drill centres.

3.8.5.4.7 Health, Safety and Environment (HSE) Management System

Husky Oil has a health, safety and environment management system for the White Rose development that meets or exceeds all statutory requirements, and facilitates continued employee safety and health as well as environmental protection. Environmental protection and compliance monitoring plans and the environmental effects monitoring program also comprise part of the HSE Management System. The HSE Management System will apply to all activities related to construction and operation of the new drill centres.

3.8.5.4.8 Emergency Procedures

Documented procedures are available to address the various tiers of emergencies that might arise on the FPSO or other offshore facilities. As well, there are contingency documents that address specific risks that have been identified as potential emergencies

3.8.5.5 Operational Limits

Environmental factors impose limitations on the following operations:

- station-keeping ability;
- deck loading;
- bulk storage;
- crane operation;
- helicopter movement;
- ice management; and
- crude storage and tanker loading.

The new facilities are expected to have a system efficiency comparable to that of the existing White Rose operation. Similar to White Rose, operating efficiency will be subject to equipment, reservoir and well performance as well as environmental factors.

3.8.5.6 Logistics

3.8.5.6.1 Marine Base, Warehousing, and Storage Yard

The marine base will be located in St. John's and will utilize the same facilities as the current White Rose Project. The current marine base is anticipated to be able to accommodate the additional equipment required for construction of the new drill centres. During operations, no additional warehousing and storage yard space will be required above that used for the current White Rose development.

3.8.5.6.2 Support Vessels

Support vessel requirements for the operation of the new drill centres will not change from the current requirements for the White Rose Project. During construction of the new drill centres, additional support vessels will be required to service drilling rigs and installation vessels.

Vessels will be continuously available in the field for standby duty in accordance with regulatory requirements. Supply vessels will convey materials, consumables and equipment to and from the offshore facilities.

All personnel staffing the support vessels will be fully trained in emergency duties. There will be routinely scheduled emergency drills and exercises.

3.8.5.6.3 Personnel Movements

As with the current White Rose Project, personnel movements between St. John's and the field will normally be carried out by helicopter. During construction of the new drill centres, some additional helicopter flights may be required to transfer personnel from drilling rigs. During operations, the current helicopter requirements will remain the same since it is anticipated that no additional personnel will be required on the FPSO.

3.8.5.7 Communications

Communication requirements related to the construction and operation of the new drill centres will be integrated into the system currently used for the White Rose Project. This system includes communications linkages between all of Husky's facilities both onshore and offshore.

Primary and back-up systems will continue to be used to ensure continuous communications capability amongst all facilities in all environmental conditions. The system comprises the following elements:

- FPSO and MODU/Shore Link;
- Telephone System;
- Local Area Network (LAN);
- Ship Radio System;
- Air/Ground/Air VHF Base Station;
- Air/Ground/Air VHF Hand-held Radios;
- Non-directional Beacon for Aircraft Approach;
- VHF Radio System; and
- Shore Base Radio Station Services (including marine vessel tracking and flight following).

3.8.6 Abandonment

At the end of the production life of the White Rose oilfield, Husky Oil will decommission and abandon the site according to C-NLOPB requirements and *Newfoundland Offshore Petroleum Production and Conservation Regulations* and any other applicable legislation. Floating production facilities will be removed from the field. Subsea infrastructure will be removed or abandoned as outlined in the White Rose Comprehensive Study and the Decision Report 2001.01. The site will be restored to a condition that minimizes environmental impact and that will not impede fishing activities.

3.8.6.1 Approval Process

At the completion of oil production from the White Rose field, Husky Oil will seek approval to decommission the facilities and abandon the field in accordance with the requirements of the *Newfoundland Offshore Petroleum Production and Conservation Regulations*.

The approval request will include all relevant data required to demonstrate that all practical and economic extraction of oil from the field has been achieved.

3.8.6.2 Abandonment Methods

3.8.6.2.1 Production and Injection Wells

Husky Oil intends to follow the following procedure for abandonment of wells:

- install cement plugs and mechanical bridge plugs as follows:
  - at the bottom of the deepest casing string;
  - above the uppermost perforations;
  - at depths not exceeding 150 m below the mudline;
  - to seal off porous, permeable formations; and
  - to seal off formations with abnormal pressures;
- remove wellheads and cut casings; and,
- displace hydrocarbons in production wells with a kill fluid and abandon.

3.8.6.2.2 FPSO

At abandonment, the FPSO will be disconnected from the risers. The topsides equipment will be decommissioned offshore, and any residual hazardous waste arising from this will be taken to shore and treated at appropriate approved waste treatment facilities. All anchors, lines and chains will be recovered.

The ultimate disposition of the FPSO will depend upon its condition at of the end of the production life of the White Rose field, and upon the options available for further use.

3.8.6.2.3 Subsea Facilities

All equipment located in glory holes will be removed and the glory holes will be left as they are. Christmas trees and manifolds will be purged, rendered safe, and recovered.

All other subsea facilities above the seafloor, including production manifolds, riser base manifolds, loading riser manifolds, flowlines, and export lines, will be purged and decommissioned in accordance with regulations prevailing at the time. Risers and umbilicals will be decommissioned, rendered safe, and recovered.

The final abandonment and decommissioning plan has to meet C-NLOPB requirements and *Newfoundland Offshore Petroleum Production and Conservation Regulations* and any other applicable laws or regulations and will be subject to final approval by the C-NLOPB.

3.9 Description of Waste Discharges and Treatments

Waste discharges during the development will include drill muds and cuttings, produced water, grey and black water, ballast water, bilge water, deck drainage, discharges from machinery spaces, cement, blowout preventer (BOP) fluid, and air emissions. All discharges will be in compliance with the *Offshore Waste Treatment Guidelines* (*OWTG*). Details are provided in the following sections.

All wastes discharges associated with the FPSO and drill rigs are itemized in the respective EPPs. Waste discharges of the dredger and supply vessels would include air emissions, grey and black water, and bilge water.

3.9.1 Drilling Muds

Water-based muds (WBM) will be used where possible, usually during the first sections of each well. Synthetic-based muds (SBM) will be used to drill the majority of each well.

Components and additives typically differ somewhat by well, the specific conditions encountered in drilling, and by the depth and purpose for drilling. Typical formulations for water based drilling mud and the quantities likely to be used when drilling a vertical well hole for the surface and the conductor are provided in Section 7.0.

The first part of the hole (i.e., the surface casing and conductor) is drilled without the riser in place and thus the water based drilling mud and associated cuttings are discharged directly to the marine environment. Approximately 230 m^3 of water based cuttings will be discharged per well during this stage of the drilling.

During the drilling of the hole for the intermediate casing, the riser and associated BOP are in place and mud is transported back to the rig. Cuttings are then removed from the drilling mud in successive separation stages through shakers, hydrocyclones, and centrifuges. After passing through the solids control system, the cleaned cuttings are then discharged overboard through a cuttings chute. Recoverable mud is then reconditioned and reused. Up to 175 m^3 of cleaned cuttings could be discharged during the installation of the intermediate casing. SBM will be recycled and reused where possible, or brought to shore for disposal when spent.

All drilling cuttings and fluid discharges will be in accordance with the C-NLOPB *OWTG* – August 2002 Revision and subject to approval by C-NLOPB.

3.9.2 Produced Water

3.9.2.1 Well Testing

If hydrocarbons are present and testing is conducted then small amounts of produced water may be discharged by atomizing with hydrocarbons and flared. If the flare capacity is at risk of being exceeded, then small amounts of treated produced water will be brought ashore for disposal.

3.9.2.2 Production

The current estimate of produced water discharge for the core White Rose Project is 22,000 m^3/day. While the specific volumes of produced water that will be generated by each of the potential tiebacks is dependant on the number of wells ultimately drilled and the nature of the reservoir accessed by the new drill centres, total amounts of produced water will be within the 30,000 m^3/day assessed in the White Rose Comprehensive Study (Husky 2000). This will be managed so as new wells come on stream (and produce little or no water for the first few years), older wells that are producing larger volumes of water will be reaching the end of their productive life. The total daily water handling capacity on the SeaRose FPSO is limited to 30,000 m^3/day, thus the total daily amount of produced water will not exceed this amount.

The composition of typical produced water is provided in Table 3.2.

Table 3.2. Typical Produced Water Composition.

Ion	Concentration (mg/L)
Na	15,860
K	250
Ca	757
Mg	102
Ba	3.01
Sr	122
Fe	2.63
B	56.4
Mn	0.25
Cl	25,550
Br	53
I	58.2
HCO_3	1068
SO_4	390

Comment No. 24: Maximum amount of produced water

3.9.2.2.1 Produced Water Treatment

As per the White Rose Oilfield Comprehensive Study (Husky 2000), produced water separated from the gas, oil and condensate will be treated on site to meet the current *OWTG* (NEB, C-NOPB and C-NSOPB 1996, revised 2002). Produced water will be treated to reduce the oil content to 30 mg/L or less averaged over a 30-d period and subsequently discharged. Minimal, if any, produced water will be discharged during development drilling.

Once produced water is realized, compliance monitoring of produced water will be conducted as per the FPSO Environmental Protection Compliance Monitoring Plan (EPCMP). A water quality specific component of the overall Environmental Effects Monitoring (EEM) program that will primarily address produced water is under development and will be implemented with C-NLOPB approval

3.9.3 Air Emissions

The SeaRose FPSO was designed to minimize greenhouse gas emissions (GHG) and volatile organic compounds (VOC's). These design modifications are addressed in the document referencing Condition 35 of Approval for the White Rose Project. Drilling operations by comparison to production operations emit small amount of greenhouse gas emissions. The quantity of emissions from the White Rose Project is calculated and sent to the C-NLOPB annually as per the *OWTG* (2002) and also sent to Statistics Canada. The VOC's are reported to the National Pollutant Release Inventory annually.

3.9.4 Grey and Black Water

Grey and black water produced on the drilling rig and FPSO is treated as per the relevant Environmental Protection Compliance Monitoring Plan (EPCMP). Black water or sewage will be macerated to 6 mm particle size or less and discharged as per the *OWTG*. Estimated amounts of black water are up to 19 m^3 per day.

3.9.5 Bilge Water

Bilge water for both the drill rig and FPSO will be treated to *OWTG* standards (15 mg/L or less).

3.9.6 Deck Drainage

Any deck drainage for both the drill rig and FPSO for both the drill rig and FPSO will be treated to *OWTG* Standards (15 mg/L of oil or less).

3.9.7 Ballast Water

Water used for stability purposes in both supply boats, FPSO's and drilling rigs is stored in dedicated closed system tanks and does not contain any oil under normal operations. If oil is suspected in the ballast water it will be tested and if necessary treated to *OWTG* standards (15 mg/L or less).

3.9.8 Cooling Water

3.9.8.1 FPSO

As per the FPSO EPCMP, cooling water (i.e., seawater) return is treated with chlorine to prevent biofouling and is monitored pursuant to the *OWTG*. Husky's target discharge concentration is 0.5 ppm. Water from closed systems will be tested daily and will comply with the *OWTG*. Any proposals for alternate biocides will be submitted to C-NLOPB for consideration prior to use.

3.9.9 Garbage

All trash and garbage, including organic waste from galleys, will be containerized and transported to shore for disposal in approved landfills. Combustible waste such as oil rags and paint cans will be placed in hazardous materials containers for transport to shore.

3.9.10 Glycol and Other Chemicals

When drilling with semi-submersibles, blowout preventer (BOP) test fluid (glycol/water) is released at intervals (typically three pressure and three function tests per 40-day drilling). About 1.0 m^3 is released per test (Husky 2000). No other substances not discussed above or covered in the *OWTG* will be discharged without prior notification and approval of the C-NLOPB. Additional information on discharges and treatment is contained in the environmental assessment sections of this document.

3.10 Seismic Survey Equipment (Geohazard and VSP Surveys)

Geohazard/well site surveys and vertical seismic profiling (VSP) using an airgun array may be conducted as part of the drilling activities. The VSP is used to assist in further defining a petroleum resource. The array is similar to that employed by 2-D or 3-D seismic surveys but is typically smaller and deployed in a smaller area over a shorter time period (12 to 36 hours). Well site or geohazard surveys may also deploy a small array and sonar. They are used to identify and avoid geotechnically unstable areas (e.g., shallow gas deposits) or hazards (e.g., shipwrecks) prior to drilling. The proposed geohazard surveys associated with the drilling program have been assessed under separate cover (LGL and Canning & Pitt 2005).

3.11 Geotechnical Surveys

The purpose of geotechnical surveys is to assure, to the degree possible, that there are no "false starts" and multiple tries for piling and excavation. It is also to assure the safety of the flowlines from damage related to unsupported sections because of protuberances on the seafloor. Geotechnical survey information may be gathered in the field for locating bottom-supported facilities, glory hole excavation, flowline path, and mooring, foundation or riser base pile locations.

The types of geotechnical survey methods that could be employed include:

- core drilling of the seabed (to 10 to 35 m);
- vane shear strength of soil at seabed and at points to approximately three metres below seabed;
- acoustic signal reflections local to installation sites; and
- visual surveys

In all geotechnical survey types, no equipment is left on the seabed. For electromagnetic wave sensing and acoustic surveys, emitted signals are short duration and very local (i.e., the emitter and the sensor are in very close proximity). For core drilling and vane shear strength surveys, the seabed is left disturbed in a small area of a few square meters.

For the proposed new drill centres, Husky is considering eliminating the geotechnical survey and instead building flexibility into the design of pipelines, well trajectories, etc. to allow relocating a glory hole up to approximately 50 m in any horizontal direction, should an obstacle too difficult to remove be encountered.

3.12 Waste Management Plan

The waste streams related to development of the new drill centres will be managed according to the Husky Waste Management Plan currently implemented for the White Rose Project. The purpose of the Husky Waste Management Plan is to provide guidance on effectively dealing with waste from the facility and avoiding environmental pollution. As with current operations, wherever possible, waste streams will be segregated so as not to create the additional problem of expensive decontamination or separation onshore.

3.13 Onsite Environmental/Ice Observers

Environmental/Ice-Observers, called weather observers are present on the MODU at all times. An onsite Environmental Observer will also be on board the MODU to record and report 24-hour weather, oceanographic and ice parameters. During any year that has been assessed as a particularly bad ice year, two Environmental/Ice Observers may be stationed on the MODU to assist the Drilling Operations personnel in strategic and tactical planning along with the recording and reporting the weather and oceanographic duties. As part of these duties these personnel will also assist in vessel monitoring under the Project Collision Avoidance Procedures outlined in the East Coast Incident Coordination Plan.

The environmental observers will also conduct seabird and marine mammal observations on a daily basis in accordance with established protocols.

In addition, an Oceanographic Monitoring Program will again be conducted in accordance with the C-NLOPB *Guidelines Respecting Physical Environment Programs*. The program will be the same as previous ones and include the installation of current meters and a wave-sensing device.

3.14 Project Site Information

3.14.1 Environmental Features

The Project has the potential to affect air, water, plankton, fish and fish habitat, fisheries, marine birds, marine mammals, and sea turtles through emissions and discharges, both routine and accidental. There are no known special or unique areas in the Project Area. A description of the physical and biological environment of the northeastern Grand Banks and potential Project interactions and effects are included in this EA. A valued ecosystem component (VEC) approach is used in the EA. VECs in the area include fish, fish habitat, commercial fisheries, seabirds, marine mammals, sea turtles, and *Species at Risk Act* (*SARA*) species (including COSEWIC-listed species). Effects on VECs including cumulative effects (within the Project and with existing and planned projects) are assessed in the EA to follow. Focus is on sensitive species, areas and times, including *SARA* species.

3.14.2 Other Users

Current and past uses of the area include marine shipping, oil and gas exploration, defence-related ship traffic, and commercial fisheries. Hunting of murres, waterfowl, and seals has occurred for many years farther inshore from the Project Area.

There is a continuing problem on the Grand Banks and the approaches to the Gulf of St. Lawrence with oily discharges (i.e., mystery spills) from marine vessels in international shipping lanes. Previous disturbance of the seabed may have occurred from bottom trawling activity associated with commercial fisheries.

The closest protected bird areas are Cape St. Mary's and Witless Bay which are located about 350 and 310 km, respectively, to the west of the Study Area. In addition, the offshore region of the Grand Bank is heavily used by migratory seabirds. The "Bonavista Cod Box," a fisheries protected area, is located approximately 200 km northwest of the Study Area. The closest urban centre is St. John's, located about 300 km to the west of the Study Area.

The physical presence of the rig and supply boats affects navigable waters on the Grand Banks to a small degree. The Study Area is close to major North Atlantic shipping lanes and may receive ship traffic from fishing vessels, tankers, freighters, naval vessels, private yachts and others. The detailed physical characteristics of the waterway are provided in Section 4.0.

Comment No. 16: Rig anchorage

Comment No. 19: Misnaming of provincial department

Comment No. 20: Well number discrepancy between EA and Development Plan Amendment

Comment No. 22: Oily residue discharge during tie-back

Comment No. 23: Pollution prevention measures

Comment No. 25: Chlorine in cooling water

4.0 Physical Environment

Effects of the Environment on the Project

Effects of the physical environment on the Project include those caused by geohazards, wind, ice, waves, currents and biofouling, particularly extreme events. The physical variables have been described in detail in Section 4.0 of the EA (see also Appendix 3 of this document).

Weather, ice and icing and wave conditions affect every project on the East Coast to some degree. It is anticipated that these effects will be mitigated by using rigs, vessels and equipment that are all certified by the appropriate authorities (e.g., DNV, Transport Canada, Coast Guard, and the C-NLOPB, and others) for use on the Grand Banks, by detailed project planning, by design in accordance with recognized and appropriate national and international standards, by operational scheduling, and by state-of-the-art forecasting. The residual effects of physical environmental factors are predicted to be adverse (i.e., in the form of delays) because they can cause delays to the Project, damage to equipment and thus economic losses, or because they can be a contributing factor to accidents. Accidental effects are discussed in detail in Section 8.0 of the EA.

The effects of ice on the Project will be minimal because most of the Project Area is often free of sea ice and subject to relatively few icebergs most of the year. Given careful timing selection and good forecasting, there is expected to be little effect on the Project from sea ice. Any potential effects on the Project from icebergs can be mitigated by timing selection and by the Ice Management Plan described below such that residual effects will be minimal.

Ice accumulations (superstructure icing) may cause delays while operations are slowed or suspended and ice accumulation is avoided or removed. Any delays are anticipated to be relatively short-lived compared to the Project's timeline.

There is some risk of seismic activity on the east coast (assessed in the White Rose Comprehensive Study). However, the risk is not abnormally high and is unlikely to significantly affect surface activities if a floating drill rig and FPSO are used and the emergency systems disconnect as designed. Other geohazards, e.g., steep slopes, slumping, shallow gas, etc., will be evaluated prior to drilling either through dedicated geohazard surveys or further analyses of 3-D seismic data.

Effects of the physical environment on the Project include those caused by wind, ice, waves, and currents. These effects may differ somewhat by equipment type. For example, bottom-founded equipment is stable under all conditions whereas floating systems are subject to heaving due to wave action. A semi-submersible may be more affected by surface currents and not by bottom type whereas bottom equipment may be more affected by bottom currents and bottom substrate type.

Aside from the obvious concerns associated with extreme wind and wave events, sea ice and icebergs are probably the greatest physical environmental and safety concerns affecting oil and gas operations on the Grand Banks. Refer to Section 4.5 for further discussion on ice and icebergs.

Effects of the biological environment on the Project are primarily those related to biofouling. Biofouling may affect rig stability and encourage corrosion by establishing itself on exposed support structures or hulls and may also affect a similar effect on the interior of pipes as well as water intakes and outlets and tankage used for waste water storage and treatment, and possibly drill mud tankage. Apart from corrosion and stability concerns, establishment of sulphur reducing bacteria in closed tankage where low oxygen tensions in water occur can result in hydrogen sulphide gas evolution that has the potential for safety risks.

Effects of the environment will be mitigated by state-of-the-art weather and ice prediction, timing, selection of suitable rigs, vessels, equipment and personnel, and by adherence to Husky's HSE Plan. Effects of the environment on the Project are assessed further in the following sections.

Physical Environment

The physical environment is described in detail in Section 4.0. Effects of the physical environment on the Project include those caused by geohazards, wind, ice, waves, currents, temperatures and currents. These effects may differ somewhat by activity or equipment type. For example, bottom-founded infrastructure is stable under all conditions whereas floating systems (e.g., semi-subs, drillships) are subject to heaving due to wave action, although DP rigs probably less so than anchored rigs. All surface vessels are constrained by ice but most can disconnect and move away albeit using different procedures and different environmental criteria. A floating rig may be more affected by surface currents and not by bottom type currents whereas bottom-founded equipment may be more affected by bottom currents and bottom substrate type.

Aside from the obvious concerns associated with extreme wind and wave events, ice poses some environmental and safety concerns affecting oil and gas operations on the Grand Banks. Icebergs will be managed by surveillance, an early warning system, and by towing. In addition, the proposed rig type and FPSO will be able to safely disconnect and move off site relatively quickly, if required.

Freezing precipitation is of concern because it can affect personnel and structural safety. Accumulations of ice may create slippery decks and cause falls and in extreme cases can affect vessel stability. Freezing precipitation in the Newfoundland and Labrador area is most likely to occur from March to April (Petro-Canada 1996). Accumulations of ice on structures may be due to precipitation, condensation or sea spray and are highly related to air temperature, wind speed, diameter of surfaces, and other factors. Husky will manage risk through forecasting, close monitoring of conditions, and adherence to documented and proven safety procedures.

Biological Environment

The biological environment can also affect the Project's efficiency, vessel stability, and safety through biofouling of water intakes, and vessel and rig undersides, and waste water treatment and storage tankage. Mud systems can also become contaminated with bacteria. These effects will be minimized through regular inspections and cleaning and where necessary treatment with appropriate biocides, usually a chlorine or gluteraldehyde based product.

Anthropogenic Environment

Contaminated environments may also create effects on worker health and safety (e.g., evolution of hydrogen sulphide from bacterial contamination of tankage where conditions exist to support this phenomenon). There are no known contaminated sites or munitions dump sites in the Project Area.

4.1 Geochemical

See Husky EEM reports for extensive documentation of sediments.

Comment No. 28:	**Iceberg scour environment, seabed sediments and character of sediments to be dredged.**

4.1.1 Geology

Text in EA remains the same.

4.1.2 Chemical Environment

Text in EA remains the same.

4.2 Climate

See Appendix 3 for an update and additional material.

Comment No. 27: Current atmospheric circulation patterns

4.2.1 Overview

Text in EA remains the same.

4.2.2 Seasonal Differences

Text in EA remains the same.

4.2.3 Marine Climate Data Sources

See Appendix 3.

Comment No. 30: Databases for derivation of marine climate statistics

4.2.4 Winds

See Appendix 3.

Comment No. 31: Winds

4.2.4.1 Wind-generated Waves

See Appendix 3.

Comment No. 32: Wind-generated waves

4.2.5 Air and Sea Surface Temperatures

Text in EA remains the same.

4.2.6 Visibility and Causes of Restricted Visibility

Text in EA remains the same.

4.3 Physical Oceanography

4.3.1 Water Masses

Text in EA remains the same.

4.3.2 Currents

Text in EA remains the same but see also Appendix 3.

Comment No. 29: Ocean current models

4.4 Extremes

4.4.1 Wind and Wave Extreme Analysis

See Appendix 3.

Comment No. 33: Wind and wave extreme analysis

4.5 Ice and Icebergs

4.5.1 General

The following is an updated ice distribution analysis of the ice environment surrounding the White Rose Field drilling and exploration site over the last 10 years. Two different forms of floating ice, sea ice and icebergs, are present in this marine environment.

This updated ice distribution analysis begins with a description of the databases used, followed by a summary of the sea ice cover and of the icebergs sighted on the White Rose Field.

4.5.2 Databases

The data used to report the thickness of sea ice on the Grand Banks was extracted from a digital database of (approximately) weekly composite ice charts produced by the Canadian Ice Services (CIS) with the past three years extracted from the CIS weekly regional ice charts.

Data on icebergs are compiled from 10 years of iceberg sightings and detections from the PAL Ice Reconnaissance flights. The data is extracted from the PAL Ice flight digital database.

4.5.3 Sea Ice

Between 1997 and 2006, sea ice was present only during three of those ten years. Sea ice was approximately 15 km from the White Rose field in 1997, 2002 and 2003. During those three years, sea ice occurred between March 12th and April 30th and the duration of coverage ranged from one to five weeks. The mean concentration of the sea ice was 4.3 (on a scale of 10). Figure 4.1 shows the results of all sea ice coverage.

4.5.4 Icebergs

Iceberg sightings made within a grid constrained by the coordinates 46.00N to 48.00N and 48.00W to 50.00W were extracted from the PAL database. For the purpose of this document, that constrained grid will be referred to as the Grand Banks.

Between 1997 and 2006, a total of 1,324 icebergs reached the Grand Banks. Figure 4.2 shows the number of icebergs by one degree block from 1997 to 2006.

In order to focus on icebergs in the vicinity of the White Rose Field, the area of review for the number of icebergs sightings was between 46.00N to 47.00N and 48.00W to 49.00W. Within the last 10 years, 388 icebergs were sighted within those coordinates. As a result of the past three very light ice seasons, the 10-year average number of icebergs observed in the White Rose block has been reduced from 46 to 38 icebergs.

Figure 4.3 graphs the iceberg sightings for the site area since 1997. The icebergs were sighted within those coordinates between the months of March and June. Figure 4.4 graphs the average number of icebergs by month in the White Rose Field grid since 1997.

There have been some recent iceberg scour studies conducted on the Grand Banks by C-CORE and BIO (GSC) but no significant changes were found for the White Rose area since the White Rose EA (G. Sonnichsen, GSC, pers. comm.).

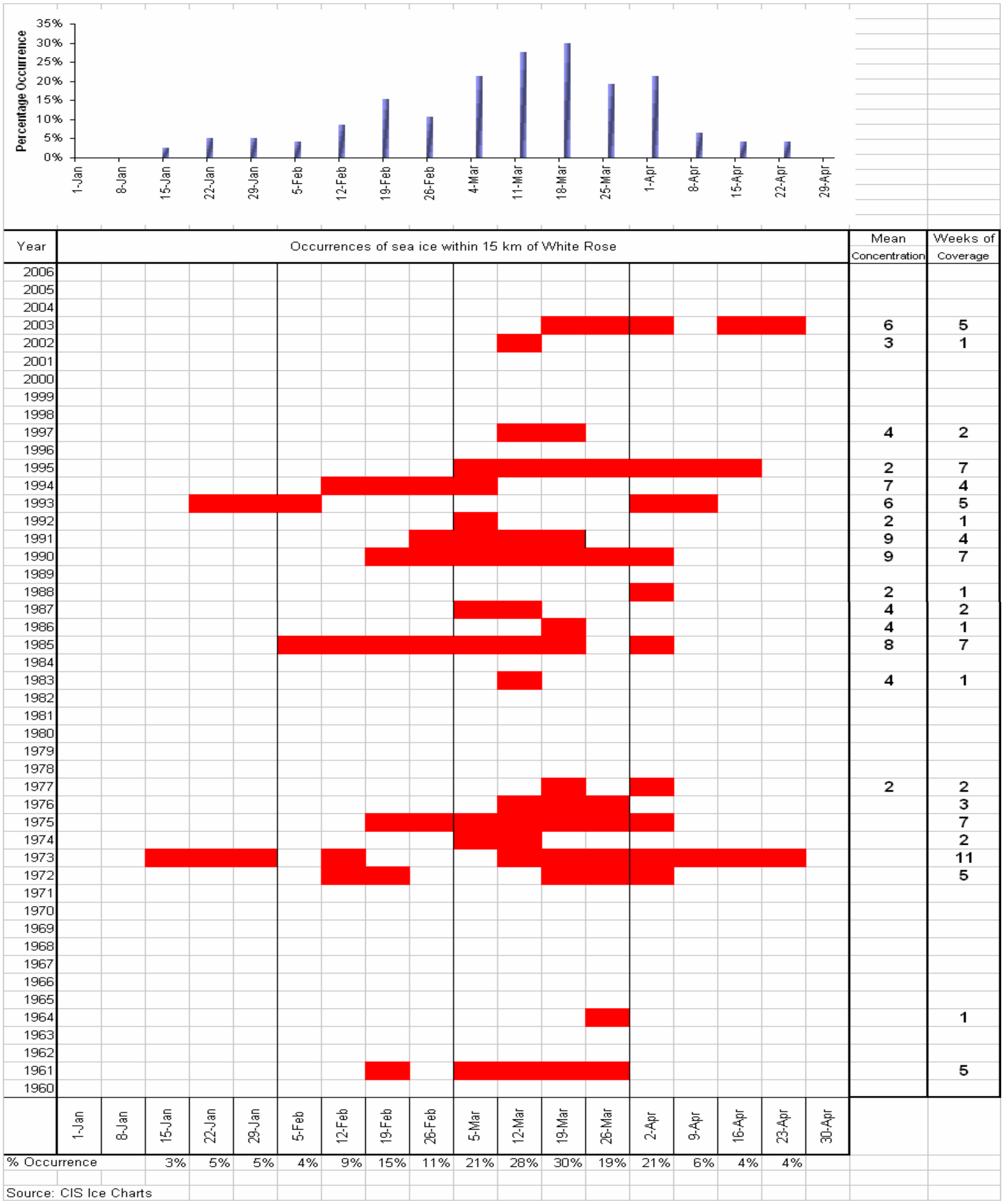

Figure 4.1 Percentage Occurrence of Sea Ice within 15 km of the White Rose Field, 1960 – 2006.

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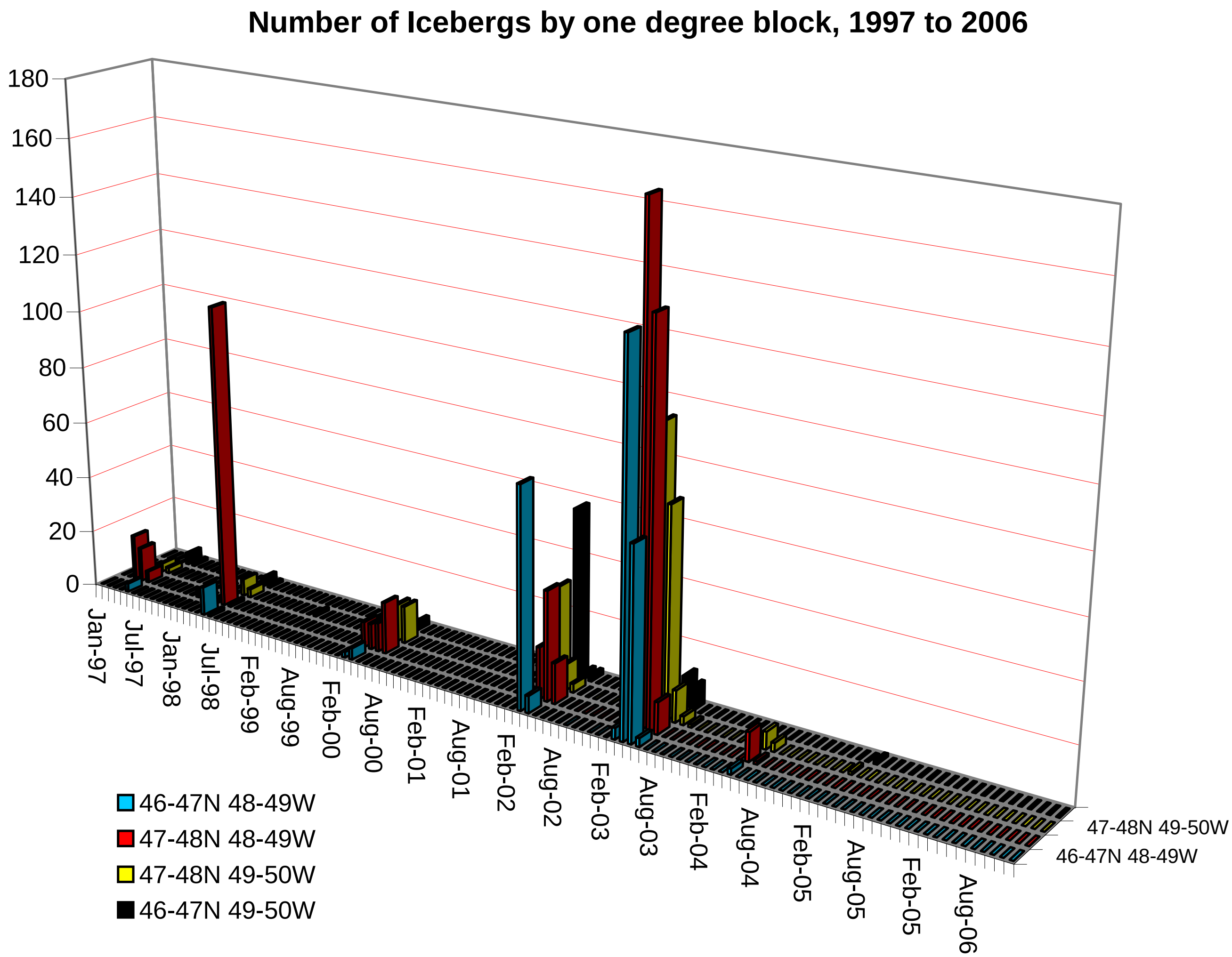

Figure 4.2. Number of Icebergs by one degree block, 1997 to 2006.

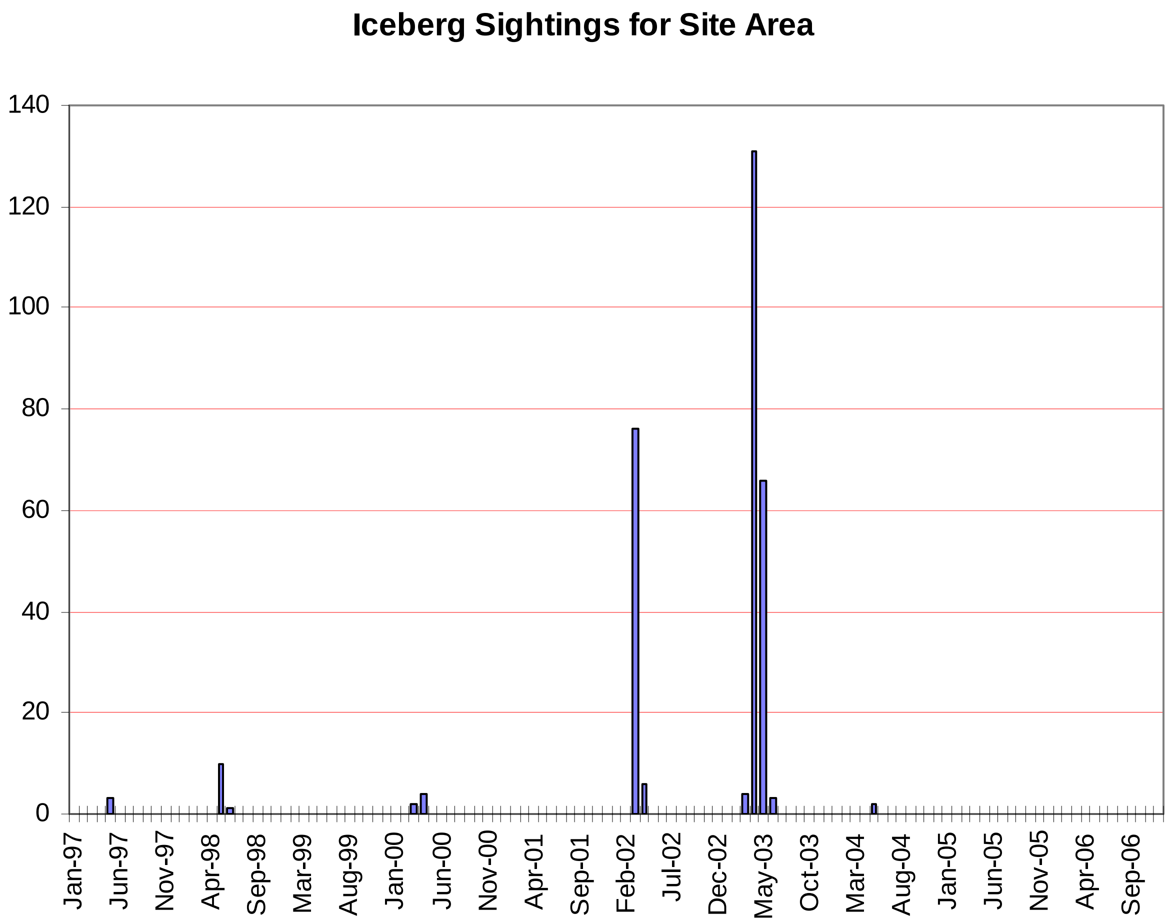

Figure 4.3. Iceberg Sightings for the White Rose Site, 1997-2006.

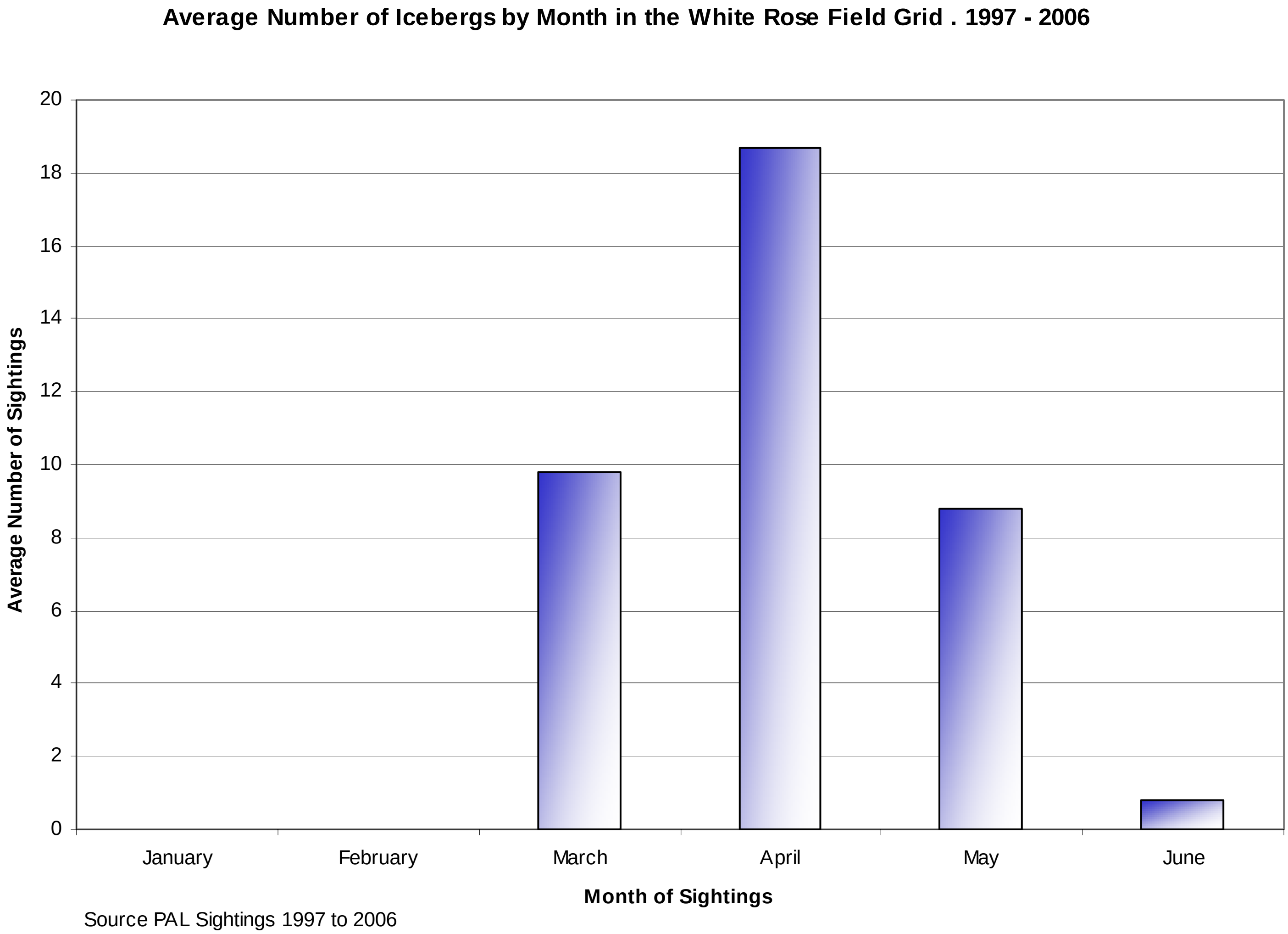

Figure 4.4. Average Number of Icebergs by Month in the White Rose Field, 1997 to 2006.

Comment No. 28:	**Iceberg scour environment, seabed sediments and character of sediments to be dredged.**

4.6 Mitigation of Effects of the Environment on the Project

The offshore industry mitigates the effects of wind, waves, and ice on project operations and safety through the state-of-the-art, site-specific forecasting by dedicated contractors. Consistent with existing practices, the Operators will use a three-fold strategy in avoiding or mitigating the potential effects of ice and icebergs:

1. Project scheduling,
2. Onboard environmental observer (s), and
3. Ice management protocols (ice mitigations as defined in the Ice Management Plan).

Marine Meteorological Observation Program

During drilling, marine observations will be conducted as required by the Physical Environmental Guidelines (PEG's) and the Drilling Regulations. A qualified observer will record and report both aviation and marine weather observations. Using WMO/MSC-approved, standard meteorological sensors, the observers will provide synoptic weather observations every three hours over the synoptic periods 00:00Z through to 21:00Z and either, hourly aviation observations between 10:00Z to 21:00Z or whenever aviation operations are planned.

All meteorological, oceanographic, and vessel response measurements and observations will be recorded on a computer running the appropriate software to facilitate logging, primary level error checking, coding, and data transmittal of meteorological, oceanographic, and rig response data (Table 4.1).

Table 4.1. Environmental Parameters to be Measured or Observed.

Measured Parameters	**Observed Parameters**	**Other Observations**
Wind Speed and Direction	Present Weather	Ocean Currents
Station Barometric Pressure	Past Weather	Passing Vessel Traffic
Sea Level Barometric Pressure	Visibility	Heave, Pitch and Roll
Pressure Trend	Wind Wave	Wildlife Numbers and Behaviour (if required)
Altimeter	Primary Swell	Anchor Tensions
Air Temperature	Secondary Swell	Well Offset (if required)
Wet-bulb Temperature	Sky Condition	
Dew Point Temperature	Cloud Type	
Sea Surface Temperature	Sea Ice/Icebergs	
Ice Accretion		

Marine weather observations will be taken every three hours (main and intermediate synoptic hours) according to procedures outlined in the MANMAR manual (including amendments) and the guidelines published by the C-NLOPB. If necessary, a Special Weather Report and/or a Storm Report will be filed whenever the criteria for such reports are met, regardless of whether the conditions were forecast or not. A Storm Report will be filed whenever the wind speed equals or exceeds 48 knots. Special Weather Reports will be issued whenever:

- Mean wind speed doubles to 25 knots (46.3 km/hr) or more;
- Mean wind speed increases to 34 knots (62.9 km/hr) or more with no gale warning in effect;
- Visibility decreases to one-half mile or less;

- Wave height increases by 1.5 m from the value reported at the last main synoptic;
- Ice forms on the superstructure.

Aviation Meteorological Program

Aviation weather observations will be taken hourly from 06:30L to 17:30L, and/or whenever helicopter operations are planned. The observations will be as outlined in the MANOBS manual and as prescribed by the C-NLOPB. Special observations will be taken when changing weather conditions meet the criteria for "specials". These specials will be reported immediately to the Company's helicopter contractor and the Husky contractor's Weather Forecasting Office. To be consistent with weather reports from shore-based stations, aviation observations from the rig will be coded and transmitted in METAR format. The onboard observer will take aviation weather observations at the MODU and will record those observations using suitable software that should code the observation into a METAR format and forward it to both the Helicopter contractor and the Weather Forecasting Office.

Environmental and Meteorological Instrumentation

Instrumentation for environmental and weather observations that meet the stated requirements of the C-NLOPB and MSC will be available onboard the MODU. The instrumentation will be inspected and calibrated by qualified personnel.

Meteorological Forecast Services

Meteorological forecasts tailored to meet the operational requirements of the program and satisfy all C-NLOPB guidelines will be in place for the duration of the drilling programs. The forecasts will be verified against the synoptic weather observations collected on the MODU.

At a minimum, the forecasts will consist of:

- A 24-hour weather watch with site-specific forecasts prepared and issued on a 12-hour basis and forecast updates on a 6-hour basis.
- Short-term forecasts out to 54 hours followed by a long-range forecast in 12-hour time steps for an additional three days.
- Updated forecasts issued on a three-hour basis or more frequent, if required, during emergency or storm conditions.
- Issuances of weather warnings when appropriate.
- Weather briefings.
- Site-specific forecasts, which will include at a minimum the following:
  - Synopsis of present weather patterns;
  - Mean and maximum wind speed and direction;
  - Precipitation;

- Visibility and sky condition;
- Air temperature;
- Mean sea level pressure;
- Potential for freezing spray/icing conditions;
- Significant and maximum wave height and direction;
- Wave period;
- Significant height and direction of swells; and
- Combined significant and maximum wave height and direction.

- An overview of weather and sea state forecast procedures and information sources.
- QA/QC processes as well as forecast verification procedures to ensure ongoing accuracy of forecasts.
- Forecasts prepared by qualified personnel who have experience in the geographical region and familiar with MSC and C-NLOPB requirements and guidance material.
- An effective data communications system to ensure timely receipt and issuance of environmental data and forecasts.
- Data archiving, processing, and preparation of all the required reports as outlined in the C-NLOPB Guidelines including the preparation of a forecast verification report.
- Quality control of weather observations. The METAR and MANMAR observations MANMAR coded observations will be forwarded to the MSC network.
- Sea state will be verified against observations collected on the MODU and any other observations available.

Ice Management and Mitigation Program

This section provides an overview of ice management practices that will be employed on this project to provide a safe environment and minimize operational disruptions caused by ice. Currently ice management is comprised of:

- Detection;
- Monitoring and Assessment; and
- Physical Management.

Detection

Detecting small floating targets in open seas is a well-understood and documented process. Technological advances in the preceding two decades have improved ice detection capabilities to a point where both sea ice and icebergs can be detected and positioned over a large area with great accuracy.

Ice detection will use a combination of radar technologies and procedures to quantify and monitor ice distribution. Between government (both Canadian and US) and private industry there are over 5,000 hours of airborne reconnaissance conducted annually over the Canadian East coast. In addition to these radar-equipped aircraft, the areas off Canada's East Coast are swept daily by an assortment of satellite-based sensors and long-range, shore-based radars. Data from all these sources are integrated into a daily summary of ice distribution. The sequential ice distribution data is then used to monitor growth and movement. Using these procedures, the operator will be able to detect and monitor ice conditions, allowing for long-term resource and operational ice management planning.

Monitoring and Assessment

Once detected, ice will be monitored to establish the speed and direction of its movement (drift) and, when enough information has been obtained, assess its potential threat to the Project. Typically this is accomplished in stages. The initial detection is usually accompanied by a general classification of the type of ice or iceberg. As successive detections are made over an area, a general drift track is established. At this stage the available data will allow for general assumptions to be made. As ice closes on the Project Area, more detailed information will be acquired.

The components of detailed ice assessment data are:

- Physical dimensions of sea ice and/or icebergs;
- Depth measurements of icebergs (draft); and
- Accurate drift (direction and speed).

The standard methodology for obtaining physical dimensions comprises a mix of measurement, calculation and in some cases estimation, depending on the operational significance of the ice in question. Smaller icebergs and ice floes are usually estimated, because their masses are well within the capabilities of ice management vessels. These methods are described in detail in Husky's Ice Management Plan that applies to its operations in the Newfoundland Offshore Area.

Obtaining accurate drift information is a simple process of measuring distance over time. The widespread use of the Global Positioning Systems (GPS) now provides very accurate positions, permitting accurate tracks, even over short distances and time spans.

Once these baseline data have been collected, a reasonable assessment of the risk posed by the ice will be made. Typical risk assessment considers the following questions:

- Is the drift of the ice likely to pose a collision risk or disrupt operations?
- Is the ice in excess of the design criteria of the facility?
- Is the ice/iceberg within manageable parameters?
- Is the drift acceptable within the time frame required to move the MODU if required?

If the answer to these simple questions is, ‘no’ then the ice need only be monitored for any drift changes. If however, the answer is ‘yes’ then either a physical ice management procedure will be initiated or the facility will be secured and prepared for a possible move.

Physical Management

In general terms, most physical iceberg management consists of towing or deflecting the iceberg off its free drifting track or braking ice floes to a size acceptable to design of the facility. Iceberg towing strategies employed over this project will be the same as those used on the Grand Banks and off Labrador for the past 30 years.

Sea ice management procedures are well documented; breaking up sea ice to assist shipping is a commonplace occurrence in Canadian waters. Because of the loose nature of the pack in the area, sea ice management primarily consists of using support vessels to break up any large ice floes that meet or exceed the design limits of the facility. The exact procedures for detection, monitoring and mitigation will be described in the project’s ice management plan, which will be submitted for regulatory approval prior to the commencement of drilling.

Effects of the biological environment will be mitigated through regular inspections and cleaning and the use of C-NLOPB approved anti-fouling coatings, chemicals and techniques.

Ice Mitigations

The offshore industry, including Husky, mitigates the effects of wind, waves, and ice on project operations and safety through the state-of-the-art, site-specific forecasting by dedicated contractors. Husky Oil Operations Limited will use a three-fold strategy in avoiding or mitigating the potential effects of ice and icebergs:

1. Onboard environmental observer (s); and
2. Protocols that deal specifically with ice mitigations for a semi-submersible have been included in the Husky Ice Management Plan.

In summary, the Ice Management Plan involves describing three zones around the rig, in order of farthest from the rig:

1. Zone 3: Monitor--track and manage (potentially “tow”). There is no set size for this zone.
2. Zone 2: React--prepare for departure to designated safe area. The size of Zone 2 is partially defined by the “T-Time” (see below).
3. Zone 1: Alert—depart to designated safe area. The size of Zone 1 (one nmi or one hour drift) is the same for both rig types.

The size of the zones may vary depending upon the capabilities of individual rigs, perceived threats, weather conditions, and the drift and speed of the ice. The "T-Time" is the total time required to suspend operations, secure the well/work site and prepare the rig to move to a safe area. This T-Time is continually being updated by senior offshore management personnel. Evaluations are made on the "ice threat" based on calculation of size and type of ice and "closest point of approach." The semi-submersible has to retrieve anchors in order to move; they also have emergency shear links on anchor chains and are able to shear links and drop chains in an emergency. There are also procedures to evacuate personnel, if necessary.

4.7 Summary of Effects on the Project

A summary of the effects of the environment on the Project is contained in Tables 4.2 and 4.3. Geohazards will be mitigated by pre-project surveys. Weather and wave conditions affect every project on the Grand Banks to some degree. It is anticipated that these effects will be mitigated for the Project by operational scheduling for dredging within the May – September period and by state-of-the-art forecasting. The residual effects of wind, waves and weather are predicted to be adverse (i.e., in the form of delays) but *not significant*.

Any potential effects on the Project from icebergs can be mitigated by timing of specific operations outside of the iceberg season and by the Ice Management Plan described above such that residual effects will be *not significant*.

Physical effects of biofouling on infrastructure are monitored during annual or more frequent ROV facility integrity inspections. Biofouling is reduced to non-significance through the use of inspections, chlorination and biocides as per standard operating procedures.

Table 4.2 Interaction of the Environment with the Project.

Project Phase/Activity	Geohazards	Weather/Wind/Waves	Ice/Icebergs	Biofouling
Glory Hole Excavation and TGB Installation				
Dredge operation	x	x	x	-
Marine vessels	-	x	x	-
Helicopter flights	-	x	-	-
Drilling/Subsea Equipment Installation				
Supply boats	-	x	x	-
Helicopter flights	-	x		-
Rig operation (including mud storage; tankage and cooling systems)	x	x	x	x
VSP	x	x	x	-
Presence of structures	x	-	x	x
Operations				
FPSO Production Operations	-	-	-	-
Tankage & Cooling Systems	-	-	-	x
Supply boats	-	x	x	-
Helicopter flights	-	x	-	-

Table 4.3 Summary of Significance of Predicted Residual Effects of the Environment on the Project.

Effects of Environment on Project				
	Significance Rating	Level of Confidence	Likelihood	
Project Activity	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Glory Hole Excavation And TGB Installation	NS	3	-	-
Drilling/Subsea Equipment Installation	NS	3	-	-
FPSO Production Operations	NS	3	-	-

Comment No. 26: Effects assessment of environment on the Project

5.0 Biological Environment

5.1 Ecosystem

5.2 Sensitive/Special Areas

Comment No. 36: Quidi Vidi IBA map label

5.3 *SARA*-listed Species

Husky acknowledges the rarity of the species-at-risk and will continue to exercise due caution to minimize impacts on them during all its operations. Husky also acknowledges the possibility of other marine species being listed as endangered or threatened on Schedule 1 during the course of the Project. Due caution will also be extended to any other species added to Schedule 1 during the life of this Project.

Species		**COSEWIC**		
Common Name	**Scientific Name**	**Endangered**	**Threatened**	**Special Concern**
Fin whale (Atlantic population)	*Balaenoptera physalus*			X
Ivory Gull	*Pagophila eburnea*	X		

Comment No. 37: Ivory Gull listing

Comment No. 38: Fin whale and misspelling of scientific name for Ivory Gull

5.4 Plankton

5.5 Invertebrates and Fish

5.5.1 Marine Habitats

Text in EA remains the same.

5.5.2 Profiles of Commercially Important Species

5.5.2.2.4 Large Pelagics

Swordfish (*Xiphias gladius*) may feed in the Study Area during the summer months. Adults are opportunistic feeders, known to forage for their food from the surface to the bottom over a wide depth range. Its diet consists predominantly of fishes, supplemented by crustaceans and squid.. Swordfish do not spawn in the Study Area (FishBase 2006).

The various tuna species (*Thunnus* spp.) that may feed in the Study Area are also oceanic fish. Bluefin, yellowfin, albacore and skipjack tunas often occur in mixed schools during their feeding migrations. As with swordfish, tunas also feed predominantly on fishes and supplement this prey type with crustaceans and squid. None of these tuna species spawn within the Study Area (FishBase 2006).

Comment No. 39: Inconsistent level of detail re: large pelagics

5.5.3 Profiles of *SARA*- and COSEWIC-listed Fish

5.5.3.1 Wolffishes

Of the three wolffish species, northern wolffish is the deepest residing species and Atlantic wolffish is the shallowest residing species. Based on DFO trawl surveys in Newfoundland and Labrador waters between 1971 and 2003 (Kulka et al. 2004), northern wolffish were most concentrated during December to May in areas where depths ranged from 500 to 1,000 m, shifting to slightly shallower areas from June to November. Spotted wolffish concentrations were highest in areas with water depths ranging from 200 to 750 m at all times of the year, peaking in 300 m areas from June to November. Atlantic wolffish were most concentrated in areas with depths approximating 250 m at all times of the year.

Comment No. 40: Wolffish depth distributions

5.5.3.2 Atlantic Cod

In March 2003, the Fisheries Resources Conservation Council (FRCC) released some recommendations for the Northern Cod. For the bank sub-stocks, the Council recommended a higher level of protection than has been in place since commencement of the moratorium. In order to reduce by-catch mortality and disturbance to spawning and juvenile cod, the FRCC recommended the establishment of experimental 'cod boxes' in both the Hawke Channel and the Bonavista Corridor (Figure 5.1). The Hawke Channel is located approximately 120 nm northwest of the Bonavista Cod Box, just off the coast of Labrador. The FRCC recommended that these areas be protected from all forms of commercial fishery (except snow crab trapping) and other activity such as seismic exploration (www.frcc-ccrh.ca). Rose and Kulka (1999) also identified an area north of the Project Study Area where cod hyper-aggregated prior to the moratorium when it is assumed stock were at a low level. In light of the aggregation observed in this area, it may be an important area used by Atlantic cod.

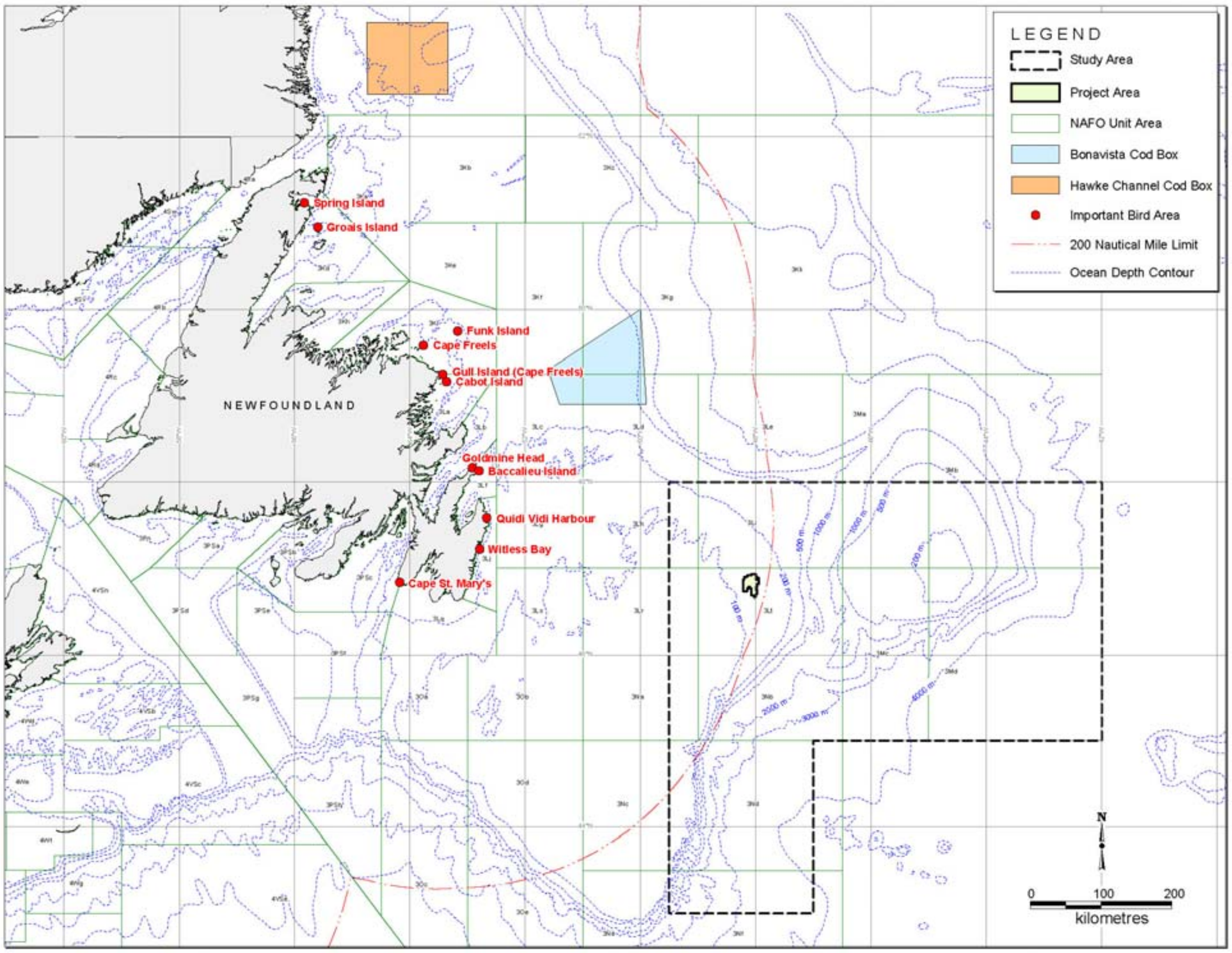

Figure 5.1. Locations of Bonavista Cod Box and Significant Seabird Breeding Colonies Relative to Project Area and Study Area.

Comment No. 41: Statement re: Northern cod by Brander (1994)

Comment No. 42: Rose and Kulka (1999) reference re: cod hyper-aggregation

Comment No. 43: Hawke Channel and Bonavista Corridor

5.5.3.3 Porbeagle Shark

Between March and July 2005, three DFO RAP meetings were held to assess the recovery potential of NAFO Subarea 3-6 porbeagle shark (O'Boyle 2005). DFO (2005) indicates that the porbeagle in the Northwest Atlantic can recover if human-induced mortality is sufficiently low. The only sources of human-induced mortality identified in DFO (2005) for incidental harm permitting are fisheries that capture this shark as bycatch.

Comment No. 44: Porbeagle shark

5.5.3.4 White Shark

White sharks are rare in Canadian waters and are recorded mostly in the Bay of Fundy area. They are extremely rare as far north as the White Rose area.

Comment No. 45: White shark

5.5.3.5 Shortfin Mako Shark

Shortfin mako sharks are commonly observed on the Grand Banks and in bays around Newfoundland.

5.5.3.6 Blue Shark

Blue sharks are commonly observed on the Grand Banks and in bays around Newfoundland.

Comment No. 46: Shortfin mako and blue sharks

5.5.3.7 Cusk

Cusk are at the extreme northern fringe of their range on the southern Grand Bank and would only occasionally occur in the White Rose area.

Comment No. 47: Cusk range

5.5.4 Invertebrate and Fish Spawning

Text in EA remains the same.

5.6 Commercial Fisheries

In this discussion of commercial fishing activities, a number of assessment and fisheries management areas are referenced. The Drill Centre Areas (the North, West, and South White Rose Extensions and North Amethyst) are the areas of proposed development, the Project Area is the area which contains the three new Drill Centre Areas and the current White Rose Project (Figure 1.2), and the Study Area contains all of the Northwest Atlantic Fisheries Organization (NAFO) Unit Areas (UAs) 3Li, 3Lt (Project Area within this UA), 3Mc, 3Md, 3Nb, 3Nf and portions of UAs 3Lh, 3Lr, 3Ma, 3Mb, 3Na and 3Nf (Figure 1.1). The Study Area is used to characterize regional historical fisheries for both foreign and domestic harvesters.

5.6.1 Information Sources

Fisheries-related information provided during the consultations is reported under the discussions of the commercial fisheries below, and any issues raised during the consultations are discussed in Section 6.0. The following fisheries agencies and industry stakeholders were consulted:

- Department of Fisheries and Oceans
- Environment Canada
- Natural History Society
- One Ocean
- FFAW
- Association of Seafood Producers
- Fishery Products International
- Clearwater Seafoods Limited Partnership
- Icewater Harvesting
- Groundfish Enterprise Allocation Council

5.6.2 Historical Overview

Figures 5.2 and 5.3 illustrate these changes in harvesting on the eastern Grand Banks since 1982. These graphs show catches for NAFO-regulated species by foreign and domestic harvesters, based on NAFO-supplied data. Figure 5.2 shows groundfish harvests (largely Atlantic cod, American plaice, capelin and redfish) over this 20-year period, and Figure 5.3 indicates shrimp catches. (Snow crab, presently another principal species harvested on the eastern Grand Banks and its slopes, is not managed by NAFO.). NAFO Unit Areas are indicated in Figure 5.1.

Comment No. 48: Mapping of NAFO Unit Areas

5.6.3 Study Area and Project Area Domestic Fisheries

5.6.3.3 Principal Species Fisheries

As indicated in the preceding tables, the domestic harvest within the Study Area has been almost exclusively shrimp, snow crab and offshore clams in recent years. This section describes these Study Area fisheries. In general, fisheries participants and DFO managers consulted expect the main 2006 fisheries in the Study and Project Areas will be similar to those of the past few years, and – as far as can be foreseen at this point - do not expect any major changes in fishing patterns or new fisheries in or near the Project Area in the near future.

Comment No. 49: Should date be 2005 or 2006?

The following figures have been revised to reflect the change in project area delineation.

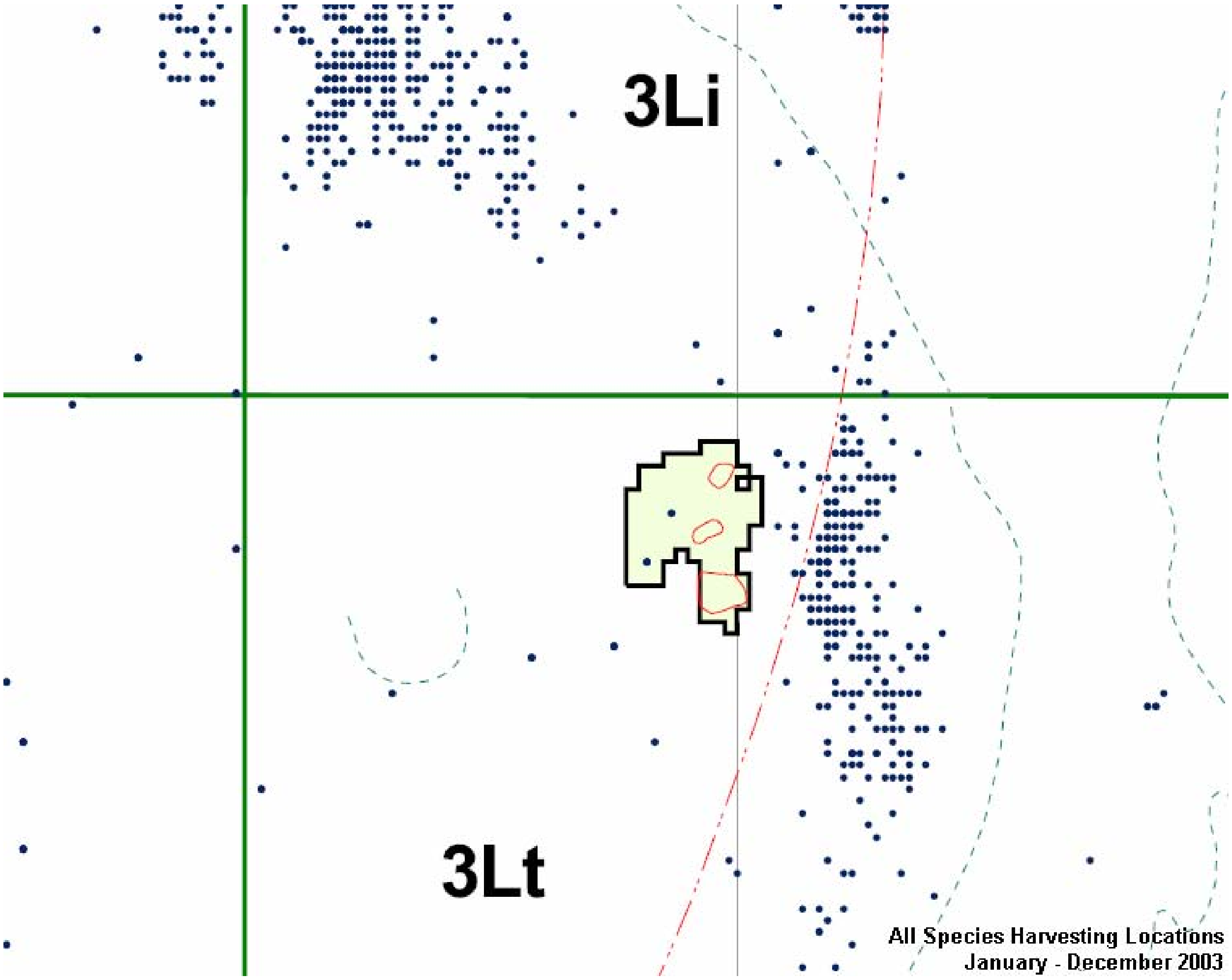

Figure 5.8 All Species Harvesting Locations (Project Area and Drill Centres) 2003.

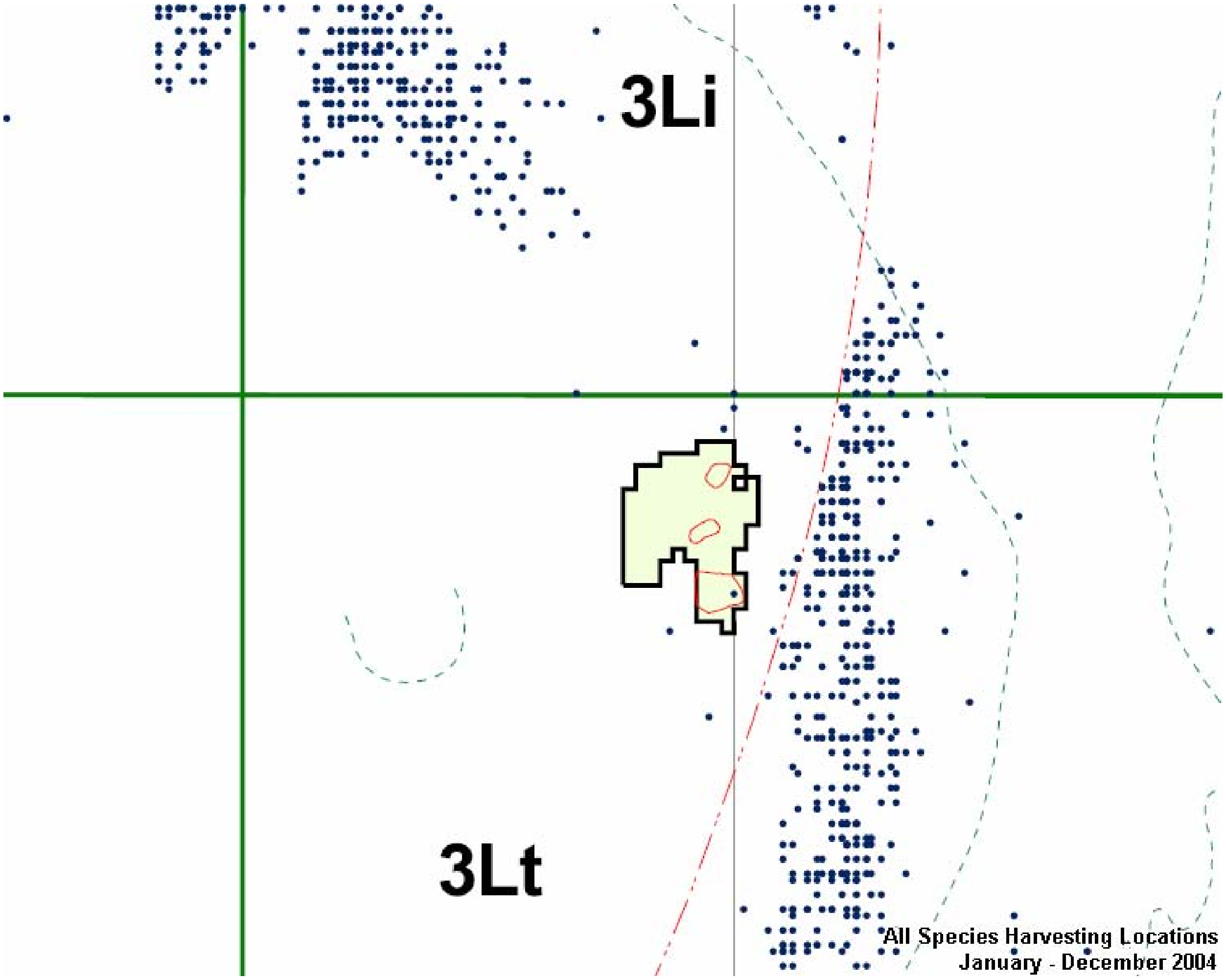

Figure 5.9. All Species Harvesting Locations (Project Area and Drill Centres) 2004.

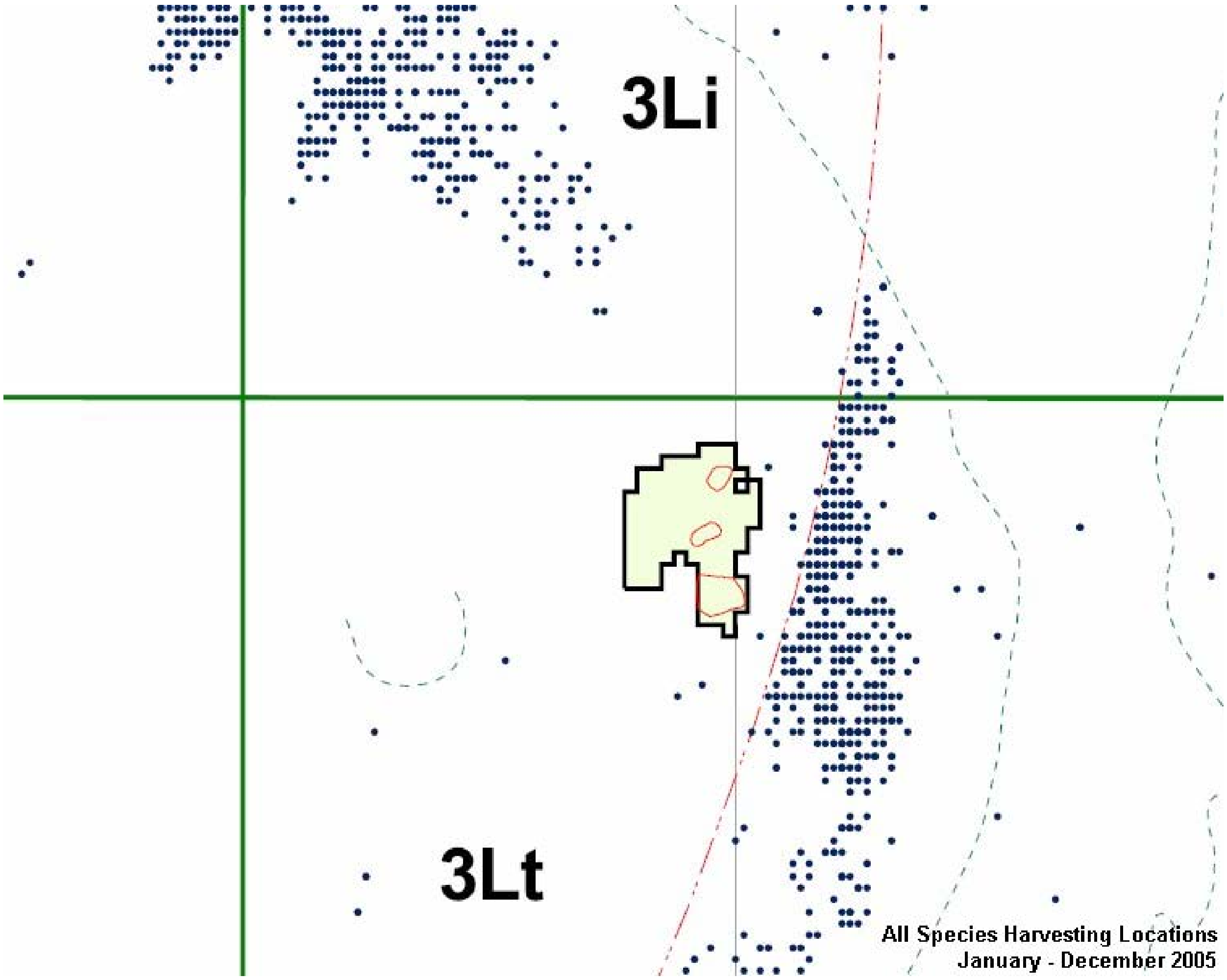

Figure 5.10 All Species Harvesting Locations (Project Area and Drill Centres) 2005.

5.6.4 DFO Science Surveys

Text in EA remains the same.

5.7 Marine Birds

Comment No. 50: PIROP spelled out

Comment No. 52: Reference for Figure 5.33

There is a pattern of increased bird numbers along the Continental Shelf edge on the northern and northeastern Grand Banks in the July to September and October to December period (Brown 1986; Lock et al. 1994) (Figure 5.33). Data from other seasons are incomplete but the shelf edge is probably important during all seasons.

The enormous numbers of nesting seabirds on the Avalon Peninsula illustrate the richness of the Grand Banks for seabirds. The seabird breeding colonies on Baccalieu Island, the Witless Bay Islands and Cape St. Mary's are among the largest in Atlantic Canada. More than 4.6 million pairs nest at these three locations (Table 5.9 and Figure 5.1). This includes the largest breeding colony of Leach's Storm-Petrel in the world (3,336,000 pair on Baccalieu Island), and the largest Atlantic Canada colonies of Thick-billed Murre (1,000 pair at Cape St. Mary's) and Atlantic Puffin (216,000 pair Witless Bay Islands). All these birds feed on the Grand Banks during the nesting season May to September. In addition, Funk Island located 150 km northwest of the Grand Banks supports the largest colony of Common Murre in Atlantic Canada. Many of these birds would reach the northern Grand Banks during the breeding season.

Comment No. 53: Interpretation of Figure 5.33 and Baccalieu Island

Comment No. 54: Incorrect table reference

An Important Bird Area (IBA) is a site that provides essential habitat for one or more species of breeding or non-breeding birds. There are nine seabird nesting sites on the southeast coast of Newfoundland from Cape Freels to the Burin Peninsula meeting the criteria for an IBA. (Figure 5.1 and Table 5.10). A grand total of 5.2 million pairs of birds breed at these sites. The Study Area is well beyond the foraging range of breeding birds during the breeding season, approximately May to August. At Witless Bay, Common Murres forage up to 200 km from the breeding site but usually only 50-100 km (Cairns et al. 1990, *in* Gaston and Jones 1998). However, during post-breeding dispersal the Study Area is within range of all seabirds breeding in eastern Newfoundland and Labrador. In addition, Grates Point, Mistaken Point and Placentia Bay qualify as IBAs because of significant wintering populations of Common Eider.

Comment No. 55: Suggested paragraph restructuring

Table 5.8. Bird Species Occurring in Study Area and Monthly Abundance.

Common Name	Scientific Name	Monthly Abundance											
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Procellariidae													
Northern Fulmar	*Fulmarus glacialis*	C	C	C	C	C	C	C	C	C	C	C	C
Cory's Shearwater	*Calonectris diomedea*							R	R	R			
Greater Shearwater	*Puffinus gravis*					C	C	C	C	C	C	U	
Sooty Shearwater	*Puffinus griseus*					S	U	U	U	U	U	S	
Manx Shearwater	*Puffinus puffinus*					S	S	S	S	S	S		
Hydrobatidae													
Wilson's Storm-Petrel	*Oceanites oceanicus*						S	S	S	S			
Leach's Storm-Petrel	*Oceanodroma leucorhoa*				C	C	C	C	C	C	C	R	
Northern Gannet	*Morus bassanus*				S	S	S	S	S	S	S		
Red Phalarope	*Phalaropus fulicarius*					S	S	S	S	S	S		
Red-necked Phalarope	*Phalaropus lobatus*					S	S	S	S	S			
Laridae													
Great Skua	*Stercorarius skua*					R	R	R	R	R	R		
South Polar Skua	*Stercorarius maccormicki*					R	R	R	R	R	R		
Pomarine Jaeger	*Stercorarius pomarinus*				S	S	S	S	S	S	S		
Parasitic Jaeger	*Stercorarius parasiticus*					S	S	S	S	S	S		
Long-tailed Jaeger	*Stercorarius longicaudus*					S	S	S	S	S	S		
Herring Gull	*Larus argentatus*	S	S	S	S	S	S	S	S	S	S	S	S
Iceland Gull	*Larus glaucoides*	R	R	R	R							R	R
Glaucous Gull	*Larus hyperboreus*	R	R	R	R							R	R
Great Black-backed Gull	*Larus marinus*	U	U	R	R	R	R	R	R	U	U	U	U
Ivory Gull	*Pagophila eburnea*		R	R									
Black-legged Kittiwake	*Rissa tridactyla*	C	C	C	C	C	S	S	S	S	C	C	C
Arctic Tern	*Sterna paradisaea*					S	S	S	S	S			
Alcidae													
Dovekie	*Alle alle*	U	U	U	U	R					U	U	U
Common Murre	*Uria aalge*	S	S	S	S	S	S	S	S	S	S	S	S
Thick-billed Murre	*Uria lomvia*	U	U	U	U	S					U	U	U
Razorbill	*Alca torda*				U	U	S	S	S	U	U	U	
Atlantic Puffin	*Fratercula arctica*				S	S	S	S	S	S	S	S	

Source: Brown (1986); Lock et al. (1994).

C = Common, U = Uncommon, S = Scarce, R = Rare occurrence. (Categories of relative abundances derived from Brown (1986), Lock (1994) and unpublished data

Comment No. 51: Missing scientific names in Table 5.8

5.7.1 Seasonal Abundance of Seabirds in the Study Area

5.7.1.2 Hydrobatidae (storm-petrels)

Comment No. 56: Incorrect spelling

5.7.1.6.1 Dovekie

Dovekies breed in the North Atlantic, primarily in Greenland and east Novaya Zemlya, Jan Mayen and Franz Josef Land in northern Russia.

Comment No. 57: Incorrect spelling

5.7.1.6.3 Thick-billed Murre

Thick-billed Murre is common in the Study Area between October and May.

Comment No. 58: Incorrect information for Thick-billed Murre

5.7.2 Prey and Foraging Habits

5.7.2.2 Hydrobatidae (storm-petrels)

Leach's and Wilson's Storm-Petrels feed on a variety small fish <100 mm long especially myctophids and various small crustaceans and gelatinous zooplankton. These storm-petrels usually feed while on the wing, picking small food items from the surface.

Comment No. 59: Additional information for Storm-Petrels

5.7.3 Ivory Gull

Comment No. 60: Reference to Species-at-Risk section for more information on Ivory Gull

5.8 Marine Mammals

The listing of the monitoring programs in Section 5.8 should read as follows:

1. Husky's 3D seismic program in Jeanne d'Arc Basin (Lang et al. 2006) where marine mammal observers (MMOs) conducted ~371 hours of observation along 2,859-km trackline from the M/V *Western Neptune* from 1 October to 8 November 2005. Most observations were made north of the Project Area (see Husky Seismic Area 2005 in Figure 5.34) as the seismic ship conducted its surveys primarily in EL1067, with the vessel making turns in EL1066 and 1089 (Figure 5.34). A total of 170 marine mammal sightings were made, totaling 530 individuals.

2. Observations conducted by a biologist aboard the CCGS *Hudson* as it sailed from Dartmouth, NS along the Scotian Shelf and the southern Grand Banks to the Orphan Basin (Lang and Moulton 2004). In total there were 61.7 h of observations along 485 km during 24 June to 7 July 2004. Of this effort, 25.5 h and 36.2 h occurred when the ship was stationary and moving, respectively. In total, there were 20 sightings of 116 marine mammals during systematic watches and incidentally.

3. Chevron Canada Resource's 3D seismic program in Orphan Basin where MMOs conducted 1,198 h of observation along 10,541 km from the SR/V *Veritas Vantage* from 26 June to 18 September 2004 (Moulton et al. 2005). In total, there were 151 sightings of 1,397 marine mammals during systematic watches from the *Vantage*.

4. Chevron Canada Limited's 3D seismic program in Orphan Basin where MMOs conducted 2,656 h of observation along 22,664 km from two seismic vessels (M/V *Geco Diamond* and *Western Patriot*) from 12 May to 10 October 2005 (Moulton et al. 2006b). In total, there were 409 sightings of 3,554 marine mammals during systematic watches.

Comment No. 61: Unfinished sentence

Table 5.10. Marine Mammals that are Known or Expected to Occur in the Study Area.

Common Name	Scientific Name	*SARA* Status	COSEWIC Status
Baleen Whales	**Mysticetes**		
Blue Whale	*Balaenoptera musculus*	Endangered (Schedule 1)	Endangered
Fin Whale	*Balaenoptera physalus*	No status; under consideration for addition to Schedule 1	Special Concern
Sei Whale	*Balaenoptera borealis*	Not listed	Data Deficient
Humpback Whale	Not listed	Not listed	Not At Risk
Minke Whale [a]	*Balaenoptera acutorostrata*	Not listed	Not Considered
North Atlantic Right Whale	*Eubalaena glacialis*	Endangered (Schedule 1)	Endangered
Toothed Whales	**Odontocetes**		
Sperm Whale	*Physeter macrocephalus*	Not listed	Not At Risk
Northern Bottlenose Whale	*Hyperoodon ampullatus*	Not listed	Not At Risk—Davis Strait Population
Sowerby's Beaked Whale	*Mesoplodon bidens*	Special Concern (Schedule 3)	Special Concern
Bottlenose Dolphin	*Tursiops truncatus*	Not listed	Not At Risk
Killer Whale	*Orcinus orca*	Not listed	Data Deficient
Long-finned Pilot Whale	*Globicephala melas*	Not listed	Not At Risk
Common Dolphin	*Delphinus delphis*	Not listed	Not At Risk
Atlantic White-sided Dolphin	*Lagenorhynchus acutus*	Not listed	Not At Risk
White-beaked Dolphin	*Lagenorhynchus albirostris*	Not listed	Not At Risk
Risso's Dolphin	*Grampus griseus*	Not listed	Not At Risk
Striped Dolphin	*Stenella coeruleoalba*	Not listed	Not At Risk
Harbour Porpoise	*Phocoena phocoena*	No status or schedule; referred back to COSEWIC	Special Concern
True Seals	**Phocids**		
Grey Seal	*Halichoerus grypus*	Not listed	Not At Risk
Harp Seal	*Phoca groenlandica*	Not listed	Not Considered
Hooded Seal	*Cystophora cristata*	Not listed	Not At Risk

Comment No. 62: Splitting columns in Table 5.10

5.8.1 Mysticetes

Text in EA remains the same.

5.8.2 Odontocetes

Text in EA remains the same.

5.8.3 Phocids

Text in EA remains the same.

5.8.4 Profiles of *SARA*- and COSEWIC-listed Marine Mammals

Text in EA remains the same.

6.0 Effects Assessment Methodology

6.1 Scoping

Text in EA remains the same.

6.2 Consultations

At each consultation meeting, Husky provided maps showing information available at the time on the proposed development of new drill centres. The information included the potential seafloor disturbance area related to the five proposed drill centres as well as the location of the spoils area where Husky proposes to dump the sediment removed during excavation of the glory holes.

The list of attendees is contained in Appendix 2.

Comment No. 63: Appendix 2 referred to but not in document

6.2.1 Issues and Concerns

Text in EA remains the same.

6.3 Valued Ecosystem Components (VECs)

6.3.1 Fish Habitat VEC

Text in EA remains the same.

6.3.2 Fish VEC

Text in EA remains the same.

6.3.3 Commercial Fishery VEC

Text in EA remains the same.

6.3.4 Marine Bird VEC

Text in EA remains the same.

6.3.5 Marine Mammal VEC

Text in EA remains the same.

6.3.6 Sea Turtle VEC

Text in EA remains the same.

6.3.7 Species-at-Risk VEC

Text in EA remains the same.

6.4 Other Issues

Text in EA remains the same.

6.5 Boundaries

6.5.1 Temporal

Effects of the routine activities associated with the development of as many as five new drill centres (i.e., pre-production) have been assessed 'year-round' for the period 2007-2016. Effects of activities associated with production operations using the new drill centres have been assessed 'year-round' for the period 2009-2020. Effects of routine activities related to abandonment have been assessed for after 2020. The potential effects of accidental events (i.e., blowouts and batch spills) have also been considered.

6.5.2 Spatial

6.5.2.1 Project Area

The Project Area is where Project activities will occur in any given year (Figure 1.1).

Comment No. 64: White Rose Operational Area

6.6 Effects Assessment Procedures

6.6.1 Identification and Evaluation of Effects

Text in EA remains the same.

6.6.2 Classifying Anticipated Environmental Effects

Text in EA remains the same.

6.6.3 Mitigation

Text in EA remains the same.

6.6.4 Application of Evaluation Criteria for Assessing Environmental Effects

Text in EA remains the same.

6.6.5 Cumulative Effects

Comment No. 65: Inclusion of aboriginal fisheries in cumulative effects

6.6.6 Integrated Residual Environmental Effects

Text in EA remains the same.

6.6.7 Significance Rating

Text in EA remains the same.

6.7 Monitoring/Follow-Up

Text in EA remains the same.

6.8 Effects of the Environment on the Project

Refer to response to Comment No. 26 – see Chapter 4.0.

Comment No. 66: More details on effect of environment on Project

7.0 Routine Project Activities

Table 7.1. Project Activity Table to Aid in Developing Frequency and Duration Ratings.

Project Phase/Activity	Frequency/Duration Base Case[a]	Maximum Number of Events	Maximum Total Duration[b,c] (months)
Glory Hole Excavation And TGB Installation			
Dredge operation	60 days	5 glory holes	10
Presence of structures	60 days	5 glory holes	10
Safety zone	60 days	5 glory holes	10
Lights	60 nighttime periods	5 glory holes	5
Deck drainage, bilge water, and ballast water[e]	60 days	5 glory holes	10
Sanitary or domestic waste water	60 days	5 glory holes	10
Routine air emissions	60 days - Dredger boats, helicopters	5 glory holes	10
Marine vessels	60 days	5 glory holes	10
Helicopter flights	54	5 glory holes	2-3
Geotechnical drilling	1 day	5 glory holes	<1
Drilling			
Presence of structures	60 days	54 wells	108
Safety zone	60 days	54 wells	108
Lights	60 nighttime periods	54 wells	54
Flaring	Periodic during testing	54 wells	N/A
Use of drilling muds[c]	40 days	54 wells	72
Cement	1	54 wells	N/A
BOP discharge[d]	Periodic during drilling by semi-submersible	54 wells	N/A
Cooling water	60 days	54 wells	108
Deck drainage, bilge water, and ballast water[e]	60 days	54 wells	108
Sanitary or domestic waste water	60 days	54 wells	108
Produced water	20 days	54 wells	36
Supply boat transits	18 trips	54 wells	8-9
Supply boat on standby	1 boat always on standby	54 wells	60
Helicopter flights	54 flights	54 wells	20-22
Rig operation	1 rig	54 wells	60
Air emissions (testing)	20 days testing	54 wells	36
Routine air emissions	60 days - Rig, boats, choppers	54 wells	60
VSP	2 days	54 wells	3-4

Table 7.1 (continued). Project Activity Table to Aid in Developing Frequency and Duration Ratings.

Project Phase/Activity	Frequency/Duration Base Case[a]	Maximum Number of Events	Maximum Total Duration[b,c] (months)
Subsea Production Equipment Installation			
Presence of structures	30 days	5 glory holes	5
Safety zone	30 days	5 glory holes	5
Lights	30 nighttime periods	5 glory holes	2.5
Deck drainage, bilge water, and ballast water[e]	30 days	5 glory holes	5
Oily residue discharge during tie-back	1 day	5 glory holes	<1
Sanitary or domestic waste water	30 days	5 glory holes	5
Routine air emissions	30 days - Boats, choppers	5 glory holes	5
Marine vessels	30 days	5 glory holes	5
Production Operations[e]			
Presence of structures	365 days/year	12 years	144
Safety zone	365 days/year	12 years	144
Lights	365 nighttime periods/year	12 years	72
Flaring	365 days/year	12 years	144
Cooling water	365 days/year	12 years	144
Deck drainage, bilge water, and ballast water[e]	365 days/year	12 years	144
Sanitary or domestic waste water	365 days/year	12 years	144
Produced water	365 days/year	12 years	144
Supply boat transits	182 days/year	12 years	72
Supply boat on standby	Nothing additional to existing traffic	12 years	144
Helicopter flights	Nothing additional to existing traffic	12 years	26
FPSO operation	365 days/year	12 years	144
Routine air emissions	365 days/year - FPSO, boats, helicopters	12 years	144
Abandonment			
Presence of structures	300 days	5 glory holes	50
Safety zone	300 days	5 glory holes	50
Well severance	1 day	5 glory holes	<1
Lights	300 nighttime periods	5 glory holes	25
Deck drainage, bilge water, and ballast water[e]	300 days	5 glory holes	50
Sanitary or domestic waste water	300 days	5 glory holes	50
Routine air emissions	300 days	5 glory holes	50
Marine vessels	300 days	5 glory holes	50
Helicopter flights[g]	30 days	5 glory holes	5

[a] Based on one event (i.e., single glory hole or well)
[b] Maximum duration of Drilling Phase is 60 months (i.e., concurrent drilling of some wells)
[c] Based on Husky estimate of total duration of each Project Phase
[d] As per regulation
[e] Frequent batch releases are likely.
[f] Note that most, if not all, production activities fall within the range of the original White Rose EA. They are included here to allow for "within project" cumulative effects assessment.
[g] Based on rationale that helicopter flights would only occur while FPSO on site (i.e., first month of abandonment)

Comment No. 69: Absence of activities in Table 7.1

Comment No. 70: Footnote 'b' in Table 7.1

Comment No. 71: Incorrect subheading in Table 7.1

Comment No. 67: Clarification of reversible effects on fish and fish habitat

Comment No. 68: Need for tie-back oily residue in assessment

7.1 Potential Zones of Influence

7.1.1 Safety Zone

Text in EA remains the same.

7.2 Sediment Excavation

Text in EA remains the same.

7.3 Lights and Flaring

Text in EA remains the same.

7.4 Drill Muds and Cuttings

The main component of SBM is a white synthetic-based oil called Pure Drill IA-35. This drilling fluid is used by all operators on the East Coast and has been demonstrated to be not acutely or chronically toxic through operator testing or through government testing (Payne et al., 2001a,b; Andrews et al. 2004). The other additives are primarily the same as WBM, mostly barite (weighting agent) with other additives.

Comment No. 72: Recommended reference change

Drilling muds and cuttings, and their potential effects were discussed in detail in the White Rose Oilfield Comprehensive Study (Husky 2000) and supplement (Husky 2001a), drilling EA update (Buchanan et al. 2003), and recent drilling EAs and updates for Husky (LGL 2002, 2005a, 2006a). Modeling of the fate of drill mud and cuttings discharges was conducted for the Comprehensive Study. It analyzed the effects of the discharge of drilling wastes from development drilling of 25 wells using SBM at multi-well drilling sites. The White Rose development drilling was deemed to create no significant effect on fish and fish habitat, the fishery, seabirds, marine mammals, or sea turtles. Additional relevant documents not available during the preparation of the White Rose Comprehensive Study include MMS (2000); CAPP (2001a,b), NEB et al. (2002), the White Rose baseline studies (Husky 2001b, 2003), Husky exploratory drilling EAs and updates (LGL 2002, 2003, 2005a, 2006a), the reviews of Buchanan et al. (2003), Hurley and Ellis (2004) and Neff (2005), and the Husky EEM reports (Husky 2005, 2006). All of these documents discuss the discharge of mud and cuttings and associated effects. These recent reports have further confirmed the conclusions of the White Rose work that routine drilling, particularly small scale drilling, has no significant effect on the marine environment of the Grand Banks. This conclusion is also supported by the studies carried out on fish health and fish habitat over a three year period at the Terra Nova site where six wells were drilled using a combination of water–based and synthetic based muds (Mathieu et al., 2005; Deblois et al., 2005).

Comment No. 73: Recommended additional references

7.4.1 Water-Based Muds

Text in EA remains the same.

7.4.2 Synthetic-Based Muds

Synthetic based muds or (SBM) include those whose base fluids are composed of synthetic hydrocarbons (olefins, paraffins, and esters) (OGP 2003). Their persistence is related to the physical conditions on and near the sea floor (e.g., re-suspension and transport, current velocity, sediment characteristics), re-working of sediments by burrowing biota and biodegradation of the base fluids. The specific rates of biodegradation of all the different formulations of SBM are mostly unknown under all environmental conditions but are known to be related to the type of base fluid, temperature, oxygen levels, the type of bacteria present (aerobic or anaerobic), the species of bacteria present, the history of the area *viz a viz* hydrocarbons, and the form, mass and topography of the material (OGP 2003; Roberts and Nguyen 2006). In general, biodegradation is expected to occur faster under aerobic conditions than anaerobic ones (OGP 2003).

Effects on benthic organisms may result from physical smothering or from the anoxic conditions created by the biodegradation which increases the oxygen demand in the sediments. Effects on benthic communities are not simply related to the rate of biodegradation. For example, esters have been found to biodegrade rapidly under laboratory conditions but to cause anoxia in the field whereas olefins which degrade slower may cause fewer effects on the benthos (Jensen et al. 1999 *in* OGP 2003).

A number of field and monitoring studies have been conducted that assessed the degradation rates of SBMs and the recovery rates of benthos [reviewed in Jensen et al. 1999 (Norwegian

North Sea); Neff et al. 2000 (UK North Sea); OGP 2003; Roberts and Nguyen 2006). Ester-based fluids generally biodegrade rapidly and the benthos is mostly recovered within 11 months. Studies on olefin-based fluids have been conducted under a wide variety of conditions with varying results but degradation and benthic recovery may take from several months to several years depending upon a wide variety of factors. In general, as many as three to five years could be required for benthos to recover fully after discharge of SBM (Neff et al. 2000). Results with paraffin-based fluids have been highly variable.

Researching the biodegradation rates of SBM in the field is a complex process because of the different formulations and mixtures used in addition to the wide variety of environmental conditions encountered. According to the above-mentioned reviews of information, simplified ideal conditions for biodegradation could be defined as:

- <u>Physical Conditions</u>
  - Small cuttings piles, thus increasing exposure to aerobic bacteria,
  - High energy seabed, thus creating dispersion and increased exposure to aerobic conditions, and
  - High temperature [Bacterial activity is often related to temperature and thus it is reasonable to assume higher rates of biodegradation at higher temperatures. Note, however, that biodegradation of at least certain types of SBM appears to occur relatively rapidly in the deepwater of the Gulf of Mexico which is on the order of 4ºC. Also, very rapid biodegradation can cause anoxia which could slow down degradation. Pressure appears to have no effect on degradation rates—Roberts and Nguyen 2006.].
- <u>Biological Conditions</u>
  - High rate of bioturbation (e.g., by burrowing species),
  - Aerobic conditions (i.e., oxygenated sediments) [Aerobic degradation is usually faster than anaerobic. Aerobic biodegradation requires oxygen as an electron acceptor whereas anaerobic biodegradation mostly uses sulphate, or carbon dioxide in the absence of sulfate—Roberts and Nguyen 2006. Both types of biodegradation probably occur in the typical situation involving SBM and cuttings piles.],
  - Presence of hydrocarbon-degrading bacteria (e.g., Pseudomanoas spp., and others), and
  - Previous exposure of the area to similar types of hydrocarbons which appears to reduce the lag time.

Comment No. 74: Biodegradation of synthetic-based muds

7.5 Noise

Comment No. 75: Supply boat sound levels in Table 7.4

Comment No. 76: Dynamic positioning thruster sound levels in Table 7.4

7.6 Potential Effects of Routine Activities

7.6.1 Fish Habitat

7.6.1.1 Presence of Structures

Text in EA remains the same.

7.6.1.2 Sediment Excavation

Considering the relatively small area of each glory hole (maximum 70 m x 70 m floor dimension equivalent to <0.0002 % of Project Area), the reuse of the original spoil area for sediment deposition, and the sandy nature of the sediment minimizing the amount and duration of sediment suspension in the water column, the magnitude, geographic extent and duration of the potential effects of sediment excavation on the fish habitat VEC are *low*, *<1 km*^{2}, and *1-12 months* (2 months per glory hole; 10 months maximum), respectively (Table 7.6). Based on these criteria evaluations, the potential residual effects of sediment excavation on the fish habitat VEC are *not significant* (Table 7.7).

7.6.1.5 Drill Muds and Cuttings

Benthic community analyses were performed during the Husky EEM Program in 2004 and 2005 (Husky 2005, 2006). In 2004, there were indications of lower abundance of amphipods near the Southern and Northern drill centres. In 2005, total abundance and dominance of polychaetes appeared to be affected by drilling activity at the Southern drill centre. Both parameters increased significantly with increasing distance from the drill centre. Amphipod abundance was reduced near all drill centres in 2005. All of these abundance and dominance differences appear to be associated with hydrocarbon concentrations in the sediment. However, the significance of these benthic community observations does not imply that effects of the White Rose development are greater than at other development sites. In fact, many effects on benthic communities observed at other development areas have not been observed at White Rose. Examples include decreases in benthos diversity in the North Sea (Kingston 1992), and reduction in benthos richness in the Gulf of Mexico (Peterson et al. 1996). Other examples are discussed in Husky (2006).

Comment No. 77: Development project effects on benthic communities

7.6.1.5.5 Cumulative Effects

A maximum of 54 wells would be drilled during the Drilling Phase, all within the constructed glory holes. If all 54 wells are drilled during the 60 month period, there would likely be the occurrence of concurrent drilling in different glory holes. Assuming 500 m as the radius of each well's biological zone of influence (ZOI) (i.e., potential smothering due to a minimum of one centimetre thickness of deposited cuttings and mud) and given that the floor dimension of each glory hole will be 70 m x 70 m, there would be essentially 100% overlap of the ZOIs of adjacent wells within a single glory hole. Therefore, the ZOI associated with each glory hole would have an area of approximately 0.78 km^2. The total area of ZOI for all five proposed glory holes will be approximately 3.9 km^2, equivalent to <1% of the area of the Project Area. Including the ZOIs of the 19 wells in the existing three glory holes increases the total ZOI area to 6.24 km^2, equivalent to <1.6% of the area of the Project Area. Since the wells will be drilled on the floor portion of each glory hole which is approximately 11 m below the surface of the ocean substrate, it is likely that much of the mud and cuttings deposition will occur within the glory holes (136 m x 136 m including sloped ramps), areas already subjected to HADD. Deposition from adjacent wells in any single glory hole will accumulate vertically (i.e., overlap of individual well biological ZOIs). Given the almost complete overlap of well ZOIs in each glory hole, the occasional occurrence of concurrent drilling is insignificant in terms of cumulative effects.

Comment No. 78: Cumulative effects

7.6.1.6.9 Produced Water

While produced water is infrequently an issue during drilling activities, it is a primary waste associated with production activities. As stated in Husky (2000), the most toxic components of produced water are the volatile hydrocarbon aromatics: benzene, toluene, ethlybenzene, xylene and polyaromatic hydrocarbons (PAHs). All but the PAHs evaporate quickly. Therefore, the more persistent PAHs would likely be responsible for any biological effects near produced water outfalls. As indicated in Section 3.9.2.2.1, produced water will be treated to reduce the oil content to 30 mg/L or less averaged over a 30-d period and subsequently discharged. Hydrocarbon concentrations in produced waters are typically less than the 96-h LC_{50} levels for most species and are not of ecotoxicological concern (GESAMP 1993 *in* Husky 2000). Most discharge will occur during production activities with minimal discharge during development drilling. More information relating to acute and chronic effects of exposure to produced water on marine organisms is presented in Husky (2000).

Comment No. 8: Produced water

7.6.1.6.11 Oily Residue Discharge During Tie-back

Development of the new drill centres may entail tying back to the FPSO through existing drill centres via new production flowlines or the new drill centres may be tied back directly to the SeaRose FPSO. In the event that new drill centres are tied back through existing drill centres, it will be necessary to disconnect valves and sections of pipework from the subsurface manifolds in the existing drill centres. Prior to disconnection of the existing manifold pipework, the complete drill centre production flowline system will be depressurized and all production fluids (i.e., oil and gas) will be flushed from the manifold and flowline system using a pig train driven by water from the FPSO. To assist in the removal of oil emulsions from the surface of the flowline and manifold pipework, a dilute surfactant if necessary may be added to the water during the flushing operation. Any chemicals used during the process will be screened through the Offshore Chemical Screening System.

Despite the flushing operations, small amounts of oil may remain trapped in the flowline carcass and manifold piping cavities due to the nature of the flexible flowlines and the intricacies of the manifold pipework. As a result, once the pipework section is removed by divers, a small amount of oily residue may be released to the environment. The pipework will be open for approximately two to four hours until the replacement pipe spools are connected to the exposed manifold flanges. The amount of oily residue released is not anticipated to exceed 0.3 m^3.

Considering the relatively small amount of oily residue discharged (approximately two barrels) and the infrequency of discharge, the effects of oily residue discharge on fish habitat would be *negligible* in magnitude, *<1 km^2* in geographic extent and *>72 months* in duration. This results in a rating of the residual effects of oily residue discharge on fish habitat of *not significant*.

Comment No. 22: Oily residue discharge during tie-back

7.6.1.7 Atmospheric Emissions

The air emissions of offshore drilling activities are within range of those from fishing vessels, tanker traffic, and military vessels that routinely transit eastern Canadian waters. Worldwide, offshore drilling probably accounts for a very small portion of photochemical pollutants, reactive hydrocarbons, NO_x emissions, inert pollutants or volatile organic compounds (VOC's) (e.g., CO, NO_2, SO_2, particulates), greenhouse gases (carbon dioxide, methane, nitrogen dioxide), ozone, water vapour, and halocarbons compared to other industries and particularly personal automobile use.

The offshore environment is windy and air emissions disperse quickly from the installations, which alleviates safety concerns. Equipment will be similar in emissions to other industrial equipment in routine use, will be within the range of what is occurring now offshore, and mitigations will be employed. State of the art safety equipment and procedures, including breathing apparatus will be available to offshore workers, as appropriate.

In summary, the proposed Project will not unduly add to air emissions; VOC's or greenhouse gases, and will not endanger the health and safety of offshore workers or the marine environment. Given the rapid dispersal offshore, there will be no cumulative effects associated with other projects. The effects of the Project, including cumulative effects on air quality will be *not significant*.

Comment No. 79: Greenhouse gas emissions

Comment No. 80: Air emissions

7.6.1.12 Geotechnical Surveying

Geotechnical surveying could potentially result in the disruption of small areas of the substrate. It is likely that these disrupted areas would occur within the area designated for glory hole excavation (Section 7.6.1.2).

7.6.2 Fish

7.6.2.2 Sediment Excavation

Considering the relatively small area of each glory hole (maximum 70 m x 70 m floor dimension equivalent to < 0.0002 % of Project Area) and the spoils site, as well as the sandy nature of the sediment which minimizes the amount and duration of sediment suspension in the water column, the magnitude, geographic extent and duration of the potential effects of sediment excavation on fish are *low*, *<1 km*^{2}, and *1-12 months* (2 months per glory hole; 10 months maximum), respectively (Table 7.9). Based on these criteria evaluations, the potential residual effects of sediment excavation on the fish VEC is *not significant* (Table 7.10).

7.6.2.6.9 Produced Water

While produced water is rare during drilling activities, it is a primary waste associated with production activities. As stated in Husky (2000), the most toxic components of produced water are the volatile organic compounds: benzene, toluene, ethlybenzene, xylene and polyaromatic hydrocarbons (PAHs). All but the PAHs evaporate quickly. Therefore, the more persistent PAHs would likely be responsible for any biological effects near produced water outfalls. As indicated in Section 3.9.2.2.1, produced water will be treated to reduce the oil content to 30 mg/L or less averaged over a 30-d period and subsequently discharged. Hydrocarbon concentrations in produced waters are typically less than the 96-h LC_{50} levels for most species and are not of ecotoxicological concern (GESAMP 1993 *in* Husky 2000). Most discharge will occur during production activities with minimal discharge during development drilling. More information relating to acute and chronic effects of exposure to produced water on marine organisms is presented in Husky (2000).

Comment No. 8: Produced water

7.6.2.6.11 Oily Residue Discharge During Tie-back

Development of the new drill centres may entail tying back to the FPSO through existing drill centres via new production flowlines or the new drill centres may be tied back directly to the SeaRose FPSO. In the event that new drill centres are tied back through existing drill centres, it will be necessary to disconnect valves and sections of pipework from the subsurface manifolds in the existing drill centres. Prior to disconnection of the existing manifold pipework, the complete drill centre production flowline system will be depressurized and all production fluids (i.e., oil and gas) will be flushed from the manifold and flowline system using a pig train driven by water from the FPSO. To assist in the removal of oil emulsions from the surface of the flowline and manifold pipework, a mild detergent may be added to the water during the flushing operation. Any chemicals used during the process will be screened through the Offshore Chemical Management System.

Despite the flushing operations, small amounts of oil may remain trapped in the flowline carcass and manifold piping cavities due to the nature of the flexible flowlines and the intricacies of the manifold pipework. As a result, once the pipework section is removed by divers, a small amount of oily residue may be released to the environment. The pipework will be open for approximately 2 to 4 hours until the replacement pipe spools are connected to the exposed manifold flanges. The amount of oily residue released is not anticipated to exceed 0.3 m^3.

Considering the relatively small amount of oily residue discharged (approximately two barrels) and the infrequency of discharge, the effects of oily residue discharge on the fish VEC would be *negligible* in magnitude, *<1 km*^{2} in geographic extent and *>72 months* in duration. This results in a rating of the residual effects of oily residue discharge on the fish VEC of *not significant*.

Comment No. 22: Oily residue discharge during tie-back

Comment No. 81: Small transfer spills and BOP fluids in Table 7.9

Comment No. 82: Safety zones as safe havens for fish

Comment No. 83: Frequency of small spills and associated negligible effect

Comment No. 84: Flaring of produced water from production

Comment No. 85: Frequency of ROV work

7.6.2.10 Noise

Another potential source of noise is geotechnical surveying during the Glory Hole excavation Phase of the Project. Surveys would be brief relative to other noise sources associated with the Project.

7.6.3 Commercial Fisheries

7.6.3.1 Presence of Structures

The potential size of the safety zone should all five drill centres be developed will be approximately 114 km^2.

7.6.3.2 Sediment Excavation

Thus the magnitude of the potential effects of sediment excavation on harvesting is *negligible*. The geographic extent will be *<1 km^2*; the duration *1-12 months* (2 months per glory hole; 10 months maximum) (Table 7-12). Based on these criteria, the potential effects of sediment excavation on the commercial fisheries VEC are *not significant* (Table 7-13).

Comment No. 86: Potential effects on species under moratorium

7.6.4 Marine Birds

7.6.4.4 Flaring

There is potential for flaring to interact with marine birds during the Drilling and Production Operations Phases of the Project (Table 7.14). While this activity is relatively infrequent and short duration on a per event basis during the Drilling Phase, flaring during the Production Operations Phase is continuous. Based on the worst-case scenario of this activity during the Production Operations Phase, the effects of flaring on marine birds are expected to be *low* in magnitude, *1-10 km^2* in geographic extent and *>72 months* in duration (Table 7.15), resulting in a rating of the residual effects of flaring on marine birds of *not significant* (Table 7.16). Cumulative effects associated with other projects/activities on the Grand Banks are likely not large enough to cause a change in the significance rating.

Comment No. 89: Flaring during drilling vs. production

7.6.4.14 Monitoring and Follow-up

Handling and release of any stranded Leach's Storm-Petrels will be in accordance with Husky protocols that are on file with CWS and are similar to those developed by Petro-Canada. Husky will obtain the appropriate bird handling permits for new vessels or facilities associated with the Project.

Comment No. 91: Suggested wording change

Comment No. 87: Storm-petrels vs. Storm-Petrels

Comment No. 88: Attraction of birds to lights

Comment No. 90: CWS pelagic seabird monitoring protocol

Comment No. 92: Seabird and marine mammal observation program

7.6.5 Marine Mammals

7.6.5.2 Sediment Excavation

The magnitude, geographic extent and duration of the potential effects of sediment excavation on the marine mammal VEC are *negligible* to *low*, *<1* km^2, and *1-12 months* (2 months per glory hole; 10 months maximum total), respectively (Table 7-17). Based on these criteria evaluations, the potential effects of sediment excavation on the marine mammal VEC is *not significant* (Table 7-18).

Comment No. 93: Ship strikes and noise

Comment No. 94: BOP frequency in Table 7.17

7.6.5.8 Noise

Another potential source of noise is geotechnical surveying during the Glory Hole excavation Phase of the Project. Surveys would be brief relative to other noise sources associated with the Project.

Comment No. 95: Noise and mitigation measures for marine mammals and sea turtles

Comment No. 96: Reference needed

Comment No. 97: Suggested reference

7.6.6 Sea Turtles

Comment No. 93: Ship strikes and noise

7.6.6.1 Hearing Abilities of Sea Turtles

Another potential source of noise is geotechnical surveying during the Glory Hole excavation Phase of the Project. Surveys would be brief relative to other noise sources associated with the Project.

7.6.7 Species-at-Risk

As indicated in Section 5.3, five marine animal species that potentially occur in the Study Area are listed as either endangered or threatened on Schedule 1 of *SARA* (i.e., officially 'at risk' according to Canadian law). They are as follows:

- Blue whale;
- North Atlantic right whale;
- Leatherback sea turtle;
- Northern wolfish; and
- Spotted wolfish.

Two marine species are also listed as special concern on Schedule 1 of *SARA*. They are as follows:

- Ivory Gull; and
- Atlantic wolfish.

Potential interactions of the routine activities associated with the Project and the seven marine species presently listed on Schedule 1 of *SARA* are indicated in Table 7.21.

Table 7.21. Potential Interactions of Routine Activities and Species-at-Risk that Could Occur in the Study Area.

Valued Ecosystem Component: Species-at-Risk					
Project Activity	**Project Phase[a]**	**Wolffishes**	**Ivory Gull**	**Blue whale; North Atlantic right whale**	**Leatherback sea turtle**
Presence of Structures					
Safety Zone	1,2,3,4,5	x		x	x
Artificial Reef Effect	1,2,3,4,5	x	x	x	x
Sediment Excavation					
Removal	1	x		x	x
Deposition	1	x		x	x
Lights	1,2,3,4,5	x	x	x	x
Flaring	2,4	x	x		
Drill Mud/Cuttings					
Water-based Muds	2	x	x	x	x
Synthetic-based Muds	2	x	x	x	x
Other Fluids/Solids[b]					
Cement	2	x		x	x
BOP Fluid	2	x	x	x	x
Cooling Water	2,4	x	x	x	x
Deck Drainage	2,4	x	x	x	x
Bilge Water	2,4	x	x	x	x
Ballast Water	Not applicable				
Sanitary/Domestic Waste Water	2,4	x	x	x	x
Small Transfer Spills	2,4	x	x	x	x
Oily Residue Discharge	3	x			
Produced Water[c]	2,4	x			
Garbage[d]	Not applicable				
Atmospheric Emissions	1,2,3,4,5		x	x	x
Ships and Boats	1,2,3,4,5		x	x	x
Helicopters	1,2,3,4,5		x		
Noise					
Dredge	1	x	x	x	x
Geotechnical Survey	1	x	x	x	x
Drilling Rigs	2	x	x	x	x
Support Vessels	1,2,3,4,5	x	x	x	x
Helicopters	1,2,3,4,5		x	x	x
FPSO	4	x	x	x	x
VSP	2	x	x	x	x
Underwater Maintenance	1,2,3,4	x			
Shore Facilities[e]	Not applicable				

Table 7.21 Continued.

Valued Ecosystem Component: Species-at-Risk					
Project Activity	**Project Phase**[a]	**Wolffishes**	**Ivory Gull**	**Blue whale; North Atlantic right whale**	**Leatherback sea turtle**
Other Projects/Activities					
Hibernia		x	x	x	x
Terra Nova		x	x	x	x
White Rose		x	x	x	x
Exploration		x	x	x	x
Fisheries		x	x	x	x
Hunting		x			
Marine Transportation		x	x	x	x

[a] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment
[b] Effects assessment of offshore accidental events (i.e., blowouts, spills) is in Section 8
[c] Produced water associated with well testing may be flared
[d] All garbage will be brought to shore
[e] Existing onshore infrastructure will be used

7.6.7.1 Wolffishes

Table 7.21 indicates the potential interactions of routine activities associated with the proposed drill centre development and production Project and wolffishes. Assessment of the effects of these interactions is presented in Table 7.22. Rationale for the assessment is provided in Section 7.6.2 where effects of routine activities on the fish VEC are discussed. Routine activities for which effects assessment was conducted include the following: (1) presence of structures, (2) sediment excavation, (3) lights and flaring, (3) discharge of drilling muds and cuttings, (4) discharge of other fluids and solids, (5) presence of ships and boats, (6) presence of helicopters, (7) sound produced by drill rigs, supply vessels, aircraft and seismic arrays, (8) underwater installation and maintenance, and (9) shore-based facilities.

Some of the potential effects mitigations indicated in Table 7.22 for wolffishes include the following: (1) recycling of drilling mud, (2) use of low toxicity additives and mud systems, (3) treatment and discharge of cuttings, (4) recycling and/or treatment of other waste fluids and solids, (5) ramp up/delay of ramp up/shutdown of seismic array, and (6) temporal and spatial avoidance of critical habitats.

Table 7.22. Environmental Effects Assessment of Potential Effects of Routine Activities on Northern Wolffish, Spotted Wolffish, and Atlantic Wolffish.

Valued Environmental Component: Wolffishes									
				Evaluation Criteria for Assessing Environmental Effects					
Project Activity	Project Phase[a]	Potential Positive (P) or Negative (N) Environmental Effect	Mitigation	Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Presence of Structures									
Safety Zone	1,2,3,4,	Safe Refuge from Fishing (P)	-	1	2	6	5	R	2
Artificial Reef Effect	1,2,3,4,5	Increased Food and Shelter (P)	-	1	2	6	5	R	2
Sediment Excavation									
Removal	1	Suspension of Sediment (N)	-	1	1	1	2	R	2
Deposition	1	Suspension of Sediment (N)	-	1	1	1	2	R	2
Lights	1,2,3,4,5	Attraction (N)	-	0	2	5	5	R	2
Flaring	2,4	Attraction (N)	-	0	2	5	5	R	2
Drill Mud/Cuttings									
Water-based Muds	2	Contamination (N)	Recycle mud; and discharge cuttings	1	1	6	4	R	2
Synthetic-based Muds	2	Contamination (N)	Recycle mud; Treat muds and discharge cuttings	1	1	6	4	R	2
Other Fluids/Solids									
Cement	2	Disruption of Substrate (N) Artificial Reef Effect (P)		0	1	1	5	R	2
BOP Fluid	2	Contamination (N)	Selection criteria	0	1	1	4	R	2
Cooling Water	2,4	Shock (N) Growth (P)	Monitor	0	1	6	5	R	2
Deck Drainage	2,4	Contamination (N)	Treatment	0	1	5	5	R	2
Bilge Water	2,4	Contamination (N)	Treatment	0	1	5	5	R	2
Ballast Water	N/A								
Sanitary/Domestic Waste Water	2,4	Contamination (N) Nutrient Source (P)	Treatment	0	1	5	5	R	2
Small Transfer Spills	2,4	Contamination (N)	Safe handling practices; Cleanup protocols	0	1	2	5	R	2

Table 7.22 Continued.

Oily Residue Discharge	3	Contamination (N)	Maximize flowline flushing	0	1	1	4	R	2
Produced Water[b]	2,4	Contamination (N)	Treatment	0	1	5	5	R	2
Garbage[c]	N/A								
Atmospheric Emissions	1,2,3,4,5	Contamination (N)	Equipment design	0	2	6	5	R	2
Ships and Boats	1,2,3,4,5	No interaction	-	-	-	-	-	-	-
Helicopters	1,2,3,4,5	No interaction	-	-	-	-	-	-	-
Noise									
Dredge	1	Disturbance (N)	-	1	2-3	6	2	R	2
Geotechnical Survey	1	Disturbance (N)	-	1	2-3	6	1	R	2
Drilling Rigs	2	Disturbance (N)	-	1	2-3	6	4	R	2
Support Vessels	1,2,3,4,5	Disturbance (N)	-	1	2-3	6	5	R	2
Helicopters	1,2,3,4,5	Disturbance (N)	-	0	1	4	5	R	2
FPSO	4	Disturbance (N)	-	1	2-3	6	5	R	2
VSP	2	Disturbance (N) Physical (N)	Source level selection; Temporal avoidance of sensitive times; Ramp up	1	1-4	1	1	R	2
Underwater Maintenance	1,2,3,4	Disturbance (N)	Material and method selection	1	1	1	1	R	2
Shore Facilities[d]	N/A		-						

Magnitude
0 = Negligible
1 = Low
2 = Medium
3 = High

Geographic Extent
1 = < 1 km^2
2 = 1-10 km^2
3 = 11-100 km^2
4 = 101-1,000 km^2
5 = 1,001-10,000 km^2
6 = > 10,000 km^2

Frequency
1 = < 11 events/year
2 = 11-50 events/year
3 = 51-100 events/year
4 = 101-200 events/year
5 = > 200 events/year
6 = continuous

Duration
1 = < 1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = > 72 months

Reversibility (population level)
R = Reversible
I = Irreversible

Ecological/Socio-Cultural and Economic Context
1 = Relatively pristine area or area not negatively affected by human activity
2 = Evidence of existing negative anthropogenic effects

[a] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment

[b] Produced water associated with well testing may be flared

[c] All garbage will be brought to shore

[d] Existing onshore infrastructure will be used

The residual environmental effects of each of these routine drilling activities on wolffishes were predicted to be *not significant* (Tables 7.23).

Table 7.23. Significance of Predicted Residual Environmental Effects of Routine Activities on Northern Wolffish, Spotted Wolffish, and Atlantic Wolffish.

Valued Environmental Component: Wolffishes					
Project Activity	**Project Phase**[a]	**Significance of Predicted Residual Environmental Effects**		**Likelihood**[b]	
		Significance Rating	**Level of Confidence**	**Probability of Occurrence**	**Scientific Certainty**
Presence of Structures					
Safety Zone	1,2,3,4,5	P	3	-	-
Artificial Reef Effect	1,2,3,4,5	P	3	-	-
Sediment Excavation					
Removal	1	NS	3	-	-
Deposition	1	NS	3	-	-
Lights	1,2,3,4,5	NS	3	-	-
Flaring	2,4	NS	3	-	-
Drill Mud/Cuttings					
Water-based Muds	2	NS	3	-	-
Synthetic-based Muds	2	NS	3	-	-
Other Fluids/Solids					
Cement	2	NS	3	-	-
BOP Fluid	2	NS	3	-	-
Cooling Water	2,4	NS	3	-	-
Deck Drainage	2,4	NS	3	-	-
Bilge Water	2,4	NS	3	-	-
Ballast Water	N/A				
Sanitary/Domestic Waste Water	2,4	NS	3	-	-
Small Transfer Spills	2,4	NS	3	-	-
Oily Residue Discharge	3	NS	3	-	-
Produced Water[c]	2,4	NS	3	-	-
Garbage[d]	N/A			-	-
Atmospheric Emissions[e]	1,2,3,4,5	NS	3	-	-
Ships and Boats	1,2,3,4,5	NS	3	-	-
Helicopters	1,2,3,4,5	NS	3	-	-
Noise					
Dredge	1	NS	3	-	-
Geotechnical Survey	1	NS	3	-	-
Drilling Rigs	2	NS	3	-	-
Support Vessels	1,2,3,4,5	NS	3	-	-
Helicopters	1,2,3,4,5	NS	3	-	-
FPSO	4	NS	3	-	-
VSP	2	NS	3	-	-

Table 7.23 Continued.

Valued Environmental Component: Wolffishes					
Project Activity	**Project Phase[a]**	**Significance of Predicted Residual Environmental Effects**		**Likelihood[b]**	
		Significance Rating	**Level of Confidence**	**Probability of Occurrence**	**Scientific Certainty**
Underwater Maintenance	1,2,3,4	NS	3	-	-
Shore Facilities[f]	N/A				

Significance Rating (significance is defined as a medium or high magnitude (2 or 3 rating) and duration > 1 year (≥ 3 rating) and geographic extent > 100 km² (≥ 4 rating)
NS = Not significant negative environmental effect
S = Significant negative environmental effect
NS = Not significant negative environmental effect
P = Positive environmental effect

Level of Confidence (professional judgement)
1 = Low level of confidence
2 = Medium level of confidence
3 = High level of confidence

Probability of Occurrence (professional judgement)
1 = Low probability of occurrence
2 = Medium probability of occurrence
3 = High probability of occurrence

Level of Scientific Certainty (based on scientific information and statistical analysis or professional judgement)
1 = Low level of scientific certainty
2 = Medium level of scientific certainty
3 = High level of scientific certainty

[a] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment
[b] Only considered in the event of significant (S) residual effect
[c] Produced water associated with well testing may be flared
[d] All garbage will be brought to shore
[e] Includes produced water which may be flared
[f] Existing onshore infrastructure will be used

7.6.7.2 Ivory Gull

Table 7.21 indicates the potential interactions of routine activities associated with the proposed drill centre development and production Project and the Ivory Gull. Assessment of the effects of these interactions is presented in Table 7.24. Rationale for the assessment is provided in Section 7.6.4 where effects of routine activities on the marine bird VEC are discussed. Routine activities for which effects assessment was conducted include the following: (1) presence of structures, (2) sediment excavation, (3) lights and flares, (4) discharge of drilling muds and cuttings, (5) discharge of other fluids and solids, (6) presence of ships and boats, (7) presence of helicopters, (8) sound produced by drill rigs, supply vessels, aircraft and seismic arrays, (9) underwater installation and maintenance, and (10) shore-based facilities.

Table 7.24. Environmental Effects Assessment of Potential Effects of Routine Activities on the Ivory Gull.

Valued Environmental Component: Ivory Gull									
				Evaluation Criteria for Assessing Environmental Effects					
Project Activity	Project Phase[a]	Potential Positive (P) or Negative (N) Environmental Effect	Mitigation	Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Presence of Structures									
Safety Zone	1,2,3,4,5	No Interaction	-	-	-	-	-	-	-
Artificial Reef Effect	1,2,3,4,5	Increased Food (P)	-	1	2	6	5	R	2
Sediment Excavation									
Removal	1	No Interaction	-	-	-	-	-	-	-
Deposition	1	No Interaction	-	-	-	-	-	-	-
Lights	1,2,3,4,5	Attraction (N)	Release stranded birds	1	2	5	5	R	2
Flaring	2,4	Attraction (N) Physical Injury/Mortality (N)	Release stranded birds	1	2	2	5	R	2
Drill Mud/Cuttings									
Water-based Muds	2	Contamination (N)	Recycle mud; Treat and discharge cuttings	1	1	6	4	R	2
Synthetic-based Muds	2	Contamination (N)	Recycle mud; Treat and discharge cuttings	1	1	6	4	R	2
Other Fluids/Solids									
Cement	2	No Interaction		-	-	-	-	-	-
BOP Fluid	2	Contamination (N)	Selection criteria	0	1	1	4	R	2
Cooling Water	2,4	Contamination (N)	Monitor	0	1	6	5	R	2
Deck Drainage	2,4	Contamination (N)	Treatment	0	1	5	5	R	2
Bilge Water	2,4	Contamination (N)	Treatment	0	1	5	5	R	2
Ballast Water	N/A								
Sanitary/Domestic Waste Water	2,4	Contamination (N) Increased Nutrients (P)	Treatment	0	1	5	5	R	2
Small Transfer Spills	2,4	Contamination (N)	Safe handling practices; Cleanup protocols	0	1	2	5	R	2
Oily Residue Discharge	3	No Interaction	-	-	-	-	-	-	-
Produced Water[b]	2,4	Contamination (N)	Treatment	0	1	5	5	R	2

Table 7.24 Continued.

Garbage[c]	N/A								
Atmospheric Emissions	1,2,3,4,5	Contamination (N)	Equipment design	0	2	6	5	R	2
Ships and Boats	1,2,3,4,5	Disturbance (N)	Colony Avoidance	0	2	6	5	R	2
Helicopters	1,2,3,4,5	Physical Injury/Mortality (N)	Avoidance of breeding colonies and repeated overflights of bird concentrations	1	3	2	5	R	2
Noise									
Dredge	1	Disturbance (N)	-	0	2-3	6	2	R	2
Geotechnical Survey	1	Disturbance (N)	-	0	2-3	6	1	R	2
Drilling Rigs	2	Disturbance (N)	-	0	2-3	6	4	R	2
Support Vessels	1,2,3,4,5	Disturbance (N)	Colony avoidance	0	2-3	6	5	R	2
Helicopters	1,2,3,4,5	Disturbance (N)	Avoidance of breeding colonies and repeated overflights of bird concentrations	1	3	4	5	R	2
FPSO	4	Disturbance (N)	-	0	2-3	6	5	R	2
VSP	2	Disturbance (N) Physical (N)	Source level selection; Temporal avoidance of sensitive times; Ramp up	0	1-4	1	1	R	2
Underwater Maintenance	1,2,3,4	No Interaction	-	-	-	-	-	-	-
Shore Facilities[d]	N/A		-						

Magnitude
0 = Negligible
1 = Low
2 = Medium
3 = High

Geographic Extent
1 = < 1 km^2
2 = 1-10 km^2
3 = 11-100 km^2
4 = 101-1,000 km^2
5 = 1,001-10,000 km^2
6 = > 10,000 km^2

Frequency
1 = < 11 events/year
2 = 11-50 events/year
3 = 51-100 events/year
4 = 101-200 events/year
5 = > 200 events/year
6 = continuous

Duration
1 = < 1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = > 72 months

Reversibility (population level)
R = Reversible
I = Irreversible

Ecological/Socio-Cultural and Economic Context
1 = Relatively pristine area or area not negatively affected by human activity
2 = Evidence of existing negative anthropogenic effects

[a] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment

[b] Produced water associated with well testing may be flared

[c] All garbage will be brought to shore

[d] Existing onshore infrastructure will be used

Some of the potential effects mitigations indicated in Table 7.24 include the following: (1) minimization of lighting, (2) release of stranded birds, (3) recycling of drilling mud, (4) treatment and discharge of cuttings, (5) recycling and/or treatment of other waste fluids and solids, (6) avoidance of marine bird colonies by supply vessels and helicopters, (7) maintenance of minimum flying altitude by helicopters, and (8) ramp up/delay of ramp up/shutdown of seismic array.

The residual environmental effects of each of these routine drilling activities on the Ivory Gull were predicted to be *not significant* (Table 7.25).

Table 7.25. Significance of Predicted Residual Environmental Effects of Routine Activities on the Ivory Gull.

Valued Environmental Component: Ivory Gull					
Project Activity	**Project Phase**[a]	**Significance of Predicted Residual Environmental Effects**		**Likelihood**[b]	
		Significance Rating	**Level of Confidence**	**Probability of Occurrence**	**Scientific Certainty**
Presence of Structures					
Safety Zone	1,2,3,4,5	-	-	-	-
Artificial Reef Effect	1,2,3,4,5	P	3	-	-
Sediment Excavation					
Removal	1	-	-	-	-
Deposition	1	-	-	-	-
Lights	1,2,3,4,5	NS	3	-	-
Flaring	2,4	NS	3	-	-
Drill Mud/Cuttings					
Water-based Muds	2	NS	3	-	-
Synthetic-based Muds	2	NS	3	-	-
Other Fluids/Solids					
Cement	2	-	-	-	-
BOP Fluid	2	NS	3	-	-
Cooling Water	2,4	NS	3	-	-
Deck Drainage	2,4	NS	3	-	-
Bilge Water	2,4	NS	3	-	-
Ballast Water	N/A				
Sanitary/Domestic Waste Water	2,4	NS	3	-	-
Small Transfer Spills	2,4	NS	3	-	-
Oily Residue Discharge	3	-	-	-	-
Produced Water[c]	2,4	NS	3	-	-
Garbage[d]	N/A			-	-
Atmospheric Emissions[e]	1,2,3,4,5	NS	3	-	-
Ships and Boats	1,2,3,4,5	NS	3	-	-
Helicopters	1,2,3,4,5	NS	3	-	-
Noise					
Dredge	1	NS	3	-	-
Geotechnical Survey	1	NS	3	-	-
Drilling Rigs	2	NS	3	-	-

Table 7.25 Continued.

Valued Environmental Component: Ivory Gull					
Project Activity	Project Phase[a]	Significance of Predicted Residual Environmental Effects		Likelihood[b]	
		Significance Rating	Level of Confidence	Probability of Occurrence	Scientific Certainty
Support Vessels	1,2,3,4,5	NS	3	-	-
Helicopters	1,2,3,4,5	NS	3	-	-
FPSO	4	NS	3	-	-
VSP	2	NS	3	-	-
Underwater Maintenance	1,2,3,4	-	-	-	-
Shore Facilities[f]	N/A				

Significance Rating (significance is defined as a medium or high magnitude (2 or 3 rating) and duration > 1 year (≥ 3 rating) and geographic extent > 100 km^2 (≥ 4 rating)
NS = Not significant negative environmental effect
S = Significant negative environmental effect
NS = Not significant negative environmental effect
P = Positive environmental effect

Level of Confidence (professional judgement)
1 = Low level of confidence
2 = Medium level of confidence
3 = High level of confidence

Probability of Occurrence (professional judgement)
1 = Low probability of occurrence
2 = Medium probability of occurrence
3 = High probability of occurrence

Level of Scientific Certainty (based on scientific information and statistical analysis or professional judgement)
1 = Low level of scientific certainty
2 = Medium level of scientific certainty
3 = High level of scientific certainty

[a] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment
[b] Only considered in the event of significant (S) residual effect
[c] Produced water associated with well testing may be flared
[d] All garbage will be brought to shore
[e] Includes produced water which may be flared
[f] Existing onshore infrastructure will be used

7.6.7.3 Blue Whale and North Atlantic Right Whale

Table 7.21 indicates the potential interactions of routine activities associated with the proposed drill centre development and production Project and the two marine mammals on Schedule 1 of *SARA*; the blue whale and the North Atlantic right whale. Assessment of the effects of these interactions is presented in Table 7.26. Rationale for the assessment is provided in Section 7.6.5 where effects of routine activities on the marine mammal VEC are discussed. Routine activities for which effects assessment was conducted include the following: (1) presence of structures, (2) sediment excavation, (3) lights and flares, (4) discharge of drilling muds and cuttings, (5) discharge of other fluids and solids, (6) presence of ships and boats, (7) presence of helicopters, (8) sound produced by drill rigs, supply vessels, aircraft and seismic arrays, (9) underwater installation and maintenance, and (10) shore-based facilities.

Table 7.26. Environmental Effects Assessment of Potential Effects of Routine Activities on Blue Whales and North Atlantic Right Whales.

Valued Environmental Component: Blue Whale and North Atlantic Right Whale									
				Evaluation Criteria for Assessing Environmental Effects					
Project Activity	**Project Phase[a]**	**Potential Positive (P) or Negative (N) Environmental Effect**	**Mitigation**	**Magnitude**	**Geographic Extent**	**Frequency**	**Duration**	**Reversibility**	**Ecological/ Socio-Cultural and Economic Context**
Presence of Structures									
Safety Zone	1,2,3,4,5	Increased Prey (P)	-	1	2	6	5	R	2
Artificial Reef Effect	1,2,3,4,5	Increased Prey (P)	-	1	2	6	5	R	2
Sediment Excavation									
Removal	1	Disruption of Substrate (N) Resuspension of Sediment (N)	-	0-1	1	1	2	R	2
Deposition	1	Disruption of Substrate (N) Resuspension of Sediment (N) Smothering (N)	-	0-1	1	1	2	R	2
Lights	1,2,3,4,5	Attraction of Prey (P)	-	0	1	5	5	R	2
Flaring	2,4	Attraction of Prey (P)	-	1	2	2	5	R	2
Drill Mud/Cuttings									
Water-based Muds	2	Effects on Health (N)	Recycle mud; Treat and discharge cuttings	0	1	6	4	R	2
Synthetic-based Muds	2	Effects on Health (N)	Recycle mud; Treat and discharge cuttings	0	1	6	4	R	2
Other Fluids/Solids									
Cement	2	Disruption of Substrate (N) Attraction of prey (P)		0	1	1	5	R	2
BOP Fluid	2	Effects on Health (N)	Selection criteria	0	1	1	4	R	2
Cooling Water	2,4	Effects on Health (N)	Monitor	0	1	6	5	R	2
Deck Drainage	2,4	Effects on Health (N)	Treatment	0	1	5	5	R	2
Bilge Water	2,4	Effects on Health (N)	Treatment	0	1	5	5	R	2
Ballast Water	N/A								

Table 7.26 Continued.

Valued Environmental Component: Blue Whale and North Atlantic Right Whale									
				Evaluation Criteria for Assessing Environmental Effects					
Project Activity	**Project Phase[a]**	**Potential Positive (P) or Negative (N) Environmental Effect**	**Mitigation**	**Magnitude**	**Geographic Extent**	**Frequency**	**Duration**	**Reversibility**	**Ecological/ Socio-Cultural and Economic Context**
Sanitary/Domestic Waste Water	2,4	Effects on Health (N) Attraction of Prey (P)	Treatment	0	1	5	5	R	2
Small Transfer Spills	2,4	Effects on Health (N)	Safe handling practices; Cleanup protocols	0	1	2	5	R	2
Oily Residue Discharge	3	Effects on Health (N)	Maximize flowline flushing	0	1	1	4	R	2
Produced Water[b]	2,4	Effects on Health (N)	Treatment	0	1	5	5	R	2
Garbage[c]	N/A								
Atmospheric Emissions	1,2,3,4,5	Effects on Health (N)	Equipment design	0	2	6	5	R	2
Ships and Boats	1,2,3,4,5	Disturbance (N)		0	2	6	5	R	2
Helicopters	1,2,3,4,5	Disturbance (N)		1	3	2	5	R	2
Noise									
Dredge	1	Disturbance (N)	-	0-1	2-3	6	2	R	2
Geotechnical Survey	1	Disturbance (N)	-	0-1	2-3	6	1	R	2
Drilling Rigs	2	Disturbance (N)	-	0-1	2-3	6	4	R	2
Support Vessels	1,2,3,4,5	Disturbance (N)	Avoidance; maintenance of steady course and speed	0-1	2-3	6	5	R	2
Helicopters	1,2,3,4,5	Disturbance (N)	Fly minimum altitude of 600 m, when possible	0-1	1	4	5	R	2
FPSO	4	Disturbance (N)	-	0-1	2-3	6	5	R	2

Table 7.26 Continued.

Valued Environmental Component: Blue Whale and North Atlantic Right Whale									
				Evaluation Criteria for Assessing Environmental Effects					
Project Activity	Project Phase[a]	Potential Positive (P) or Negative (N) Environmental Effect	Mitigation	Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
VSP	2	Disturbance (N) Physical (N)	Ramp up; Delay start up if marine mammal in safety zone; Shut down if endangered marine mammal in safety zone	0-1	2-3	1	2	R	2
Underwater Maintenance	1,2,3,4	Disturbance (N)	Material and method selection	1	1	1	1	R	2
Shore Facilities[d]	N/A		-						

Magnitude
0 = Negligible
1 = Low
2 = Medium
3 = High

Geographic Extent
1 = < 1 km^2
2 = 1-10 km^2
3 = 11-100 km^2
4 = 101-1,000 km^2
5 = 1,001-10,000 km^2
6 = > 10,000 km^2

Frequency
1 = < 11 events/year
2 = 11-50 events/year
3 = 51-100 events/year
4 = 101-200 events/year
5 = > 200 events/year
6 = continuous

Duration
1 = < 1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = > 72 months

Reversibility (population level)
R = Reversible
I = Irreversible

Ecological/Socio-Cultural and Economic Context
1 = Relatively pristine area or area not negatively affected by human activity
2 = Evidence of existing negative anthropogenic effects

[a] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment
[b] Produced water associated with well testing may be flared
[c] All garbage will be brought to shore
[d] Existing onshore infrastructure will be used

Some of the potential effects mitigations indicated in Table 7.26 include the following: (1) minimization of lighting, (2) recycling of drilling mud, (3) treatment and discharge of cuttings, (4) recycling and/or treatment of other waste fluids and solids, (5) avoidance of marine mammals by supply vessels, (6) maintenance of minimum flying altitude by helicopters, and (7) ramp up/delay of ramp up/shutdown of seismic array.

The residual environmental effects of each of these routine drilling activities on the blue whale and the North Atlantic right whale were predicted to be *not significant* (Table 7.27).

Table 7.27. Significance of Predicted Residual Environmental Effects of Routine Activities on Blue Whales and North Atlantic Right Whales.

Valued Environmental Component: Blue Whale and North Atlantic Right Whale					
Project Activity	**Project Phase**[a]	**Significance of Predicted Residual Environmental Effects**		**Likelihood**[b]	
		Significance Rating	**Level of Confidence**	**Probability of Occurrence**	**Scientific Certainty**
Presence of Structures					
Safety Zone	1,2,3,4,5	P	3	-	-
Artificial Reef Effect	1,2,3,4,5	P	3	-	-
Sediment Excavation					
Removal	1	NS	3	-	-
Deposition	1	NS	3	-	-
Lights	1,2,3,4,5	NS	3	-	-
Flaring	2,4	NS	3	-	-
Drill Mud/Cuttings					
Water-based Muds	2	NS	3	-	-
Synthetic-based Muds	2	NS	3	-	-
Other Fluids/Solids					
Cement	2	NS	3	-	-
BOP Fluid	2	NS	3	-	-
Cooling Water	2,4	NS	3	-	-
Deck Drainage	2,4	NS	3	-	-
Bilge Water	2,4	NS	3	-	-
Ballast Water	N/A				
Sanitary/Domestic Waste Water	2,4	NS	3	-	-
Small Transfer Spills	2,4	NS	3	-	-
Oily Residue Discharge	3	NS	3	-	-
Produced Water[c]	2,4	NS	3	-	-
Garbage[d]	N/A			-	-
Atmospheric Emissions[e]	1,2,3,4,5	NS	3	-	-
Ships and Boats	1,2,3,4,5	NS	3	-	-
Helicopters	1,2,3,4,5	NS	3	-	-
Noise					
Dredge	1	NS	3	-	-
Geotechnical Survey	1	NS	3	-	-
Drilling Rigs	2	NS	3	-	-
Support Vessels	1,2,3,4,5	NS	3	-	-
Helicopters	1,2,3,4,5	NS	3	-	-

Table 7.27 Continued.

Valued Environmental Component: Blue Whale and North Atlantic Right Whale					
Project Activity	Project Phase[a]	Significance of Predicted Residual Environmental Effects		Likelihood[b]	
		Significance Rating	Level of Confidence	Probability of Occurrence	Scientific Certainty
FPSO	4	NS	3	-	-
VSP	2	NS	3	-	-
Underwater Maintenance	1,2,3,4	NS	3	-	-
Shore Facilities[f]	N/A				

Significance Rating (significance is defined as a medium or high magnitude (2 or 3 rating) and duration > 1 year (≥ 3 rating) and geographic extent > 100 km^2 (≥ 4 rating)
NS = Not significant negative environmental effect
S = Significant negative environmental effect
NS = Not significant negative environmental effect
P = Positive environmental effect

Level of Confidence (professional judgement)
1 = Low level of confidence
2 = Medium level of confidence
3 = High level of confidence

Probability of Occurrence (professional judgement)
1 = Low probability of occurrence
2 = Medium probability of occurrence
3 = High probability of occurrence

Level of Scientific Certainty (based on scientific information and statistical analysis or professional judgement)
1 = Low level of scientific certainty
2 = Medium level of scientific certainty
3 = High level of scientific certainty

[a] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment
[b] Only considered in the event of significant (S) residual effect
[c] Produced water associated with well testing may be flared
[d] All garbage will be brought to shore
[e] Includes produced water which may be flared
[f] Existing onshore infrastructure will be used

7.6.7.4 Leatherback Sea Turtle

Table 7.21 indicates the potential interactions of routine activities associated with the proposed drill centre development and production Project and the leatherback sea turtle. Assessment of the effects of these interactions is presented in Table 7.28. Rationale for the assessment is provided in Section 7.6.6 where effects of routine activities on the sea turtle VEC are discussed. Routine activities for which effects assessment was conducted include the following: (1) presence of structures, (2) sediment excavation, (3) lights and flares, (4) discharge of drilling muds and cuttings, (5) discharge of other fluids and solids, (6) presence of ships and boats, (7) presence of helicopters, (8) sound produced by drill rigs, supply vessels, aircraft and seismic arrays, (9) underwater installation and maintenance, and (10) shore-based facilities.

Table 7.28. Environmental Effects Assessment of Potential Effects of Routine Activities on Leatherback Sea Turtles.

Valued Environmental Component: Leatherback Sea Turtle									
Project Activity	Project Phase[a]	Potential Positive (P) or Negative (N) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
				Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Presence of Structures									
Safety Zone	1,2,3,4,5	Increased Prey (P)	-	1	2	6	5	R	2
Artificial Reef Effect	1,2,3,4,5	Increased Prey (P)	-	1	2	6	5	R	2
Sediment Excavation									
Removal	1	Disruption of Substrate (N) Resuspension of Sediment (N)	-	0-1	1	1	2	R	2
Deposition	1	Disruption of Substrate (N) Resuspension of Sediment (N) Smothering (N)	-	0-1	1	1	2	R	2
Lights	1,2,3,4,5	Attraction of Prey (P)	-	0	1	5	5	R	2
Flaring	2,4	Attraction of Prey (P)	-	1	2	2	5	R	2
Drill Mud/Cuttings									
Water-based Muds	2	Effects on Health (N)	Recycle mud; Treat and discharge cuttings	0	1	6	4	R	2
Synthetic-based Muds	2	Effects on Health (N)	Recycle mud; Treat and discharge cuttings	0	1	6	4	R	2
Other Fluids/Solids									
Cement	2	Disruption of Substrate (N) Attraction of prey (P)		0	1	1	5	R	2
BOP Fluid	2	Effects on Health (N)	Selection criteria	0	1	1	4	R	2
Cooling Water	2,4	Effects on Health (N)	Monitor	0	1	6	5	R	2
Deck Drainage	2,4	Effects on Health (N)	Treatment	0	1	5	5	R	2
Bilge Water	2,4	Effects on Health (N)	Treatment	0	1	5	5	R	2
Ballast Water	N/A								
Sanitary/Domestic Waste Water	2,4	Effects on Health (N) Attraction of Prey (P)	Treatment	0	1	5	5	R	2
Small Transfer Spills	2,4	Effects on Health (N)	Safe handling practices; Cleanup protocols	0	1	2	5	R	2

Table 7.28 Continued.

Valued Environmental Component: Leatherback Sea Turtle									
				Evaluation Criteria for Assessing Environmental Effects					
Project Activity	**Project Phase**[a]	**Potential Positive (P) or Negative (N) Environmental Effect**	**Mitigation**	**Magnitude**	**Geographic Extent**	**Frequency**	**Duration**	**Reversibility**	**Ecological/ Socio-Cultural and Economic Context**
Oily Residue Discharge	3	Effects on Health (N)	Maximize flowline flushing	0	1	1	4	R	2
Produced Water[b]	2,4	Effects on Health (N)	Treatment	0	1	5	5	R	2
Garbage[c]	N/A								
Atmospheric Emissions	1,2,3,4,5	Effects on Health (N)	Equipment design	0	2	6	5	R	2
Ships and Boats	1,2,3,4,5	Disturbance (N)		0	2	6	5	R	2
Helicopters	1,2,3,4,5	Disturbance (N)		1	3	2	5	R	2
Noise									
Dredge	1	Disturbance (N)	-	0-1	2-3	6	2	R	2
Geotechnical Survey	1	Disturbance (N)	-	0-1	2-3	6	1	R	2
Drilling Rigs	2	Disturbance (N)	-	0-1	2-3	6	4	R	2
Support Vessels	1,2,3,4,5	Disturbance (N)	Avoidance; maintenance of steady course and speed	0-1	2-3	6	5	R	2
Helicopters	1,2,3,4,5	Disturbance (N)	Fly minimum altitude of 600 m, when possible	0-1	1	4	5	R	2
FPSO	4	Disturbance (N)	-	0-1	2-3	6	5	R	2
VSP	2	Disturbance (N) Physical (N)	Ramp up; Delay start up if marine mammal in safety zone; Shut down if endangered marine mammal in safety zone	0-1	2-3	1	2	R	2

Table 7.28 Continued.

Valued Environmental Component: Leatherback Sea Turtle									
Project Activity	Project Phase[a]	Potential Positive (P) or Negative (N) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
				Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Underwater Maintenance	1,2,3,4	Disturbance (N)	Material and method selection	1	1	1	1	R	2
Shore Facilities[d]	N/A		-						

Magnitude
0 = Negligible
1 = Low
2 = Medium
3 = High

Geographic Extent
1 = < 1 km^2
2 = 1-10 km^2
3 = 11-100 km^2
4 = 101-1,000 km^2
5 = 1,001-10,000 km^2
6 = > 10,000 km^2

Frequency
1 = < 11 events/year
2 = 11-50 events/year
3 = 51-100 events/year
4 = 101-200 events/year
5 = > 200 events/year
6 = continuous

Duration
1 = < 1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = > 72 months

Reversibility (population level)
R = Reversible
I = Irreversible

Ecological/Socio-Cultural and Economic Context
1 = Relatively pristine area or area not negatively affected by human activity
2 = Evidence of existing negative anthropogenic effects

[a] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment

[b] Produced water associated with well testing may be flared

[c] All garbage will be brought to shore

[d] Existing onshore infrastructure will be used

Some of the potential effects mitigations indicated in Table 7.28 include the following: (1) minimization of lighting, (2) recycling of drilling mud, (3) treatment and discharge of cuttings, (4) recycling and/or treatment of other waste fluids and solids, (5) avoidance of sea turtles by supply vessels, (6) maintenance of minimum flying altitude by helicopters, and (7) ramp up/delay of ramp up/shutdown of seismic array.

The residual environmental effects of each of these routine drilling activities on the leatherback sea turtle were predicted to be *not significant* (Table 7.29).

Table 7.29. Significance of Predicted Residual Environmental Effects of Routine Activities on Leatherback Sea Turtles.

Valued Environmental Component: Leatherback Sea Turtle					
Project Activity	**Project Phase**[a]	**Significance of Predicted Residual Environmental Effects**		**Likelihood**[b]	
		Significance Rating	**Level of Confidence**	**Probability of Occurrence**	**Scientific Certainty**
Presence of Structures					
Safety Zone	1,2,3,4,5	P	3	-	-
Artificial Reef Effect	1,2,3,4,5	P	3	-	-
Sediment Excavation					
Removal	1	NS	3	-	-
Deposition	1	NS	3	-	-
Lights	1,2,3,4,5	NS	3	-	-
Flaring	2,4	NS	3	-	-
Drill Mud/Cuttings					
Water-based Muds	2	NS	3	-	-
Synthetic-based Muds	2	NS	3	-	-
Other Fluids/Solids					
Cement	2	NS	3	-	-
BOP Fluid	2	NS	3	-	-
Cooling Water	2,4	NS	3	-	-
Deck Drainage	2,4	NS	3	-	-
Bilge Water	2,4	NS	3	-	-
Ballast Water	N/A				
Sanitary/Domestic Waste Water	2,4	NS	3	-	-
Small Transfer Spills	2,4	NS	3	-	-
Oily Residue Discharge	3	NS	3	-	-
Produced Water[c]	2,4	NS	3	-	-
Garbage[d]	N/A			-	-
Atmospheric Emissions[e]	1,2,3,4,5	NS	3	-	-
Ships and Boats	1,2,3,4,5	NS	3	-	-
Helicopters	1,2,3,4,5	NS	3	-	-
Noise					
Dredge	1	NS	3	-	-

Table 7.29 Continued.

Valued Environmental Component: Leatherback Sea Turtle					
Project Activity	Project Phase[a]	Significance of Predicted Residual Environmental Effects		Likelihood[b]	
		Significance Rating	Level of Confidence	Probability of Occurrence	Scientific Certainty
Geotechnical Survey	1	NS	3	-	-
Drilling Rigs	2	NS	3	-	-
Support Vessels	1,2,3,4,5	NS	3	-	-
Helicopters	1,2,3,4,5	NS	3	-	-
FPSO	4	NS	3	-	-
VSP	2	NS	3	-	-
Underwater Maintenance	1,2,3,4	NS	3	-	-
Shore Facilities[f]	N/A				

Significance Rating (significance is defined as a medium or high magnitude (2 or 3 rating) and duration > 1 year (≥ 3 rating) and geographic extent > 100 km^2 (≥ 4 rating)
NS = Not significant negative environmental effect
S = Significant negative environmental effect
NS = Not significant negative environmental effect
P = Positive environmental effect

Level of Confidence (professional judgement)
1 = Low level of confidence
2 = Medium level of confidence
3 = High level of confidence

Probability of Occurrence (professional judgement)
1 = Low probability of occurrence
2 = Medium probability of occurrence
3 = High probability of occurrence

Level of Scientific Certainty (based on scientific information and statistical analysis or professional judgement)
1 = Low level of scientific certainty
2 = Medium level of scientific certainty
3 = High level of scientific certainty

[a] 1 = Glory Hole Excavation/TGB Installation
2 = Drilling
3 = Subsea Production Equipment Installation
4 = Production Operations
5 = Abandonment
[b] Only considered in the event of significant (S) residual effect
[c] Produced water associated with well testing may be flared
[d] All garbage will be brought to shore
[e] Includes produced water which may be flared
[f] Existing onshore infrastructure will be used

Comment No. 9: Insufficient discussion of environmental effects on SAR

Comment No. 98: Insufficient discussion of environmental effects on SAR

Comment No. 99: Potential change of status for Ivory Gull

Comment No. 60: Reference to Species-at-Risk section for more information on Ivory Gull

8.0 Accidental Events

Accidental events could potentially occur during any of the five Project Phases. This section considers a range of accident spill size scenarios which adequately represents any accidental event that might occur during any of the Project Phases.

Comment No. 100: Consider effects of accidental events for each Phase

8.1 Probability of Accidental Events

Husky is proposing the development of five new drill centres and subsequent production operations using these drill centres. A maximum of 54 development wells are proposed for the Project Area during the period between 2007 and 2016.

8.1.1 General Oil Pollution Record of the Offshore Exploration and Production Industry

Text in the EA remains the same.

8.1.2 Sources of Information

Text in t.

8.1.3 Categories of Accidental Event Size

Text in the EA remains the same.

8.1.4 Extremely Large, Very Large and Large Accidental Events

8.1.4.1 Historical Statistics for Extremely Large and Very Large Spills

The main concern from a safety, environmental and economic perspective, is the possibility of a well blowout occurring and discharging large quantities of oil into the marine environment. In the US, only two moderate-size oil-well blowouts involving oil spills greater in size than 50,000 barrels have occurred since offshore drilling began in the mid-fifties. One must therefore look beyond the US to find a reasonable database on very large and extremely large oil-well blowouts. Table 8.2 lists all worldwide blowouts involving spillage of more than 10,000 barrels as of 2005.

With respect to "extremely large" spills (i.e., oil spills ≥ 150,000 barrels in size), there have been five such spills in the history of offshore drilling, two of which occurred during development drilling and two of which occurred during production or work-over activities. The fifth was from exploration drilling, namely the 1979 Ixtoc 1 oil-well blowout in the Bay of Campeche, Mexico. This largest oil spill in history was caused by drilling procedures (used by PEMEX, Mexico's national oil company) that are not practiced in US or Canadian waters. These drilling procedures are contrary to US and Canadian regulations and to the accepted practices within the international oil and gas industry.

Spill frequencies are best expressed in terms of a risk exposure factor such as number of wells drilled. On a worldwide basis it has been estimated that 11,737 exploration wells and 24,896 development wells were drilled from 1955 to 1980 (Gulf Canada 1981). The total number of exploration and development wells drilled up to 1988 has been estimated to be 20,000 and 51,000, respectively (Sharples et al. 1989). It is estimated from a number of Internet sources that the number of exploration and development wells drilled to date is approximately 35,000 and 75,000, respectively. There have been only two extremely large spills (>150,000 bbl) during offshore development drilling (Table 8.2), so the frequency up to the present is 2.66 x 10^{-5} spills per well drilled (2/75,000). [1]

Table 8.2. Historical Very Large (>10,000 bbl) Oil Spills from Offshore Blowouts, 1970-2005.

Area	Reported Spill Size (bbl)	Date	Operation Underway
U.S.A., Santa Barbara	77,000	1969	Production
U.S.A., S. Timbalier 26	53,000	1970	Wireline
U.S.A., Main Pass 41	30,000	1970	Production
Dubai	2,000,000	1973	Development Drilling
Trinidad	10,000	1973	Development Drilling
North Sea/Norway	158,000	1977	Workover
Mexico (Ixtoc 1)	3,000,000	1979	Exploratory Drilling
Nigeria	200,000	1980	Development Drilling
Iran	100,000	1980	Development Drilling
Saudi Arabia	60,000	1980	Exploratory Drilling
Iran[a]	see note	1983	Production
Mexico	247,000	1986	Workover
Mexico	56,000	1987	Exploratory Drilling
U.S.A., Timbalier Bay/Greenhill	11,500	1992	Production

[a] The Iranian Norwuz oil-well blowouts in the Gulf of Arabia, which started in February 1983, were not caused by exploration or drilling accidents but were a result of military actions during the Iraq/Iran war.

Source: Gulf (1981), updated to present (2005) by reference to the Oil Spill Intelligence Report.

Spill frequencies are best expressed in terms of a risk exposure factor such as number of wells drilled. On a worldwide basis it has been estimated that 11,737 exploration wells and 24,896 development wells were drilled from 1955 to 1980 (Gulf Canada 1981). The total number of exploration and development wells drilled up to 1988 has been estimated to be 20,000 and 51,000, respectively (Sharples et al. 1989). It is estimated from a number of Internet sources that the number of exploration and development wells drilled to date is approximately 35,000 and

[1] In this and other similar calculations in the report, spill frequency rates are kept as three-decimal data, and the probability numbers are rounded off to two decimal points.

75,000, respectively. There have been only two extremely large spills (>150,000 bbl) during offshore development drilling (Table 8.2), so the frequency up to the present is 2.66 x 10^{-5} spills per well drilled (2/75,000).[2]

A similar analysis can be done for so-called "very large" spills (i.e., those larger than 10,000 barrels). Table 8.2 indicates that four development drilling blowouts have produced spills in the "very large" spill category (including Ixtoc 1), resulting in a spill frequency for "very large" spills of 5.33 x 10^{-5} spills per well drilled (4/75,000).

8.1.4.2 Historical Statistics for Large Spills (>1,000 bbl) from Blowouts

Almost no historical information is available on blowout-related spills in the size range of 1,000 bbl to 10,000 bbl. These likely have occurred with greater regularity than very large spills (>10,000 bbl), but historical information is lacking. Certainly no large spills (>1,000 bbl) from blowouts have occurred in US GOM OCS operations since 1972. However, it seems likely that several have occurred elsewhere.

To check this possibility, spill statistics published by the Oil Spill Intelligence Report (OSIR) (Cutter Information Corp., Arlington, MA) were analyzed. OSIR publishes annual lists detailing all worldwide spills larger in size than 10,000 gallons (238 bbl). Annual reports from 1994 to 1999 were available and surveyed.

Only one large spill (>1,000 bbl) from a blowout occurred during this six-year period. It happened on March 15, 1998 off India, and involved 100,000 gallons (2,380 bbl) of crude. It can be estimated that during this six-year period, approximately 20,000 exploration and development wells were drilled offshore on a worldwide basis. This translates to a frequency of 5.0 x 10^{-5} large spills (>1,000 bbl) per well drilled. This frequency is smaller than the above-calculated value for very large (>10,000) bbl spills, which is 5.33 x 10^{-5}. The lower value can be explained by a number of factors including incompleteness of data. It is certainly possible that better blowout prevention methods were developed and used in the 1990s compared to the 1970s and 1980s when most offshore blowout occurred (Table 8.2). For the purposes of this EA, spills in this size category are not discussed further because of uncertainties associated with the database.

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[2] In this and other similar calculations in the report, spill frequency rates are kept as three-decimal data, and the probability numbers are rounded off to two decimal points.

8.1.4.3 Large Spills in the Newfoundland and Labrador Offshore Area (NLOA)

A spill of approximately 1,038 bbl (165,000 l) of crude oil occurred in November 2004 at Petro-Canada's Terra Nova production site (Table 8.3). The spill was associated with the FPSO's produced water separation process. This is the only 'large' oil spill recorded to date in the Newfoundland offshore area.

Comment No. 101: Terra Nova spill in 2004 needs to be included

8.1.4.4 Calculated Probability for Husky's Development of New Drill Centres Project

Based on 54 development wells being drilled over a five year period, the spill frequencies estimated for the Drilling Phase of the development of new drill centres Project would be as follows:

Predicted frequency of extremely large oil spills (>150,000 bbl) from blowouts during the Drilling Phase based on an exposure of thirty wells drilled is $54 \times 2.66 \times 10^{-5} = 1.44 \times 10^{-3}$ spills. This equates to a probability during the Drilling Phase of one in 696.

Predicted frequency of very large oil spills (>10,000 bbl) from blowouts during the Drilling Phase based on an exposure of wells drilled is $54 \times 5.33 \times 10^{-5} = 2.88 \times 10^{-3}$ spills. This equates to a probability during the Drilling Phase of one in 347.

Predicted frequency of large oil spills (>1,000 bbl) from blowouts during the Drilling Phase based on an exposure of wells drilled is $54 \times 5.0 \times 10^{-5} = 2.70 \times 10^{-3}$ spills. This equates to a probability during the Drilling Phase of one in 370.

8.1.5 Blowouts Involving Gas Only or Small Discharges of Oil

Gas blowouts from offshore wells that do not involve a discharge of liquid petroleum are generally believed to be relatively innocuous to the marine environment. Such blowouts do, however, represent a threat to human life and property because of the possibility of explosion and fire.

Two sources are used for historical statistics on blowouts involving only gas or small oil discharges. A particularly good source for US blowouts is the MMS web site because MMS keeps track of spills down to one barrel in size. This is not the case in other parts of the world. A good source for blowouts in the North Sea and in the US GOM is Scandpower (2000), although no reference is given as to whether or not oil spills were involved in the reported blowouts.

Table 8.3. Oil Spill (> 1 Liter) Data Pertaining to the Newfoundland and Labrador Offshore Area, 1997-2006.

Year	Number Of Spills By Oil Type						Volume Of Spills By Oil Type (L)					
	Crude	Diesel	Hydraulic	Synthetic Based Mud	Others[1]	TOTAL	Crude	Diesel	Hydraulic	Synthetic Based Mud	Others[1]	TOTAL
2006	3	0	3	2	0	**8**	605	0	16	610	0	**1,231**
2005	4	0	6	1	1	**12**	17	0	24	4,030	140	**4,211**
2004	8	1	9	5	3	**26**	165,813	3	68	108,103	12	**273,999**
2003	2	1	8	4	1	**16**	11	100	275	30,102	925	**31,413**
2002	2	1	0	2	2	**7**	5	10	0	12,250	11	**12,276**
2001	0	2	4	2	1	**9**	0	5	118	5,600	3	**5,726**
2000	2	0	0	5	1	**8**	220	0	0	4,700	2	**4,922**
1999	12	7	4	8	7	**38**	983	924	690	7,372	265	**10,234**
1998	7	8	0	2	8	**25**	375	3,312	0	2,008	95	**5,790**
1997	2	6	2	0	1	**11**	1,004	476	211	0	40	**1,731**
TOTAL	**42**	**26**	**36**	**31**	**25**	**160**	**169,033**	**4,830**	**1,402**	**174,775**	**1,493**	**351,533**

Source (CNLOPB website, 21 November 2006)

[1] Includes mixed oil, condensate, well bore fluids, unidentified oil, jet, lubricating oil

8.1.5.1 MMS US GOM OCS Statistics

Data representing the 34-year period from 1972 to 2005 are contained in Table 8.4. Note that there are no large spills (>1,000 bbl) in the entire database. However, if the database had started in 1970, two very large blowout spills would have been included of 30,000 barrels and 53,000 barrels respectively (Table 8.2).

The total number of exploration and development wells drilled in the US OCS from 1972 to 2005 is not shown in Table 8.4, but it is derived from other sections of MMS (1997), the E&P Forum (1996), and from current Internet sources. The approximate numbers of development wells drilled in the US during the thirty four-year period are 20,000. The number of blowouts from development well drilling is shown to be 91. Therefore, the blowout frequency is 91/20,000 or 4.55 x 10^{-3} blowouts per development well drilled or one blowout for every 220 development wells drilled. Only one of the blowouts involved any oil spill and that involved only 1 bbl. The statistics suggest that most blowouts occurred in gas-prone fields or were shallow-gas blowouts.

8.1.5.2 Calculated Probability for Husky's Development of New Drill Centres

There are a maximum of 54 development wells to be drilled during the five year Drilling Phase between fall 2007 and summer 2012. The calculated blowout frequency is 54 x 4.55 x 10-3 = 2.46 x 10-1 or an approximate one-in-four chance of a blowout occurring over the 54-well Drilling Phase. However, the chances of having an oil discharge associated with the blowout are extremely low, actually 1.1% (one oil spills from 91 development well blowouts) according to the statistics in Table 8.4. This means the chance of having a blowout involving any oil is 0.011 x 4.55 x 10-3 or 5.0 x 10-5 per well drilled (for the 54-well Drilling Phase, 54 x 5.0 x 10-5 = 2.7 x 10-3, or a probability of one-in-370 during the 54-well Drilling Phase).

Table 8.4. Blowouts and Spillage from US Federal Offshore Wells, 1972-2005.

Year	Well Starts	Drilling Blowouts				Non-drilling Blowouts								
		Exploration		Development		Production		Workover		Completion		Total Blowouts		OCS Production
		No.	bbl	No.	bbl	No.	bbl	No.	bbl	No.	bbl	No.	bbl	MMbbl
1972	845	2	0	2	0	1	0	0	0	0	0	5	0	396.0
1973	820	2	0	1	0	0	0	0	0	0	0	3	0	384.8
1974	816	1	0	1	0	4	275	0	0	0	0	6	275	354.9
1975	372	4	0	1	0	0	0	1	0	1	0	7	0	325.3
1976	1,038	1	0	4	0	1	0	0	0	0	0	6	0	314.5
1977	1,064	3	0	1	0	1	0	3	0	1	0	9	0	296.0
1978	980	3	0	4	0	0	0	3	0	1	0	11	0	288.0
1979	1,149	4	0	1	0	0	0	0	0	0	0	5	0	274.2
1980	1,307	3	0	1	0	2	1	1	0	1	0	8	1	274.7
1981	1,284	1	0	2	0	1	0	3	64	3	0	10	64	282.9
1982	1,035	1	0	4	0	0	0	4	0	0	0	9	0	314.5
1983	1,151	5	0	5	0	0	0	2	0	0	0	12	0	350.8
1984	1,386	3	0	1	0	0	0	1	0	0	0	5	0	385.1
1985	1,000	3	0	1	0	0	0	2	40	0	0	6	40	380.0
1986	1,538	0	0	1	0	0	0	1	0	0	0	2	0	384.3
1987	772	2	0	0	0	3	0	1	0	2	60	8	60	358.8
1988	1,007	1	0	1	0	0	0	1	0	0	0	3	0	332.7
1989	911	2	0	[1]5	0	3	0	1	0	0	0	11	0	313.7
1990	987	1	0	1	0	0	0	3	9	1	0	6	9	304.5
1991	667	3	0	[2]3	0	0	0	0	0	0	0	6	0	326.4
1992	943	3	100	0	0	0	0	0	0	0	0	3	100	337.9
1993	717[3]	1	0	2	0	0	0	0	0	0	0	3	0	352.7
1994	717[3]	0	0	0	0	0	0	1	0	0	0	1	0	370.4
1995	717[3]	1	0	0	0	0	0	0	0	0	0	1	0	429.2
1996	921	1	0	1	0	0	0	0	0	2	0	4	0	433.1
1997	1,333	1	0	3	0	0	0	0	0	1	0	5	0	466.0
1998	1,325	1	0	1	0	2	0	3	0	0	0	7	2	490.5
1999	364	1	0	2	0	0	0	1	0	0	0	5	0	534.6
2000	1,061	5	200	4	0	0	0	0	0	0	0	9	200	551.6
2001	1,007	1	0	4	1	2	0	2	0	1	0	10	1	591.5
2002	828	1	0	2	0	2	350	1	1	0	0	6	351	602.1
2003	835	1	0	1	0	2	1	1	10	0	0	5	11	594.7
2004	861	2	16	0	0	0	0	2	1	0	0	4	17	567.0
2005	859[4]	3	0	1	0	0	0	0	0	0	0	4	0	557.3[4]
Total	**32,617**	**67**	**316**	**91**	**1**	**24**	**627**	**38**	**125**	**14**	**60**	**205**	**1,131**	**13520.7**

1 Two of the drilling blowouts occurred during drilling for sulphur.
2 Two of the drilling blowouts occurred during drilling for sulphur.
3 Estimated: cumulative total correct.
4 Forecast.

8.1.6 Small and Medium Platform Spills

8.1.6.1 Historical Record

Small spills occur with some regularity at offshore platforms. Table 8.5 lists spills of size larger than one barrel of all pollutants from facilities and operations on federal OCS leases from the period 1971 to 1995. It is derived from a more detailed table in MMS (1997) and from data at the MMS web site.

Table 8.5. Spill Frequency from Platforms for Spills in the Ranges of 1 to 49 bbl and 50 to 999 bbl (US OCS 1971 to 1995).

Spill Size Range	Number of Spills	Spills per Well Drilled
1 to 49 bbl	1,857	7.7×10^{-2}
50 to 999 bbl	86	3.6×10^{-3}

Total volume of 1,857 + 86 spills = 122,232 barrels.

The spills involved various pollutants including crude oil, condensate, refined product, mineral oil, and diesel. The period between 1971 and 1995 involved the production of 8.5 billion barrels of oil and condensate and the drilling of 24,065 wells (MMS 1997). This means that $1{,}857/24{,}065 = 7.7 \times 10^{-2}$ spills having size between 1 and 49 barrels occurred for every well drilled, and that 86/24,065 or 3.6×10^{-3} spills having size in the range of 50 to 999 barrels occurred for every well drilled.

It is of interest to note that the small spill frequencies in the Gulf of Mexico OCS were relatively high in its early stages, but have decreased by almost a factor of ten over the past 25 years. This is shown in Figure 8.1. The spill frequency statistics in Table 8.5 represent the average over the 25-year period.

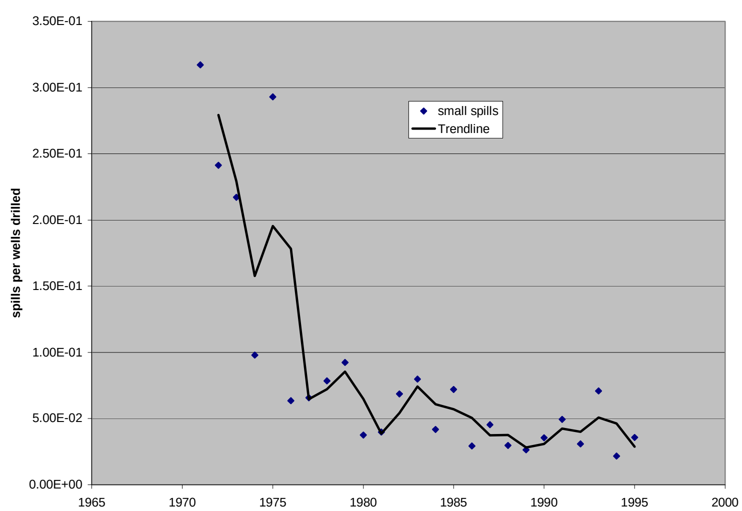

Figure 8.1. Frequency of Small Platform Spills (1 to 49 bbl) in the US GOM, 1971 to 1995.

Spill statistics for 1997 through 2006 are shown for operations in the Newfoundland and Labrador Offshore Area in Table 8.3 (C-NLOPB web site). Small and medium spill statistics associated with only development drilling in the NLOA are presented in Table 8.6. Four medium spills (50-999 bbl) occurred in the ten-year period, all of them involving synthetic based mud (three during development drilling and the fourth during production). Between 1997 and November 2006, 133 development wells have been drilled in the NLOA. Based on these NLOA statistics, the calculated frequency of 'medium' spills associated with development drilling is 3/133 or 2.26×10^{-2} (Table 8.7). This translates to the occurrence of one 'medium' spill for every 44 development wells drilled.

Between 1997 and November 2006, 155 'small' spills were reported in the NLOA. Thirty-five of the reported 'small' spills occurred during exploration drilling, 52 during development drilling, and 68 during production. Based on these NLOA statistics, the calculated frequency of 'small' spills associated with development drilling is 52/133 or 3.91×10^{-1} (Table 8.7). This translates to the occurrence of one 'small' spill for every 2 to 3 development wells drilled.

If exploration and delineation wells drilled from 1997 to 2006 are included, the calculated frequency of 'small' and 'medium' spills associated with drilling in the NLOA is 90/158 or 5.7×10^{-1} (Table 8.7). This translates to the occurrence of one 'small' or 'medium' spill for every 1 to 2 wells drilled in the NLOA.

Table 8.6. Small and Medium Spills During Development Well Drilling in the Newfoundland and Labrador Offshore Area, 1997-2006.

Year	Number of Development Wells Drilled	Number of Spills Associated with Development Drilling
1997	2	0
1998	8	0
1999	7	3
2000	15	2
2001	12	5
2002	18	4
2003	13	9
2004	23	22
2005	18	9
2006[1]	17	1
Total	**133**	**55**

Source: CNLOPB Website 24 November 2006

[1] Development well statistics as of 3 October 2006

Table 8.7. Small and Medium Spill Frequencies, Based on US GOM and NLOA Experiences.

Spill Size Range	US GOM Experience, 1971 to 1995, spills/well drilled	NLOA Experience, 1997 to 2006, spills/well drilled	NLOA Experience, 1997 to 2006, spills/development well drilled
Small Spill 1 to 49 bbl	7.7×10^{-2}	5.7×10^{-1}	3.91×10^{-1}
Medium Spill >50 bbl	3.6×10^{-3}	0	2.26×10^{-2}

8.1.6.2 Calculated Frequencies for the Drilling Phase of Husky's Development of New Drill Centres Project

Table 8.8 indicates the calculated accidental event statistics for the Drilling Phase of this Project, based on US GOM statistics.

Table 8.8. Predicted Number of Blowouts and Spills for Five-Year Drilling Phase of Husky's Development of New Drill Centres Project, Based on US GOM Statistics.

Event	Historical Frequency[a]	No. of Events (54-well Drilling Phase)	Probability
Gas blowout during development drilling	4.55×10^{-3} /well drilled	2.46×10^{-1}	1 in 4
Development drilling blowout with oil spill > 10,000 bbl	5.33×10^{-5}/well drilled	2.88×10^{-3}	1 in 347
Development drilling blowout with oil spill > 150,000 bbl	2.66×10^{-5}/well drilled	1.44×10^{-3}	1 in 696
Platform-based oil spill, 50 to 999 bbl	3.6×10^{-3}/well-drilled	1.94×10^{-1}	1 in 5
Platform-based oil spill, 1 to 49 bbl	7.7×10^{-2}/well drilled	4.16	1 in 0.24

[a] The US GOM

Based on frequencies calculated for development wells in the Newfoundland and Labrador Offshore Area (Table 8.7), the number of small and medium oil spills predicted during the Drilling Phase of this Project are 4 and 0.19, respectively. The probabilities of small and medium spills are 1 in 0.24 and 1 in 5, respectively. Newfoundland and Labrador statistics predict higher frequencies of small and medium spills than the US GOM statistics.

8.1.7 Summary of Blowout and Spill Frequencies

The calculated oil spill frequencies are summarized in Table 8.8. The highest frequencies are for the smallest, platform-based spills (i.e., 1 to 49 bbl) which have a >100% chance of occurring during the 54-well Drilling Phase of the development of new drill centres. The average size of this small spill type can be expected to be less than 10 barrels. There is a 20% chance that a platform-based spill larger than 50 barrels (<999 bbl) might occur over the course of the entire Drilling Phase.

The chances of an extremely large (>150,000 bbl) and very large (>10,000 bbl) oil well blowouts from development drilling are very small: 0.14% and 0.29%, respectively. These predictions are based on worldwide blowout data and are strongly influenced by blowouts that have occurred in Mexico, Africa and the Middle East, where drilling and production regulations may be less rigorous than in North America. It might be reasonable to expect even lower frequencies for the Drilling Phase of this Project in the Jeanne d'Arc Basin given the significant improvement of technology and/or practice over the past 15 years. There could be about a 25% chance of having a blowout involving gas only.

8.2 Oil Spill Behaviour and Fate from Hypothetical Blowouts and Spills

8.2.1 Oil Characteristics

Text in EA remains the same.

8.2.2 Selection of Blowout/Spill Scenarios

Text in EA remains the same.

8.2.3 Blowout/Spill Scenarios

Text in EA remains the same.

8.2.4 Modeling and Description of Selected Blowout/Spill Scenarios

Text in EA remains the same.

8.3 Spill Trajectories

8.3.1 Hibernia and Terra Nova Analyses

Text in EA remains the same.

8.3.2 White Rose Spill Trajectories

Text in EA remains the same.

8.3.3 White Rose Spill Areas and Concentrations of Dispersed Oil

Text in EA remains the same.

8.3.4 Effects of Pack Ice on Oil Spills

The White Rose site lies close to the extreme southern limit of the regional pack ice (see Section 4.5 for a discussion of pack ice distribution). Pack ice incursions within 15 km of White Rose occur about half the data years (1960 to 2006), centered on mid-March, with durations varying from one to 11 weeks. Mean sea ice concentrations on the Grand Banks south of 49 degrees latitude are fairly consistent at 6/10ths coverage. Coverages greater that 5/10ths occur by early February and continue through mid-April, at which time they slowly decrease to 2/10ths.

Comment No. 103: Reference in text to Appendix 1 – NO Appendix 1

8.4 Estimation of Potential Cleanup Effectiveness

Text in EA remains the same.

8.5 Alternatives to Containment and Recovery

Text in EA remains the same.

8.6 Spill Response

Text in EA remains the same.

8.7 Potential Effects of Accidental Events

Comment No, 104: References to 'exploratory drilling' are incorrect

8.7.1 Fish Habitat

Comment No. 105: 'Fish Habitat' should be renumbered to 8.7.1, and all subsequent sections at this level

8.7.2 Fish

8.7.2.2 Juveniles and Adults

There is an extensive body of literature regarding the effects of exposure to oil on juvenile and adult fish. Although some of the literature describes field observations, most refers to laboratory studies. Reviews of the effects of oil on fish have been prepared by Armstrong et al. (1995), Rice et al. (1996), Payne et al. (2003) and numerous other authors.

Comment No. 106: Suggested additional reference

8.7.3 Commercial Fishery

With respect to commercial fish harvesting, the present assessment concurs with the White Rose Comprehensive Study (Husky 2000) that effects on fish populations due to an oil spill or blow-out would be *not significant (*see Section 8). That study concluded that a large (>10,000 bbl) oil spill or blow-out would not cause significant effects on fish and fish habitat or result in tainting of fish flesh. Thus, effects on commercial fisheries as a result of physical effects on fish during the Husky White Rose development Project are considered to be *not significant*.

Comment No. 4: References to 'exploratory drilling' rather than present Project

Comment No. 107: Harm to future fishery should be considered rather than just immediate compensation

8.7.4 Marine Birds

According to the CWS report, an estimated 10,000 to 16,000 alcids were put at risk by the Terra Nova spill (Wilhelm et al. 2006). Estimated numbers of birds at risk were derived using two methods: (1) estimate based on the densities of seabirds observed during helicopter and vessel-based surveys following the spill and the total area covered by the slick (three scenarios), and (2) a mortality estimate based on a published empirical relationship between the volume of oil released during an incident and the number of seabirds killed. Estimates derived from each method shared the same order of magnitude.

Comment No. 102: CWS report of Terra Nova spill needs to be referenced

Comment No. 108: Measures to prevent spills

8.7.4.4 Sensitive Species

Adult alcids are also flightless during moulting which increases their vulnerability to oil spills.

Comment No. 109: Adult alcids being flightless during moult should be noted

8.7.4.7 Enhancement Techniques

Effects interactions, assessment and significance predictions of accidental events associated with the proposed Husky White Rose Development Project on marine birds are presented in Tables 8.26 to 8.28.

Comment No. 4: References to 'exploratory drilling' rather than present Project

Comment No. 110: Incorrect reference to 'exploratory drilling'

8.7.5 Marine Mammals

8.7.5.1.5 Summary of Effects on Cetaceans

Depending on the time of year, location of toothed and baleen whales within the affected area, and type of oil spill or blowout, the effects of an offshore oil release on the health of cetaceans is predicted to range from a *negligible to low* magnitude over varying geographic extents. A geographic extent of >10,000 km^2 is predicted for all subsea and above-surface blowout scenarios which were modelled. A geographic extent of 1001-10,000 km^2 is predicted for all modelled batch spill releases. As indicated above, this estimate is quite conservative and any effects on cetaceans will likely occur over a much smaller area. For all spill scenarios considered, the duration is predicted to be 1-12 months and effects are considered reversible (Table 8.30). It is predicted that there will be *no significant* negative effect on cetaceans from an accidental release of oil during the proposed Husky White Rose Development Project (Table 8.31).

Comment No. 4: References to 'exploratory drilling' rather than present Project

Comment No. 111: Incorrect reference to 'exploratory drilling'

Comment No. 112: Rationale behind level of confidence rating

8.7.5.2.5 Summary of Effects on Seals

Depending on the time of year and type of oil spill or blowout, the effects of an offshore oil release on seals could range from a *negligible* to *low* magnitude over varying geographic extents. For subsea and above-surface blowouts, it is estimated that the geographic extent is >10,000 km^2. A geographic extent of 1001-10,000 km^2 is predicted for all modelled batch spill scenarios. As indicated previously, this estimate is quite conservative and any effects on seals will likely occur over a much smaller area. It is unlikely that oil from a blowout or spill will reach the Front were harp seals congregate to pup and breed given that oil spill trajectories are to the east and northeast. For all spill scenarios considered, the duration is predicted to be 1-12 months and effects are considered reversible (Table 8.30). It is predicted that there will be *no significant* negative effect on seals from an accidental release of oil during the proposed Husky White Rose Development Project (Table 8.31). Similar predictions were made in the Hibernia, Terra Nova EIS and White Rose EA regarding spills or blowouts at those sites (Mobil 1985; Petro-Canada 1996a,b; Husky 2000).

Comment No. 4: References to 'exploratory drilling' rather than present Project

8.7.6 Sea Turtles

8.7.6.1 Summary of Effects on Sea Turtles

Depending on the time of year and type of oil spill or blowout, the effects of an offshore oil release on sea turtles could range from a *negligible* to *low* magnitude over varying geographic extents. For subsea and above-surface blowouts, it is estimated that the geographic extent is >10,000 km^2. A geographic extent of 1001-10,000 km^2 is predicted for all modelled batch spill scenarios. As indicated previously, this estimate is quite conservative and any effects on sea turtles will likely occur over a much smaller area. Also, it is unlikely that many sea turtles will occur in Jeanne d'Arc Basin. For all spill scenarios considered, the duration is predicted to be 1-12 months and effects are considered reversible (Table 8.30). It is predicted that there will be *no significant* negative effect on sea turtles from an accidental release of oil during the proposed Husky White Rose Development (Table 8.31).

Comment No. 4: References to 'exploratory drilling' rather than present Project

8.7.7 Species-at-Risk

As indicated in Section 5.3, five marine animal species that potentially occur in the Study Area are listed as either endangered or threatened on Schedule 1 of *SARA* (i.e., officially 'at risk' according to Canadian law). They are as follows:

- Blue whale;
- North Atlantic right whale;
- Leatherback sea turtle;
- Northern wolfish; and
- Spotted wolfish.

Two marine species are also listed as special concern on Schedule 1 of *SARA*. They are as follows:

- Ivory Gull; and
- Atlantic wolfish.

Potential interactions of accidental events associated with the Project and the seven marine species presently listed on Schedule 1 of *SARA* are indicated in Table 8.32.

Table 8.32. Potential Interactions of Accidental Events and Species-at-Risk that Could Occur in the Study Area.

Valued Ecosystem Component: Species-at-Risk				
Accidental Event Scenario	**Wolffishes**	**Ivory Gull**	**Blue whale; North Atlantic right whale**	**Leatherback sea turtle**
Subsea Blowout 7 Day	x	x	x	x
Subsea Blowout 45 Day	x	x	x	x
Above-surface Blowout 7 Day	x	x	x	x
Batch Spill 800 m^3	x	x	x	x
Batch Spill 10,000 m^3	x	x	x	x
Batch Spill 30,000 m^3	x	x	x	x

8.7.8.1 Wolffishes

Table 8.32 indicates the potential interactions of accidental events associated with the proposed drill centre development and production Project and the three species of wolffish currently listed on Schedule 1 of *SARA*. Assessment of the effects of these interactions is presented in Table 8.33. Rationale for the assessment is provided in Section 8.7.3 where effects of accidental events on the fish VEC are discussed.

Prevention of accidental events is the primary mitigative measure. However, in the case of an accidental event, appropriate response measures are required. Husky's plans for spill response are discussed in detail in two documents currently on file with the C-NLOPB. They are (1) East Coast Oil Spill Response Plan WR-ERP-PR-0001, and (2) East Coast Offshore Operations – Stage 1 Spill Response Procedures WR-ERP-PR-0002.

The residual environmental effects of each of these accidental event scenarios on wolffishes were predicted to be *not significant* (Table 8.34).

8.7.8.2 Ivory Gull

Table 8.32 indicates the potential interactions of accidental events associated with the proposed drill centre development and production Project and the Ivory Gull. Assessment of the effects of these interactions is presented in Table 8.35. Rationale for the assessment is provided in Section 8.7.5 where effects of accidental events on the marine bird VEC are discussed.

Prevention of accidental events is the primary mitigative measure. However, in the case of an accidental event, appropriate response measures are required. Husky's plans for spill response are discussed in detail in two documents currently on file with the C-NLOPB. They are (1) East Coast Oil Spill Response Plan WR-ERP-PR-0001, and (2) East Coast Offshore Operations – Stage 1 Spill Response Procedures WR-ERP-PR-0002.

The residual environmental effects of each of these accidental event scenarios on the Ivory Gull were predicted to be *significant* (Table 8.36). The significant negative effect is deemed to be irreversible at the individual level but reversible at the population level.

8.7.8.3 Blue Whales and North Atlantic Right Whales

Table 8.32 indicates the potential interactions of accidental events associated with the proposed drill centre development and production Project and two marine mammal species currently listed on Schedule 1 of *SARA*, the blue whale and the North Atlantic right whale. Assessment of the effects of these interactions is presented in Table 8.37. Rationale for the assessment is provided in Section 8.7.6 where effects of accidental events on the marine mammal VEC are discussed.

Prevention of accidental events is the primary mitigative measure. However, in the case of an accidental event, appropriate response measures are required. Husky's plans for spill response are discussed in detail in two documents currently on file with the C-NLOPB. They are (1) East Coast Oil Spill Response Plan WR-ERP-PR-0001, and (2) East Coast Offshore Operations – Stage 1 Spill Response Procedures WR-ERP-PR-0002.

The residual environmental effects of each of these accidental event scenarios on blue whales and North Atlantic right whales were predicted to be *not significant* (Table 8.38).

Table 8.33 Environmental Effects Assessment of Potential Effects of Accidental Events on Wolffishes.

Valued Environmental Component: Wolffishes									
				Evaluation Criteria for Assessing Environmental Effects					
Accidental Event Scenario	Potential Positive (P) or Negative (N) Environmental Effect	Regulative Mitigation	Project Specific Mitigation	Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural And Economic Context
Subsea Blowout 7 Day	Contamination (N)	Contingency Plan	Training, Preparation, Equipment, Inventory, Prevention	0-1	6	<1	2	R	1
Subsea Blowout 45 Day	Contamination (N)	Contingency Plan	Training, Preparation, Equipment, Inventory, Prevention	0-1	6	<1	2	R	1
Above-surface Blowout 7 Day	Contamination (N)	Contingency Plan	Training, Preparation, Equipment, Inventory, Prevention	0-1	6	<1	2	R	1
Batch Spill 800 m^3	Contamination (N)	Contingency Plan	Training, Preparation, Equipment, Inventory, Prevention	0-1	5	<1	2	R	1
Batch Spill 10,000 m^3	Contamination (N)	Contingency Plan	Training, Preparation, Equipment, Inventory, Prevention	0-1	5	<1	2	R	1
Batch Spill 30,000 m^3	Contamination (N)	Contingency Plan	Training, Preparation, Equipment, Inventory, Prevention	0-1	5	<1	2	R	1

Magnitude
0 = Negligible
1 = Low
2 = Medium
3 = High

Geographic Extent
1 = < 1 km^2
2 = 1-10 km^2
3 = 11-100 km^2
4 = 101-1,000 km^2
5 = 1,001-10,000 km^2
6 = > 10,000 km^2

Frequency
1 = < 11 events/year
2 = 11-50 events/year
3 = 51-100 events/year
4 = 101-200 events/year
5 = > 200 events/year
6 = continuous

Duration
1 = < 1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = > 72 months

Reversibility (population level)
R = Reversible
I = Irreversible

Ecological/Socio-Cultural and Economic Context
1 = Relatively pristine area or area not negatively affected by human activity
2 = Evidence of existing negative anthropogenic effects

Geographic extent differed between summer and winter for each scenario but both were always within the same category.
Effects on individuals irreversible but any population effects are likely reversible.

Table 8.34. Significance of Predicted Residual Effects of Accidental Events on Wolffishes.

Valued Environmental Component: Wolffishes				
Accidental Event Scenario	Significance of Predicted Residual Environmental Effects		Likelihood[a]	
	Significance Rating	Level of Confidence	Probability of Occurrence	Scientific Certainty
Subsea Blowout 7 Day	NS	3	-	-
Subsea Blowout 45 Day	NS	3	-	-
Above-surface Blowout 7 Day	NS	3	-	-
Batch Spill 800 m^3	NS	3	-	-
Batch Spill 10,000 m^3	NS	3	-	-
Batch Spill 30,000 m^3	NS	3	-	-

Significance Rating (significance is defined as a medium or high magnitude (2 or 3 rating) and duration > 1 year (≥ 3 rating) and geographic extent > 100 km^2 (≥ 4 rating)
NS = Not significant negative environmental effect
S = Significant negative environmental effect
NS = Not significant negative environmental effect
P = Positive environmental effect

Level of Confidence (professional judgement)
1 = Low level of confidence
2 = Medium level of confidence
3 = High level of confidence

Probability of Occurrence (professional judgement)
1 = Low probability of occurrence
2 = Medium probability of occurrence
3 = High probability of occurrence

Level of Scientific Certainty (based on scientific information and statistical analysis or professional judgement)
1 = Low level of scientific certainty
2 = Medium level of scientific certainty
3 = High level of scientific certainty

[a] Only considered in the event of significant (S) residual effect

Table 8.35. Environmental Effects Assessment of Potential Effects of Accidental Events on the Ivory Gull.

Valued Environmental Component: Ivory Gull									
Accidental Event Scenario	Potential Positive (P) or Negative (N) Environmental Effect	Regulative Mitigation	Project Specific Mitigation	Evaluation Criteria for Assessing Environmental Effects					
				Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural And Economic Context
Subsea Blowout 7 Day	Mortality (N)	Contingency Plan	Training, Preparedness, Prevention, Cleanup Inventory	1-3	6	<1	2	I[a]	2
Subsea Blowout 45 Day	Mortality (N)	Contingency Plan	Training, Preparedness, Prevention, Cleanup Inventory	1-3	6	<1	2	I[a]	2
Above-surface Blowout 7 Day	Mortality (N)	Contingency Plan	Training, Preparedness, Prevention, Cleanup Inventory	1-3	6	<1	2	I[a]	2
Batch Spill 800 m^3	Mortality (N)	Contingency Plan	Training, Preparedness, Prevention, Cleanup Inventory	1-3	5	<1	2	I[a]	2
Batch Spill 10,000 m^3	Mortality (N)	Contingency Plan	Training, Preparedness, Prevention, Cleanup Inventory	1-3	5	<1	2	I[a]	2
Batch Spill 30,000 m^3	Mortality (N)	Contingency Plan	Training, Preparedness, Prevention, Cleanup Inventory	1-3	5	<1	2	I[a]	2

Magnitude
0 = Negligible
1 = Low
2 = Medium
3 = High

Geographic Extent
1 = < 1 km^2
2 = 1-10 km^2
3 = 11-100 km^2
4 = 101-1,000 km^2
5 = 1,001-10,000 km^2
6 = > 10,000 km^2

Frequency
1 = < 11 events/year
2 = 11-50 events/year
3 = 51-100 events/year
4 = 101-200 events/year
5 = > 200 events/year
6 = continuous

Duration
1 = < 1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = > 72 months

Reversibility (population level)
R = Reversible
I = Irreversible

Ecological/Socio-Cultural and Economic Context
1 = Relatively pristine area or area not negatively affected by human activity
2 = Evidence of existing negative anthropogenic effects

[a] Effects on individuals irreversible but any population effects are reversible

Geographic extent differed between summer and winter for each scenario but both were always within the same category.

Table 8.36. Significance of Predicted Residual Effects of Accidental Events on the Ivory Gull.

Valued Environmental Component: Ivory Gull				
Accidental Event Scenario	**Significance of Predicted Residual Environmental Effects**		**Likelihood[a]**	
	Significance Rating	**Level of Confidence**	**Probability of Occurrence**	**Scientific Certainty**
Subsea Blowout 7 Day	S	3	1	1
Subsea Blowout 45 Day	S	3	1	1
Above-surface Blowout 7 Day	S	3	1	1
Batch Spill 800 m^3	S	3	1	1
Batch Spill 10,000 m^3	S	3	1	1
Batch Spill 30,000 m^3	S	3	1	1

Significance Rating (significance is defined as a medium or high magnitude (2 or 3 rating) and duration > 1 year (≥ 3 rating) and geographic extent > 100 km^2 (≥ 4 rating)
NS = Not significant negative environmental effect
S = Significant negative environmental effect
NS = Not significant negative environmental effect
P = Positive environmental effect

Level of Confidence (professional judgement)
1 = Low level of confidence
2 = Medium level of confidence
3 = High level of confidence

Probability of Occurrence (professional judgement)
1 = Low probability of occurrence
2 = Medium probability of occurrence
3 = High probability of occurrence

Level of Scientific Certainty (based on scientific information and statistical analysis or professional judgement)
1 = Low level of scientific certainty
2 = Medium level of scientific certainty
3 = High level of scientific certainty

[a] Only considered in the event of significant (S) residual effect

Table 8.37. Environmental Effects Assessment of Potential Effects of Accidental Events on Blue Whales and North Atlantic Right Whales.

Valued Environmental Component: Blue Whale, North Atlantic Right Whale									
				Evaluation Criteria for Assessing Environmental Effects					
Accidental Event Scenario	**Potential Positive (P) or Negative (N) Environmental Effect**	**Regulative Mitigation**	**Project Specific Mitigation**	**Magnitude**	**Geographic Extent**	**Frequency**	**Duration**	**Reversibility**	**Ecological/ Socio-Cultural and Economic Context**
Subsea blowout 7 days	Effects on Health (N)	Contingency Plan	Training, Preparation, Equipment Inventory, Prevention	0-1	6	<1	2	R	1
Subsea blowout 45 days	Effects on Health (N)	Contingency Plan	Training, Preparation, Equipment Inventory, Prevention	0-1	6	<1	2	R	1
Above-surface blowout 7 days	Effects on Health (N)	Contingency Plan	Training, Preparation, Equipment Inventory, Prevention	0-1	6	<1	2	R	1
Batch spill 800 m^3	Effects on Health (N)	Contingency Plan	Training, Preparation, Equipment Inventory, Prevention	0-1	5	<1	2	R	1
Batch spill 10,000 m^3	Effects on Health (N)	Contingency Plan	Training, Preparation, Equipment Inventory, Prevention	0-1	5	<1	2	R	1
Batch spill 30,000 m^3	Effects on Health (N)	Contingency Plan	Training, Preparation, Equipment Inventory, Prevention	0-1	5	<1	2	R	1

Key:

Magnitude:	Geographic Extent:	Frequency:	Duration:	Reversibility:
0 = negligible	1 = <1 km²	1 = < 11 events/yr	1 = < 1 month	R = Reversible
1 = Low	2 = 1-10 km²	2 = 11-50 events/yr	2 = 1-12 months	I = Irreversible
2 = Medium	3 = 11-100 km²	3 = 51-100 events/yr	3 = 13-36 months	
3 = High	4 = 101-1000 km²	4 = 101-200 events/yr	4 = 37-72 months	
	5 = 1001-10,000 km²	5 = >200 events/yr	5 = > 72 months	
	6 = >10,000 km²	6 = continuous		

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not negatively affected by human activity.
2 = Evidence of existing negative effects.

[a] Geographic Extent differed during summer & winter but always fell within the same category of Geographic Extent.

Table 8.38. Significance of Predicted Residual Effects of Accidental Events on Blue Whales and North Atlantic Right Whales.

Valued Environmental Component: Blue Whale, North Atlantic Right Whale				
Accidental Event Scenario	Significance of Predicted Residual Environmental Effects		Likelihood[a]	
	Significance Rating	Level of Confidence	Probability of Occurrence	Scientific Certainty
Subsea Blowout 7 Day	NS	3	1	1
Subsea Blowout 45 Day	NS	3	1	1
Above-surface Blowout 7 Day	NS	3	1	1
Batch Spill 800 m^3	NS	3	1	1
Batch Spill 10,000 m^3	NS	3	1	1
Batch Spill 30,000 m^3	NS	3	1	1

Significance Rating (significance is defined as a medium or high magnitude (2 or 3 rating) and duration > 1 year (≥ 3 rating) and geographic extent > 100 km^2 (≥ 4 rating)
NS = Not significant negative environmental effect
S = Significant negative environmental effect
NS = Not significant negative environmental effect
P = Positive environmental effect

Level of Confidence (professional judgement)
1 = Low level of confidence
2 = Medium level of confidence
3 = High level of confidence

Probability of Occurrence (professional judgement)
1 = Low probability of occurrence
2 = Medium probability of occurrence
3 = High probability of occurrence

Level of Scientific Certainty (based on scientific information and statistical analysis or professional judgement)
1 = Low level of scientific certainty
2 = Medium level of scientific certainty
3 = High level of scientific certainty

[a] Only considered in the event of significant (S) residual effect

8.7.8.4 Leatherback Sea Turtle

Table 8.32 indicates the potential interactions of accidental events associated with the proposed drill centre development and production Project and the leatherback sea turtle. Assessment of the effects of these interactions is presented in Table 8.39. Rationale for the assessment is provided in Section 8.7.7 where effects of accidental events on the sea turtle VEC are discussed.

Prevention of accidental events is the primary mitigative measure. However, in the case of an accidental event, appropriate response measures are required. Husky's plans for spill response are discussed in detail in two documents currently on file with the C-NLOPB. They are (1) East Coast Oil Spill Response Plan WR-ERP-PR-0001, and (2) East Coast Offshore Operations – Stage 1 Spill Response Procedures WR-ERP-PR-0002.

The residual environmental effects of each of these accidental event scenarios on leatherback sea turtles were predicted to be *not significant* (Table 8.40).

Table 8.39. Environmental Effects Assessment of Potential Effects of Accidental Events on Leatherback Sea Turtles

Valued Environmental Component: Leatherback Sea Turtle									
				Evaluation Criteria for Assessing Environmental Effects					
Accidental Event Scenario	Potential Positive (P) or Negative (N) Environmental Effect	Regulative Mitigation	Project Specific Mitigation	Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Subsea blowout 7 days	Effects on Health (N)	Contingency Plan	Training, Preparation, Equipment Inventory, Prevention	0-1	6	<1	2	R	1
Subsea blowout 45 days	Effects on Health (N)	Contingency Plan	Training, Preparation, Equipment Inventory, Prevention	0-1	6	<1	2	R	1
Above-surface blowout 7 days	Effects on Health (N)	Contingency Plan	Training, Preparation, Equipment Inventory, Prevention	0-1	6	<1	2	R	1
Batch spill 800 m^3	Effects on Health (N)	Contingency Plan	Training, Preparation, Equipment Inventory, Prevention	0-1	5	<1	2	R	1
Batch spill 10,000 m^3	Effects on Health (N)	Contingency Plan	Training, Preparation, Equipment Inventory, Prevention	0-1	5	<1	2	R	1
Batch spill 30,000 m^3	Effects on Health (N)	Contingency Plan	Training, Preparation, Equipment Inventory, Prevention	0-1	5	<1	2	R	1

Key:

Magnitude:	Geographic Extent:	Frequency:	Duration:	Reversibility:
0 = negligible	1 = <1 km²	1 = < 11 events/yr	1 = < 1 month	R = Reversible
1 = Low	2 = 1-10 km²	2 = 11-50 events/yr	2 = 1-12 months	I = Irreversible
2 = Medium	3 = 11-100 km²	3 = 51-100 events/yr	3 = 13-36 months	
3 = High	4 = 101-1000 km²	4 = 101-200 events/yr	4 = 37-72 months	
	5 = 1001-10,000 km²	5 = >200 events/yr	5 = > 72 months	
	6 = >10,000 km²	6 = continuous		

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not negatively affected by human activity.
2 = Evidence of existing negative effects.

[a] Geographic Extent differed during summer & winter but always fell within the same category of Geographic Extent.

Table 8.40. Significance of Predicted Residual Effects of Accidental Events on Leatherback Sea Turtles.

Valued Environmental Component: Leatherback Sea Turtle				
Accidental Event Scenario	**Significance of Predicted Residual Environmental Effects**		**Likelihood[a]**	
	Significance Rating	**Level of Confidence**	**Probability of Occurrence**	**Scientific Certainty**
Subsea Blowout 7 Day	NS	3	1	1
Subsea Blowout 45 Day	NS	3	1	1
Above-surface Blowout 7 Day	NS	3	1	1
Batch Spill 800 m^3	NS	3	1	1
Batch Spill 10,000 m^3	NS	3	1	1
Batch Spill 30,000 m^3	NS	3	1	1

Significance Rating (significance is defined as a medium or high magnitude (2 or 3 rating) and duration > 1 year (≥ 3 rating) and geographic extent > 100 km^2 (≥ 4 rating)
NS = Not significant negative environmental effect
S = Significant negative environmental effect
NS = Not significant negative environmental effect
P = Positive environmental effect

Level of Confidence (professional judgement)
1 = Low level of confidence
2 = Medium level of confidence
3 = High level of confidence

Probability of Occurrence (professional judgement)
1 = Low probability of occurrence
2 = Medium probability of occurrence
3 = High probability of occurrence

Level of Scientific Certainty (based on scientific information and statistical analysis or professional judgement)
1 = Low level of scientific certainty
2 = Medium level of scientific certainty
3 = High level of scientific certainty

[a] Only considered in the event of significant (S) residual effect

Comment No. 113: Insufficient level of detail for SAR

Comment No. 114: More thorough discussion on SAR

Comment No. 115: Evidence that effects on Ivory Gull population is reversible

9.0 Summary and Conclusions

9.1 Residual Effects of the Project

The predicted residual effects of the Husky White Rose Development Project: New Drill Centre Construction & Operations Program including accidental events on Species-at-Risk are assessed as negative but *not significant*.

Comment No. 116: Species-at-Risk not discussed

9.2 Cumulative Effects of the Project

Projects and activities considered in the cumulative effects assessment included:

- New Drill Centre Construction & Operations Program within-Project cumulative impacts. For the most part, and unless otherwise indicated, within-Project cumulative effects are fully integrated within this assessment;
- Hibernia, Terra Nova, and White Rose (existing offshore oil developments);
- Other offshore oil exploration activity (seismic surveys and exploratory drilling). In 2007, Grand Banks activity could include multiple seismic surveys and delineation/exploration drilling. The Labrador Shelf may also see some exploration activity because there has been recent seismic survey activity there.
- Commercial fisheries;
- Marine transportation (tankers, cargo ships, supply vessels, naval vessels, fishing vessel transits, etc.); and
- Hunting activities (marine birds and seals).

CAPP had predicted that there would be between one and four drill rigs per year operating on the Grand Banks between 2000 and 2010 (CAPP 1999). CAPP's scenario for a moderate level of activity predicts two rigs drilling exploration, delineation and production wells on the Grand Banks each year over the ten-year period. It is reasonable to assume that there will be at least two exploratory drilling programs on the Grand Banks in 2007. Any cumulative effects on the Grand Banks ecosystem from drilling outside the proposed drilling area will probably not overlap in time and space and thus, will be additive but not multiplicative. This level of activity will not change the effects predictions when viewed on a cumulative basis unless significant oil spills or blowouts occur.

A potential scenario for cumulative effects from drill mud and cuttings discharge would be if the material settles on the ocean floor, smothers benthic communities partially or completely, and effects are persistent over time. This scenario is subject to numerous variables such as type of mud, weather conditions, water depth and velocity, discharge depth, species involved, biological and biodegradation activity. In order to obtain some order of magnitude of the area of seabed potentially affected by the Husky development drilling during the 2007-2012 period, one can quickly calculate a very rough approximation of the total affected area.

A maximum of 54 wells would be drilled during the Drilling Phase, all within the constructed glory holes. Assuming 500 m as the radius of each well's biological zone of influence (ZOI) (i.e., potential smothering due to a minimum of 1 cm thickness of deposited cuttings and mud) and given that the floor dimension of each glory hole will be 70 m x 70 m, there would be essentially 100% overlap of the ZOIs of adjacent wells within a single glory hole. Therefore, the ZOI associated with each glory hole would have an area of approximately 0.78 km^2. The total area of ZOI for all five proposed glory holes will be approximately 3.90 km^2, equivalent to <1% of the area of the Project Area. Including the ZOIs of the 19 wells in the existing 3 glory holes increases the total ZOI area to 6.24 km^2, equivalent to <1.6% of the area of the Project Area. Since the wells will be drilled on the floor portion of each glory hole which is approximately 11 m below the surface of the ocean substrate, it is likely that much of the mud and cuttings deposition will occur within the glory holes (136 m x 136 m including sloped ramps), areas already subjected to HADD. Deposition from adjacent wells in any single glory hole will accumulate vertically (i.e., overlap of individual well biological ZOIs).

Comment No. 117: Uncertainty associated with cumulative effects estimations and potential for future data collection

9.3 Monitoring and Follow-up

Comment No. 118: Spill specific EEM

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Appendix 1: Comments and Responses for the Husky White Rose Development Project: New Drill Centre Construction and Operations Program Environmental Assessment.

COMMENT ID	COMMENT	RESPONSE
General Comments		
No.1	For the discussion on sea ice/icebergs and accidental events, it appears that most of the information was taken from the White Rose Comprehensive Study Report, without an attempt to provide an update to the data. For instance, sea ice and iceberg data set consulted for the Drill Centre EA includes only data up to 2001. The data set used in the discussion of accidental events only covers spills up to 2000. Recent data, for sea ice/icebergs and spill events, up to at least 2005 should have been referenced in the EA report. In addition, spill information for the Newfoundland and Labrador Offshore area is now available on the C-NLOPB website. This data set should be referenced in discussing spill probability in the NL offshore area.	See Section 4.5 for updated ice and iceberg information. See Section 8.1 for updated accidental event information.
No. 2	Section 5.3.14 of the Scoping Document (C-NLOPB 2006) does not appear to be addressed in its entirety. For instance, "…the EA should address…whether any elements of that project…are additional or supplementary to the project already assessed." Please clarify if this requirement of the scoping document has been satisfied within the EA Report.	As noted throughout the EA, the proposed project is construction of subsea drill centres that will tie back to the FPSO currently operating at the White Rose Oil field. Operation of the FPSO and all associated activities such as helicopters, stand by/supply vessels, and tanker traffic were assessed under the White Rose Comprehensive Study Report. During construction of the new drill centres, there will be additional activity in the form of a dredging vessel to construct glory holes, drilling rigs to drill new wells, vessels to install subsea equipment as well as the associated support activities including helicopter and stand by/supply vessels. Also during new drill centre development, there will be additional discharges of drill cuttings from the new wells as well as routine discharges from the various vessels that will be employed in the development activities. Glory hole construction will be addressed through a Habitat Compensation Agreement with DFO and subsequent disposal of spoils from dredging will be addressed through an Ocean Dumping permit from Environment Canada.

		During operation of the new drill centres, FPSO operation and the supporting activities will be the same as those previously assessed (i.e., there will be no additional vessel/helicopter activity, and discharges and emissions from the FPSO will not exceed the daily maximums levels that were assessed in the White Rose Comprehensive Study Report). The above noted additional activities related to construction of the new drill centres are the focus of this EA.
No. 3	Chemicals used in the offshore will be screened according to the Offshore Chemical Guidelines (NEB et al., 1999), but the EA provides no information on the matter.	Husky like all other offshore operators is required to comply with the GUIDELINES RESPECTING THE SELECTION OF CHEMICALS INTENDED TO BE USED IN CONJUNCTION WITH OFFSHORE DRILLING & PRODUCTION ACTIVITIES ON FRONTIER LANDS, JANUARY 1999, National Energy Board, Canada - Newfoundland Offshore Petroleum Board, Canada - Nova Scotia Offshore Petroleum Board http://www.cnlopb.nl.ca/publicat/guidelin/ocsg/ocsg.pdf Husky has procedures in place to implement these guidelines for both drilling and production operations. These procedures are subject to audit by the CNLOPB and have been audited by that agency in 2006 The guidelines address Canadian regulatory requirements in combination with the experience and information accumulated in the North Sea. In addition, as the processes in the North Sea jurisdictions have evolved the approaches and information generated by those processes have been taken into consideration and used. CEPA requirements with respect to the DSL/NDSL and lists of chemical proscribed as toxics are taken into consideration as is the *Pest Control Product Act* and the *Hazardous Products Act*. It is Husky's understanding that the Offshore Petroleum Boards are planning to review and update these guidelines in the near future.
No. 4	Care should be taken when information extracted from the Jeanne d'Arc Basin exploratory drilling project report is incorporated into this document. Instead of stating the White Rose New Drill Centre Construction project, the exploratory drilling project is stated.	Changes made in Sections 8.7.3 (Commercial Fishery), 8.7.4.7 (Enhancement Techniques), 8.7.5.1.5 (Summary of Effects on Cetaceans), 8.7.5.2.5 (Summary of Effects on Seals), and 8.7.6.1 (Summary of Effects on Sea Turtles)
No.5	In some sections, a list of organizations is inserted to show who was involved in consultations. Some of these lists present One Ocean and the Fish, Food and Allied Workers on the same line. Please separate these two organizations in all sections.	Changes made in Section 5.6.1 (Information Sources).

No. 6	Figures are used quite often in the document, but they are usually hard to read or interpret. These figures should be larger to be much more effective.	So noted.
No. 7	Sediment excavation will remove 155,540 m^3 of sediment in a zone of 70 X 70 meters for each glory hole. In addition to direct habitat/sediment removal, suspension of sediment will occur. In light of bottom currents, the zone of influence has the potential to be greater than 70m X 70m. Has the actual zone of influence been modeled or assessed to this point?	The technology that will be used to dredge the new glory holes will be a suction hopper dredge. Material is lifted through the trailing pipes by one or more pumps and discharged into a hopper contained within the hull of the dredge, thus minimizing sediment suspension in the water column. As well, the sediments in the White Rose area are predominantly sand (> 95%) rather than silt or clay, thus sediment suspension is less of a concern. The zone of influence of sediment suspension as a result of glory hole construction has not been modeled. It should be noted however that any sediment suspension will be primarily associated with the deposition of dredge spoils at the existing sediment disposal site in the south-west of the White Rose Field. It is not expected that the area affected will be any greater than that area already affected by previous disposal activities especially as any new spoils will be deposited on the already affected areas at the disposal site. In addition, the extent of any dispersal of the kinds of sediment to be excavated can be reasonably considered as significantly less in terms of physical area that was modeled for drill cuttings in the White Rose comprehensive study. Activities associated with glory hole construction are regulated through the Habitat Compensation Agreement with DFO and the Ocean Dumping permit issued by Environment Canada.
No. 8	Produced water discussion. Throughout the document, the discussion of produced water appears to focus on the discharge associated with drilling activities. Produced water is typically not encountered during drilling activities. It is, however, a primary waste associated with production activities. This is not evident in the EA report. In addition, in the effects assessment sections, for each of the VECs, the discussion of produced water and the potential effects associated with its discharge is insufficient. In addition, cumulative effects discussion does not address the discharges from other production installations.	Produced water is indicated as a potential product for both drilling and production in Table 7.1 (Project Activity Table to Aid in Developing Frequency and Durations Ratings) and in all VEC assessment tables for routine activities (Tables 7.5 to 7.20). Produced water from both delineation drilling and production operations is discussed in text accompanying the assessment tables. See additional text in Sections 7.6.1.6.9 and 7.6.2.6.9.
No. 9	The coverage of Species at Risk is dismissive and thus, inadequate. Evaluation of SAR is basically a description of the various listed species without the benefit of any added measures to ensure the protection of those species – something that should be the main component of the document. While the report addresses legal aspects of *SARA* by considering listed species, it is a minimum requirement and DFO recommends that the report fully acknowledge the rarity of all species at risk and that due caution will	Text added to Section 5.3 (*SARA*-listed Species) New text in Sections 7.6.7 and 8.7.8.

	necessarily need to be exercised. Finally, the report, in assessing effects of both routine and accidental events, avoids directly assessing effects on SAR by stating: "The details of potential effects…on relevant marine animals species…have been discussed in previous sections…". For *SARA* listed species with low estimated populations, a detrimental effect on individuals may translate into a significant effect at the population level. Given their importance, these sections are not adequate and a better effects analysis and specific mitigations for SAR should be presented. The SAR assessment should clearly identify adverse effects and significant adverse effects on listed SAR, and propose and describe mitigation and monitoring to address the adverse effects. Where applicable, the proponent should refer to listed SAR recovery strategies/action plans to ensure that proposed mitigation is consistent with the applicable strategies/plans.	
No. 10	This document often refers the reader to the White Rose Oilfield Comprehensive Study Report and other previous EA reports for details on effects assessment. DFO reiterates that it is inefficient to expect reviewers to refer to other EA documents for detailed information on the biophysical environment and on effects assessment. The report should present a summary of the information and original references to support it.	The document does summarize relevant information presented in other documents. Revised summary text regarding the physical environment has been included in Section 4.0.
No. 11	DFO has produced a review of the potential hydrophysical-related issues in Canada, risks to marine mammals, and monitoring and mitigation strategies for seismic activities (Lawson and McQuinn, 2004) that it recommends for referral as it is relevant to both this assessment and to other places in Canada. This reference, as well as others is attached to this document.	It is anticipated that the monitoring and mitigation strategies for seismic activities outlined in the referenced document (Lawson and McQuinn 2004) will be incorporated into the forthcoming Mitigation of Seismic Noise in the Marine Environment – Statement of Canadian Practice. Once referenced in regulation the relevant mitigation measures in the Statement of Practice will be implemented. Currently, the relevant mitigations in the Statement of Practice are considered and incorporated into our seismic operations as appropriate.
No.12	There are spelling and typographical errors throughout the document.	Corrections of spelling and typographical errors are included in the revised text.
No. 13	Table of Contents: A "Personal Communication" section has not been included in the document.	Personal Communication now included.
No. 14	Table of Contents: Appendix 2 (List of People Consulted) has not been included in the document.	Appendix 2 now included.

Specific Comments		
No. 15	Section 1.0, page 1, 3rd paragraph, line 1: Summer is identified for construction to begin. Fall is identified later in the document**.**	Despite searches of the document, examples of statements that construction will begin the fall could not be found.
No. 16	Section 3.0, page 6: Anchorage of a rig is not discussed, demonstrating the size, type and number of anchors typically used. This would be interesting to know to add to the disturbance or dredging of the sea floor from certain styles of anchors and chains.	The MODUs that will be used to drill the new wells will have 8-point or 12-point mooring systems. For example, the *GSF Grand Banks* has an 8-point mooring system using Stevin MK3 anchors with two flukes angled at 32 degrees. The anchors are typically located 1200 to 1300 m from the drilling platform, radiating out in an approximate 45 degree pattern. For a 12-point system, the anchors would be placed in groups of three (approximately 15 degrees apart) with an approximate 60 degree angle between each grouping. The anchoring systems are computer controlled to maintain station keeping.
No. 17	Section 3.0, page 6, 1st paragraph: It is stated that the currently active drill centres are shown on Figures 1.1 and 1.2. It is not obvious on these figures**.**	Abbreviations for the three currently active drill centres have been added to the first paragraphs of Section 1.0 (Introduction) and Section 3.0 (Project Description).
No. 18	Page 8: The use of jack-up drilling rigs is not discussed in this section. If there is a possibility that jack-up rigs could be used throughout the life of the project, then they should be included in the EA report**.**	Section 3.5.2 explicitly states that jack-up drilling rigs will not be used for the Project.
No. 19	Section 3.7, page 11: It should be the "Department of Fisheries and Aquaculture" not the "Department of Fisheries, Food and Aquaculture".	Change is made in Section 3.7.
No. 20	Section 3.8, page 12. In the discussion of the number of well per drill centre, it is stated that the SWR drill centre will have up to 8 wells. However, in the "White Rose Development Plan Amendment – South White Rose Extension Tie-back" (Husky 2006) a maximum of 16 wells in the SWR Drill Centre is contemplated. The information presented in the EA report should be consistent with that presented in the Development Plan Amendment. As such it is required that the EA be modified to include an assessment of environmental effects associated with a maximum of 16 wells in the SWR drill centre.	The EA has been modified to include a revised project description and an assessment of the environmental effects associated with the addition of 8 wells in the SWRX drill centre and the addition of another glory hole with 16 wells in the North Amethyst drill centre. The Project Area has also been revised to include the area of the North Amethyst drill centre.
No. 21	Table 3.1, page 13. A potential schedule of activities is presented in Table 3.1, and the temporal scope of the EA for the drilling activities is indicated as a four-year period, to end in 2011. Husky is proposing to drill 30 wells in approximately 48 months. However, the effects assessment indicates a drill	The revised Project Description (Section 3.0) has addressed this discrepancy. The maximum number of wells has been revised to 54 and the period of drilling has been extended to 2016. Concurrent drilling may occur if the maximum number of wells is realized.

	time of 60 days per well. Therefore, for 30 wells, it will take approximately 60 months, a full year beyond project estimates. If drilling is required to be undertaken beyond 2011, these activities will be outside the scope of project/scope of assessment and will require an additional environmental assessment.	
No. 22	Section 3.8.4, page 15. The 3rd paragraph in this section indicates that a discharge of approximately 0.330 m^3 of oily residue will be discharged during subsea equipment installation. In the discussion of environmental effects with respect to production activities, the effects associated with tie-back to the FPSO, including the above, and mitigations to reduce or eliminate effects, are not included. The EA report should include a discussion of environmental effects for all phases of the project, including tie-back/hook-up to the existing FPSO.	The oily discharge associated with tie-back has potential to interact with primarily fish habitat and fish. See new sections 7.6.1.6.11 discussing effects of oily discharge on fish habitat, and 7.6.2.6.11 discussing effects of oily discharge on fish VEC. This activity is considered in Section 7.6.7 (Species-at-Risk) in relation to the wolffishes. The primary mitigation is to maximize efficiency of flowline flushing in order to minimize the oily discharge.
No. 23	Section 3.9, page 23: The Offshore Waste Treatment Guidelines (NEB et al., 2002) place an onus on operators to review and implement pollution prevention measures that minimize waste generation and discharge. Consideration of pollution prevention measures has important implications for the nature and extent of environmental impacts from offshore activities. Nonetheless, the discussion of pollution prevention opportunities is limited in the EA. Similarly, consideration of alternative means of carrying out the project is essentially restricted to a brief paragraph on rig type and a sentence on the use of vertical wells (p. 10). Examples of pollution prevention opportunities which could be considered in revisions to the EA include the following: • opportunities to recover water-based mud as opposed to a bulk release at the end of the well; • alternative means of managing synthetic-based muds such as measures that reduce drilling mud volumes, reduce or substitute the toxic constituents of drilling muds, and other means of managing the resulting waste (e.g., re-injection of cuttings, transport to shore) recognizing that technology is being developed to remove oil from cuttings); • substitute drilling additives; and • options related to the length and/or diameter of the surface-hole section.	Although a discussion of alternative means of carrying out the project is not required for a Screening under CEAA, the environmental assessment did note where alternative means of carrying out the project (i.e., well type, drilling rig and dredger) were considered. Husky has in place a Compliance Monitoring Plan for drilling activities that addresses and monitors the management of drill fluids to minimize their discharge to the environment. Husky utilizes low toxicity SBM fluids and selects drilling and utility chemicals that minimize toxicity to the environment. In the past year, Husky has employed reconditioning of drill muds onshore and recovery of base oil that is then re-used offshore to minimize SBM base oil discharges. Husky also employs a Duster Cutting Dryer on its development drilling rig. This equipment is advanced technology for optimal drying of synthetic, mineral-oil and diesel-base drilled cuttings and is recognized by the CNLOPB as BAT for this type of activity. Husky has also experimented with RVD (rotary vacuum drier) technology on its exploration drilling rig. This technology is a secondary processing unit for treatment of SOC (synthetics on cuttings) and is applied following treatment by the shakers in order to recover more drilling mud from cuttings prior to disposal.

No. 24	Section 3.9.2.2, page 23: The maximum amount of produced water associated with increased production from the new drill centres, and that already estimated from existing production should be stated. If this amount is anticipated to exceed that assessed in the White Rose Comprehensive Study, the Drill Centre EA report should include an assessment of effects associated with the additional produced water.	See revised Section 3.9.2.
No. 25	Section 3.9.8.1, page 24: The EA states that the target discharge concentration for chlorine in cooling water is 0.5 ppm. Chlorinated wastewater effluent through once-use coolant systems is listed as a toxic substance under CEPA. It is recommended that the EA include a discussion of alternatives to chlorine use and whether these are feasible for the proposed project. If chlorine is to be employed, the proponent should indicate which chlorine product has been selected for use and consider the potential for the dechlorination of cooling water prior to discharge. The Pest Management Regulatory Agency should be contacted with respect to the applicability of the *Pest Control Products Act* and use of chlorine in any non-closed-loop cooling water systems.	Husky has complied with the White Rose Decision Report Condition #36 which required Husky to document the rationale for the chosen system for biofouling control. This report titled *Condition 36: Cooling Water Discharge* (WR-HSE-RP-0063) was provided to the C-NOPB in 2003. Husky's current chlorine discharge level (0.5 ppm) has been approved by the C-NLOPB pursuant to the OWTG. As well, the Canadian Council of Environment Ministers has called for a level of hypochlorous acid of 0.5 ppm and Husky is meeting this target. In fact, discharge records for the SeaRose show that the facility is routinely below the 0.5 ppm target for chlorine discharge.
No. 26	Section 4.0, page 28: There is no effects assessment of the environment on the project, as stated later in the document. Section 5.3.4 of the Scoping document states that the EA report is to include effects of the environment on the Project. However, no such assessment is provided in the EA report. The effects of the project on the environment assessment piece should be consistent, in terms of information presented and analysis undertaken as is provided for the VECs, and include all project activities.	See response to Comment No. 26 in Chapter 4.0.
No. 27	Section 4.0, page 28: The EA references a detailed report by Oceans Ltd (2005) provided in Appendix 1. Sections 1 and 2, and Appendices A and B of this Oceans Ltd report, are nearly identical to the wind and wave information presented in Section 4.2, Climate, and Appendices A & B, in LGL (2005a). It would be clearer to refer to LGL (2005a) in the EA report rather than Oceans Ltd (2005), since the wind and wave information in LGL (2005a) has been more widely distributed and reviewed. Response to the EC review comments on the wind and wave climate and its effects on the project, are contained in LGL (2005a), should be incorporated into this document. The EA did not include any mention of long-term or decadal climate variation or change as it relates to the marine climate in this area, even though this project includes a production program scheduled out to 2020. Most climate	See Appendix 3.

	studies to date have not yet definitely shown an increasing trend in winds and waves over the Grand Banks or the Scotian Shelf. In fact, some studies have shown a flat or slightly decreasing trend. However, projections from coupled atmosphere-ocean climate models show that an increasing trend is expected in the future. While the effects of long-term climate change may or may not impact the area by that date, the time period is long enough to include variations due to inter-annual or decadal variability. It is recommended that current atmospheric circulation patterns, such as the North Atlantic Oscillation or the Pacific-North America pattern, how they vary over a decadal scale, and how they relate to marine climate over the Grand Banks, be discussed.	
No. 28	Section 4.0, page 28: There is no discussion of the iceberg scour environment, seabed sediments, or the character of the sediments that will be dredged.	See Husky EEM reports for extensive documentation of sediments and Section 4.5 Ice and Icebergs..
No. 29	Section 4.0, page 28: Physical Environment - In general, the material as it relates to the physical environment is acceptable. However, the ocean current models commonly used for spill trajectory tracking in the NL Region are inadequate. In this report, the International Ice Patrol map of mean currents is used; but these do not contain any fluctuations about the mean and miss much of the horizontal and temporal variability present in real currents. At some point, a future trajectory exercise should be conducted with a modern model that simulates the real ocean more closely.	See Appendix 3.
No. 30	Section 4.2.3, page 31: This section lists the databases used to derive the marine climate statistics in recent assessments of the Project Area. In addition to the AES40 hindcast database, it lists the marine weather and sea state observations by ships and platforms archived by ICOADS; marine weather observations from Husky programs on the Grand Banks during the 1980s and 1990s; and wind observations, waverider buoy data, and ocean current data, from a number of drilling programs on the Grand Banks from 1980-1989. It does not appear that any of the databases of observations or measurements were used in the derivation of the wind and wave climate, despite what is suggested in this section. The EA report itself contains almost no specific information on climatological wind and wave statistics for the area. Instead it refers to Oceans Ltd. (2005), contained in the Appendix. The wind and wave information in Oceans Ltd. (2005) is based entirely on the AES40 dataset of hindcast values. The assessment of the physical environment would be much enhanced by the analysis of the observations mentioned in this section. ICOADS observations	See Appendix 3.

	are available directly from the ICOADS website, which allows downloading of subsets of data defined by specific areas. Waverider data are available directly from the MEDS website. The wind sources listed in this section come from marine reports, which include a 10-minute mean wind. However, aviation observations include a 2-minute mean wind, which is of more use for design (platform selection) and operational considerations. Aviation reports and other instrument measurements, including waverider data, would be available from industry archives. Specifically, the Hibernia platform has been in place and transmitting 3-hourly marine reports, since November 1997. The Henry Goodrich and the GSF Grand Banks semi-submersible platforms have been operating in the area for the past several years, and have sent marine reports on a 3-hourly basis. As mentioned in this section, a waverider has usually been located near a drilling platform. The Terra Nova FPSO has been operating in the area since January 2002 and the Sea Rose FPSO has been on site at White Rose since August 2005. While these FPSOs have not sent marine reports, they would have aviation observation programs in support of helicopter operations to each ship, and this data would be available in industry archives. It is recommended that recent aviation and marine observations of winds and waves from platforms and waverider buoys operating in the area in recent years also be analyzed and results presented and compared to the AES40 hindcast results. This would be of particular value as there have been a number of very extreme storms in the last 10 years, and given that the AES40 hindcast wind is a somewhat different quantity than what is observed by platforms.	
No. 31	Section 4.2.4, page 33: This section requires elaboration. Even if the physical environment is described in a separate report, pertinent details should be summarized in the EA report. As it stands, the EA does not provide specific values, other than that maximum monthly wind speeds exceed 30 m/s in February. This value represents the maximum one-hour mean wind speed at 10 m, but this was not stated. The kind of wind speed should be defined in terms of averaging period and equivalent anemometer height as it makes a significant difference, as noted below. The anemometer height affects the mean wind speed value, and higher peak values are expected for shorter averaging periods. The AES40 hindcast winds represent a one-hour mean wind speed. Peak values from one-hour mean winds will be lower than peak values from the 10-minute means in marine	See Appendix 3.

	reports and lower than the peak values from the one to two-minute means used for aviation. Anemometers are generally well above 10 m, around 80 m for drilling platforms, as indicated in Section 4.2.3, or as high as 139 m at Hibernia. The 2005 reports gives 10-minute and 1-minute mean equivalents to the 1-hour mean, for the extremal analysis winds. These are determined by increasing the one-hour maximum values by 1.06 and 1.22, respectively. A maximum one-hour mean wind speed of 30 m/s (58 kt) would correspond to a maximum 10-minute mean wind of (31.8 m/s) 61 kt, for example. References to the adjustment factors should be given. There are also methods to adjust the winds for height. The accuracy of these statistical or empirical adjustment methods is uncertain and dependent on actual conditions in the marine surface layer. The 2005 Oceans Ltd. report indicates that the wind speeds are based on gridded data at 6-hourly intervals, and may be slightly underestimated, and that it is highly probable that some of the peaks in the wind speed have been missed by the hindcasting methodology. It would be prudent to analyze winds that have been measured for marine reports and for aviation, by platforms located near the area of interest for more than 2 decades, in some cases. These results, including description of peak events, should be presented. There does not appear to be any consideration of extreme winds and waves that might be experienced during passage of a tropical, transitioning, or post-tropical cyclone during the summer and fall. This analysis should be conducted or previous studies applicable to this area should be referenced and summarized. Although the passage of tropical, transitioning, or post-tropical cyclones over this area is relatively rare, the EA should include some consideration of the possible conditions should one occur. Description of the climate typically includes descriptions of the means, maximum values, and some indication of the frequency distribution of the field of interest. Wind roses, frequency distribution (percent exceedance) plots, and joint frequency distribution tables of wind speed and direction, on an annual and monthly basis, are provided in Appendix 1 of the EA report. These are useful ways of describing typical climate conditions. However, the wind roses, frequency distribution plots, and joint frequency distribution tables are not usually adequate to describe the top 10 percent or so of the wind speed distribution. The extreme values occur too infrequently to appear on diagrams or in tables giving percent frequency of occurrence to the hundredths decimal place. These will not show the most extreme values.	

	For any additional analyses of wind climate that may be undertaken for this EA, such as for observed data, it is recommended that additional means of showing the frequencies of the more extreme values be explored. For example, this could include box plots showing the 75th, 90th, and 99th percentile values, and peak values, of wind speed, by wind direction.	
No. 32	Section 4.2.4.1, page 33: There is no quantitative information presented in the main body of the EA. The relevant information should either be presented in this section or summarized from the appendix or other sources. The EA should include an analysis of hourly significant wave height and peak period measurements made by waverider buoys in the area. This should include presentation of means, peak values, and frequency distributions. This may show useful wave information for the local area that cannot be obtained from the AES40. As recommended for the section on wind, any additional analyses of wave climate that may be undertaken for this EA, such as for measured waves, should explore methods of showing the frequencies of the more extreme values of the wave height and period distributions.	See Appendix 3.
No. 33	Section 4.4.1, page 36: This section should be retitled as either Wind and Wave Extremal Analysis or Wind and Wave Extreme Value Analysis. The EA only refers to the analysis in LGL (2005a), but does not include a summary. Pertinent results should be summarized. There is no reference to the extremal analysis presented in the appendix (as noted, it is the same as in LGL 2005a). The appendix gives extremal analysis results for one-hour mean wind speeds, and gives those values adjusted to 10-minute mean and 1-minute mean equivalent extreme values. For 10-minute mean winds, at 10-m, the 1-yr, 10-yr, 25-yr, and 100-yr return period wind speeds are 50kt, 57kt, 60kt, and 64kt, respectively. However, observed wind speeds during extreme storms in recent years have exceeded these values. Examination of storm summaries for the North Atlantic in the Mariners Weather Log, produced by NOAA (US National Oceanic and Atmospheric Administration) shows that the Hibernia platform winds have reached or exceeded 75kt in each of the last 5 autumn/winter seasons, when the anemometer height was 139 m. If an adjustment factor of .77 is used to reduce these winds to 10 m (assuming neutral stability and a logarithmic profile), that corresponds to a wind at 10 m of 58kt. This is more than the AES40 10-yr return period value. A sustained	See Appendix 3.

	southwest wind of 97kt was measured at the Hibernia platform on 11 February 2003. Reduced by 0.77, this would correspond to a 10 m wind of 75kt. This exceeds the AES40 100-yr return period value. Reports from the Henry Goodrich semi-submersible platform or other platforms, when available, tend to confirm the validity of these extreme values. As indicated in the Mariners Weather Log, these very high wind speeds are also sometimes confirmed by QuikScat satellite-sensed wind speeds. Summary values from the extreme value analysis of AES40 hindcast data should be given in the body of the EA report and compared to the extreme wind speeds measured by platforms in recent severe storms over the Grand Banks. The wind comparison should include adjustment of values to a standard reference height, using air and sea temperature observations if possible. Peak one-hour mean hindcast wind values should be adjusted to be equivalent to the shorter averaging periods corresponding to observed peak values, using the best methods available. Standard adjustment methods for wind, to account for height and averaging period, are empirical and/or statistical. Research and analysis of continuous wind measurements obtained and archived by the offshore industry at various heights from various platforms under extreme conditions might result in improved adjustment methods that could be tailored to the conditions and the platforms on the Grand Banks. In addition, analysis of continuously measured winds speeds would allow assessment of the frequency of rapid wind direction changes at high wind speeds, a particular concern for FPSOs (the kind of vessel planned for use in the production phase of this project). This kind of analysis of rapid wind changes is not possible from 3 or 6-hourly values. Both of these types of research would make valuable contributions to improved understanding of the severe climate in the area and its effects on offshore structures. During the 11 February 2003 storm mentioned above, a waverider in the area measured a significant wave height of 14.66 m. This is close to the AES40 50-yr return period wave height of 14.5 m. Peak significant wave heights from other recent extreme storms have been measured between 7 and 13 m, which were in the same ball park as the AES40 hindcast values. It is recommended that the EA present peak significant wave heights measured by waverider buoys, and compare them to AES40 hindcast waves, and to the extreme value analysis wave heights.	

No. 34	Section 4.5, page 36: The information on ice and icebergs is a succinct summary of what was used in previous reports on Jeanne-d'Arc Basin. In section 4.5.1, it is stated that sea ice cover occurs for an average of four weeks once every three years. Based on the Canadian Ice Service (CIS) report, "Sea Ice Climatic Atlas East Coast of Canada 1971-2000", there have been occurrences of ice in the area 1-15% of the years from the end of January to the end of April, and 16-33% of the years between the end of February and the end of March. In section 4.5.2, the first sentence mentions that in the "last ten years" an average of 900 icebergs reached the Grand Banks each year. It should be specified what period is implied by "the last ten years" (not 1997-2006).	See Section 4.5 for updated ice and iceberg information.
No. 35	Section 4.5.1, page 36: The following sentence requires clarification and/or rewording: "The thickness of most of the sea ice that occurs on the Grand Banks ranges from 30 to 100 cm, based on CIS ice chart data for periods of ice coverage (1985-2001) that exceeded four weeks duration".	See Section 4.5 for updated ice and iceberg information.
No. 36	Section 5.2, Figure 5.1, page 38: The Important Bird Area at Quidi Vidi is Quidi Vidi Lake, not Quidi Vidi Harbour as stated in the document.	The IBA label on Figure 5.1 should be 'Quidi Vidi Lake', not 'Quidi Vidi Harbour'.
No. 37	Section 5.3, page 37: Although the Ivory Gull is still legally listed as Special Concern, it has been upgraded by COSEWIC to Endangered.	The COSEWIC status of the Ivory Gull was redesignated to endangered in April 2006.
No. 38	Section 5.3, Table 5.1, page 40": The Fin Whale is COSEWIC-listed as Special Concern and should be included in the table. Please refer to Lawson, 2006, for preliminary information on distribution and abundance and population estimates of fin whales in waters off Newfoundland and Labrador. Also, the scientific name for the Ivory Gull is Pagophila eburnea, the `n` should be removed from eburnean in the table.	See additional row to Table 5.1 in Section 5.3 for fin whale. Misspelling of scientific name for Ivory Gull is noted.
No. 39	Section 5.5.2.2.3, page 50: The level of detail is not consistent with the rest of the report**.**	See additional text in Section 5.5.2.2.4

No. 40	Section 5.5.3, page 50: In terms of depth distribution of the 3 wolffish species, it appears that there might be some confusion between spotted and northern wolffish. Northern wolffish is the deepest residing species, based on Kulka et al., 2004. Otherwise the descriptions are accurate.	See additional text in Section 5.5.3.1.
No. 41	Section 5.5.3.2, page 52: "The Northern Cod has been called one of the least productive of the major cod stocks (Brander 1994)". This statement seems to downplay the importance of Northern Cod. Updated information on cod should be used here.	Remove the statement attributed to Brander (1994) from Section 5.5.3.2.
No. 42	Section 5.5.3.2, page 52: An additional recommended reference is Rose and Kulka, 1999 who showed that just before final collapse, cod hyper-aggregated just north of the project study area, meaning it is possible that it is an area critical for recovery. This important aspect should be noted in this report.	The reference Rose and Kulka (1999) is noted.
No. 43	Section 5.5.3.2, page 54: Cod boxes should be illustrated on figures/maps, i.e. Hawke Channel & Bonavista Corridor. A map is needed on page 54, or at least make reference to one.	See revised Figure 5.1
No. 44	Section 5.5.3.3, page 54: The authors should make note of the Porbeagle Recovery Potential Proceedings (on the CSAS website under publications/ Proceedings/2005). A key point missed with regard to the Grand Banks is that the area, including White Rose is the pupping ground for this species at risk and therefore a very ecologically important area. As well, the Grand Banks was once a major fishing ground for porbeagle. These are important details that should be mentioned.	See additional text in Section 5.5.3.3.
No. 45	Section 5.5.3.4, page 55: White sharks are very rare in Canadian waters and sightings are recorded mostly in the Bay of Fundy area. They are extremely rare as far north as the White Rose area. This should be noted.	So noted.
No. 46	Section 5.5.3.5 & 5.5.3.6, page 55: Shortfin Mako and blue shark are common in the area and used to be taken in both the porbeagle and the swordfish fishery. Blue is the most common shark species in the world although both have shown decline. Both mako and blue are commonly seen on the banks and even in the bays, a point which should be mentioned.	See additional text in Sections 5.5.3.5 and 5.5.3.6.

No. 47	Section 5.5.3.7, page 55: It should be noted that cusk are at the extreme northern fringe of their range on the southern Grand Bank and would only be itinerant in the White Rose area.	So noted.
No. 48	Section 5.6.2, page 58: The Unit Areas should be included on a figure in this section even though they are identified on Figure 5.1.	Added reference to Figure 5.1 in Section 5.6.2.
No. 49	Section 5.6.3.3, page 74, line 4. Should 2005 be 2006?	See revised text in Section 5.6.3.3.
No. 50	Section 5.7, 2nd paragraph, page 87: The first letter of each word should be capitalized when spelling Programme Intégré de Recherches sur les Oiseaux Pélagiques out in full.	Programme Integer de Recherches sur les Oiseaux Pélagiques
No. 51	Section 5.7, Table 5.8, page 88: Some of the scientific names are missing from the table: Sooty Shearwater – Puffinus griseus and Red-necked Phalarope – *Phalaropus lobatus*. It is not clear how the categories Common, Uncommon, Scarce and Rare occurrence are designated. These categories should be quantified.	See revised Table 5.8 in Section 5.7.
No. 52	Section 5.7, Figure 5.33, page 89: Please provide a reference for this figure.	Lock et al. (1994)
No. 53	Section 5.7, 1st paragraph, page 90: It is stated that there are increased bird numbers along the continental shelf edge from July to September, however, Figure 5.33 (page 89) does not support this conclusion. There is an increasing pattern of effort from July to September but comparisons between blocks for which there is both summer and winter data, for example, show similar patterns of abundance along the shelf edge. It should be noted that Baccalieu Island is not only the largest Leach's Storm-Petrel colony in Atlantic Canada (p. 90), but is the largest in the world.	See revised text in Section 5.7.
No. 54	Section 5.7, page 90, 3rd paragraph, line 2: Table 5.10 lists marine mammals not seabirds.	Reference to Table 5.10 should be to Table 5.9.
No. 55	Section 5.7, page 90, 4th paragraph: The last sentence describing what an IBA is should be moved up to follow the first sentence in that paragraph where the term IBA is introduced.	See revised text in Section 5.7.

No. 56	Section 5.7.1.2, page 94: The correct spelling for the title of this section should be Hydrobatidae.	See revised caption for Section 5.7.1.2.
No. 57	Section 5.7.1.6.1, page 97: The Dovekie breeding area listed as "Nova Zemlya" is spelled incorrectly. The correct spelling is Novaya Zemlya. Other breeding sites that could be added to the list include Severnaya Zemlya and Svalbard.	See revised text in Section 5.7.1.6.1.
No. 58	Section 5.7.1.6.3, page 97, 2nd paragraph, line 6 & last sentence: It states that "Thick-billed Murre is common from October to May" and it also states "Thick-billed Murre is uncommon in the Study Area between October and April".	See revised text in Section 5.7.1.6.3.
No. 59	Section 5.7.2.2, page 99: Storm-Petrels also feed on fish (myctophids, cod, rockfish), squid and octopus.	See revised text in Section 5.7.2.2.
No. 60	Section 5.7.3.1, page 100, 1st paragraph, line 4: It states that "More information on the Ivory Gull can be found in the Species at Risk section". Information on the Ivory Gull is not presented in the SAR section. However, the SAR section should be updated to include a discussion of all SAR (Schedule 1 and COSEWIC listed, as per the Scoping Document).	Remove the sentence in question from Section 5.7.3.1.
No. 61	Section 5.8, page 100: The sentence "Husky's 3D seismic program…observation along" is not finished.	See revised text in Section 5.8.
No. 62	Section 5.8, page 101, Table 5.10: The last column should be split into two columns (COSEWIC and *SARA*).	See revised Table 5.10 in Section 5.8.
No. 63	Section 6.2, page 115, 1st paragraph: There is no "Appendix 2" in the document.	Appendix 2 now included.
No. 64	Section 6.5.2.1, page 119: The "White Rose Operational Area" is not identified on Figure 1.1.	See revised text in Section 6.5.2.1. Project Area is indicated in Figure 1.1.
No. 65	Section 6.6.5, page 123: The Scoping Document states that "Aboriginal Fisheries" should be considered in the cumulative effects assessment.	No aboriginal fisheries are persecuted in the immediate vicinity of the Study Area. The nearest location of aboriginal fisheries is likely off the central Labrador coast.

No. 66	Section 6.8, page 125: This very short section states that wind, ice, waves, and currents, particularly extreme events, that have effects on the Project, are described in detail in Section 4. This is an incomplete statement, since there is very little information in Section 4 itself. The details are in the Appendix. As it stands, Section 4 of the EA does not even include a summary of specific significant values likely to affect the project. There is no description of how the environment could impact on the project, and there is no justification for the statement that effects of the environment on the Project are expected to be not significant. EC has prepared a short document entitled, "Guidance on the Consideration of the Effects of the Environment on a Drilling Project", which could provide some guidance in developing the appropriate justification for EA conclusions. In the EA, the assessment of effects of the environment on the project should include a very brief description of threshold and extreme values likely to impact operations, both in the drilling phase and in the production phase. This would allow assessment of potential downtime. Environmental conditions would have more impact on the production phase, since this would include the wind and wave sensitive offloading from the FPSO to shuttle tankers. Also, FPSOs are more sensitive to severe wind and wave conditions than semi-submersibles, so different thresholds would be required. The assessment of this factor should also include description of weather and wave impacts and methods to mitigate against impacts, under various worst case scenarios for the different platforms and vessels to be used for the project. For example, in the rare event of a blow-out, severe winter weather could hamper or delay efforts to cap a well. Weather at the thresholds of normal operating conditions could increase the risk of a collision between the shuttle tanker and the FPSO. Severe sea states could impact on the ability of the platform to disconnect safely from the well.	See revised text in Section 4.0.
No. 67	Section 7.0 – For fish habitat and fish tables that summarize the environmental effects, the tables indicate negative effects that occur at a continuous frequency. More clarity is needed when you identify these effects as reversible. What is the time frame for disturbed habitat restoration and for negatively affected fish species to rehabilitate?	In their large-scale marine field experiment, Dernie et al. (2003) found that clean sand communities showed the most rapid recovery rate following physical disturbance compared to muddy sand habitats. No significant differences in total number of benthic species and total number of benthic individuals were found between disturbed and undisturbed sites 213 days after disturbance. They suggested that physical and biological recovery rates are mediated by a combination of physical, chemical and biological factors that differ in relative importance in different habitats.

No. 68	In the discussion of environmental effects with respect to production activities, the effects associated with tie-back to the FPSO, and mitigations to reduce or eliminate effects, are not included. The EA report should include a discussion of environmental effects for all phases of the project, including tie-back/hook-up to the existing FPSO.	See response to Comment No. 22.
No. 69	Section 7.0, Table 7.1, page 127: This table does not include several activities which could have important effects, including well spudding and vertical profiling (during which airgun arrays or a single airgun would be used), and well severance during decommissioning (during which explosive charges might be used). These noise-producing activities should be included in the table especially as they are discussed later in Section 7.5.	VSP is included in Table 7.1. See revised Table 7.1 in Section 7.0 for inclusion of oily residue discharge during tie-back and well-severance.
No. 70	Table 7.1. Footnote 'b' states (i.e., concurrent drill of some wells). Is there a possibility that more than one drilling unit will be operating at the same time? If concurrent drilling is planned, then it must be addressed in the EA report, particularly in regards to potential cumulative effects.	See Section 7.6.1.5.5 for reference to concurrent drilling with respect to cumulative effects.
No. 71	Section 7.0, Table 7.1, page 128: The first subheading "Glory Hole Excavation and TGB Installation" should be "Subsea Production Equipment Installation"?	See revised Table 7.1 in Section 7.0
No. 72	Section 7.4, page 131, 1st paragraph: Change the reference list from Payne, et al., 2000 to Payne et al., 2001a, Payne et al., 2001b, Andrews et al., 2004. (See attached references).	See text revision to Section 7.4
No. 73	Section 7.4, page 131, 4th paragraph, last sentence: This conclusion is also supported by the studies carried out on fish health and fish habitat over a three year period at the Terra Nova site where 6 wells were drilled using a combination of water–based and synthetic based muds (Mathieu et al., 2005; Deblois et al., 2005).	See text revision to section 7.4
No. 74	Section 7.4.2, page 133: Synthetic Based Muds supposedly "biodegrade relatively rapidly in certain conditions." Expand on this, outline ideal conditions.	See text revision to Section 7.4.2

No. 75	Section 7.5, Table 7.4, page 135: Supply Boats sound levels are not included for normal operation. This only shows the changes from the extra use of propeller nozzles and bow thrusters. There is no level presented to compare with other vessels and installations.	Broadband source levels for most small ships are ~170-180 dB re 1µPa (Richardson et al. 1995).
No. 76	Section 7.5, Table 7.4, page 135: The table does not include data on the use of vessels with large dynamic positioning thrusters (e.g., larger thrusters than on a typical supply vessel). If data are available on these sources, then they should be included here as applicable.	There are limited data available on DP thruster source levels. A recent report by JASCO Research Ltd. cited a nominal broadband acoustic source level of 177 dB re 1µPa @ 1 m for a rock dumping vessel (the *Pompei*) using DP thrusters (JASCO 2006).
No. 77	Section 7.6.1.5.1, last paragraph, last line, page 144: "In fact, many project effects on benthic communities observed at other development areas have not been observed at White Rose". Please specify what development areas are being referred to – e.g. Offshore Newfoundland and Labrador, or development elsewhere. Also, please provide further explanation as to what effects are being referred to.	See revised text in Section 7.6.1.5.
No. 78	Section 7.6.1.5.5, page 145: The final paragraph downplays cumulative effects by comparing the affected area to the total area of the Grand Banks. This is not necessary to make cumulative effects deem/seem not significant.	So noted.
No. 79	Section 7.6.1.7, page 150: The project will result in the release of greenhouse gas (GHG) emissions, including emissions from blowdowns, maintenance activities, leaks, and accidents and malfunctions. The current federal government has committed to developing a plan to reduce GHGs and ensuring clean air, land, water and energy for Canadians. Several GHGs contribute to climate change. The main anthropogenic contributor is carbon dioxide (CO_2) and the second major contributor is methane (CH_4). Methane is also the primary component of natural gas. Although annual anthropogenic emissions of methane are less than (CO_2) methane is a more effective heat-trapping gas. Each kilogram of methane warms the earth about 23 times more than the same mass of carbon dioxide. Minimizing GHG releases is important from an environmental and economic perspective. It is generally easier to reduce emissions by implementing best practice options at the project planning and design stage rather than after project construction. Estimates of the quantity and composition of GHG emissions can provide a basis for comparing the project with industry profiles,	See additional text in Section 7.6.1.7.

	evaluating reduction opportunities and verifying the effectiveness of the measures implemented. GHGs are a cumulative, global issue and reducing GHG emissions from all sources, both large and small, should be considered. Environment Canada continues to encourage consideration of best practices in an effort to reduce GHGs. The proponent is encouraged to take the following steps in planning the project: • estimate GHG emissions from all project phases (e.g., installation, commissioning, operation, maintenance) and sources; and • consider and implement best practices available for GHG emissions reduction and verify the effectiveness of these efforts.	
No. 80	• Section 7.6.1.7, page 150: For greater clarity and certainty, the proponent should include the following considerations in an assessment of impacts to air quality: • emission estimates for SO2, NOx, H2S, PM, PM2.5, PM10, and VOCs according to source; • potential local effects and contributions to atmospheric loadings as they pertain to ambient air quality objectives in the immediate area; and • a demonstration of how every reasonable effort to adopt best available technologies and best management practices is being taken so as to minimize emissions of air pollutants. Dispersion modeling is the appropriate method for estimating local air pollutant concentrations as a result of the project.	See additional text in Section 7.6.1.7.
No. 81	Table 7.9, page 154. Small transfer spills have a frequency of 5 (more than 200), yet this is ranked negligible. BOP fluid is released at a frequency of 6 (continuous), and is also negligible. Why? Some clarification regarding these releases, in terms of rationale for their occurrence should be provided. Can mitigations be implemented to reduce their frequency? Please clarify.	Frequencies given for small transfer spills and BOP fluid in EA were incorrect. Frequency ratings for small transfer spills and BOP fluids should be 2 (11-50 events/year) and 1 (<11 events/year), respectively. Mitigations for small transfer spills and BOP fluid discharges are indicated in the assessment tables.

No. 82	Section 7.6.2.1, page 157. What scientific evidence, or reference is available to support the statement that safety zones are a 'safe haven for fish' and therefore be a 'positive effect'?	There is extensive scientific documentation that offshore oil and gas platforms attract large numbers of both young (Hernandez et al. 2003) and adult fish (Wilson et al. 2006). For example, Wilson et al. (2006) recorded 10,000 to 30,000 fish associated with individual platforms in the Gulf of Mexico. There is still scientific debate if the increased fish numbers are mainly due to attraction from other areas or if they represent an actual increase in production. Interestingly, the numbers recorded are higher at operating platforms than at natural or artificial reefs and are higher at upper portions of the rig than the lower (Wilson et al. 2006). The following is excerpted a comment/response contained in the White Rose Comprehensive Study Supplement Report (Husky 2001): *Regulator Comment 109 Considering the effect of the sub-sea structures on productivity (artificial reef effect) as positive is unreasonable. Attracting organisms or enhancing productivity at a contaminated site is a potential negative effect and may result in taint.* *Husky Response:* The artificial reef effect and the associated fishery exclusion zone can be considered positive from the perspective of fish and fish habitat. The artificial reef effect at petroleum platforms has been known for some time and is well documented (Gallaway et al. 1979; Gallaway et al. 1981; Stanley and Wilson 1990, 1991, 1997; Black et al. 1994, and others). In the northern Gulf of Mexico, there are over 4,000 petroleum platforms that add approximately 12 km^2 of hard substrate to the 2,600 km^2 of natural hard substrate (Stanley and Wilson 1997). Over 40 species of fish have been reported to be associated with platforms in the Gulf of Mexico (Stanley and Wilson 1990). A recent study by Stanley and Wilson (1997) found between 1,990 and 28,100 fish of 19 species to be closely associated with a petroleum platform that they monitored for 15 months using stationary dual beam hydro acoustics. Seven species accounted for the majority and included commercially and recreationally important species such as amberjack, red snapper and bluefish. Numbers of fish varied seasonally. Both anglers and commercial fishers routinely fish near platforms in the Gulf of Mexico and consume their catches with no apparent complaints of ill effects (Gallaway and Lewbel 1992). In the case of White Rose, underwater structures are expected to attract fish to some extent because of the associated shelter and biofouling

		communities (a potential source of food) that may become established. In addition, the associated fishery exclusion zone will protect local resident fish. These effects were considered positive in the assessment for fish and fish habitat, albeit at a relatively small scale. Taint was considered to be a potential adverse effect in the assessment, but again not a significant effect because in the unlikely event that it did occur, it would only affect resident fish, only sedentary species, and only those individuals not subject to a commercial fishery. Furthermore, tainting is unlikely to occur at White Rose because of the use of synthetic and water-based drilling fluids, treatment of produced water, and strict concentration on eliminating spills. In the unlikely event of a blowout or large oil spill, the oil would go to the surface, where the interaction between the oil and fish would be minimal." Admittedly, most of the research conducted on the fish attraction issue has been conducted in the Gulf of Mexico where there are over 5,000 operating oil and gas platforms in Gulf waters. The Gulf of Mexico also supports about 33% and 40% of the US recreational and commercial fisheries (see Hernandez et al. 2003). In the Gulf of Mexico, the platforms also attract fishers whereas on the Grand Banks, there is a fishery exclusion zone around each platform. Other key differences between the two areas are that there are many more reef-dependent and reef-associated fish in the Gulf than on the Grand Banks and reef habitat may limit production in the Gulf area where the bottom is mostly mud. Nonetheless, it is reasonable to predict that structures on the Grand Banks will attract fish and that this association will protect them from being killed by the fishery. Thus, this can be considered a positive effect, albeit a negligible one given the small geographic area involved.
No. 83	Section 7.6.2.4, page 158: Small spills occur quite frequently in flaring operations. According to Figure 7.9, the occurrence is over 200 times a year. Please explain how this is considered negligible.	According to C-NLOPB statistics, 268 oil spills have occurred in the Newfoundland and Labrador Offshore Area since 1997, an annual average of < 30 spills. This number includes spills of less than 1 litre. Therefore, the small transfer spill frequency indicated in all tables showing environmental effects assessment of routine activities on various VECs should be 2 (11-50 events/year), not 5 (>200 events/year).
No. 84	Section 7.6.2.6.9, page 163. It is implied that any produced water encountered during production operations is sent to the flare. This is incorrect and should be restated.	The reviewer has misinterpreted the section.

No. 85	Section 7.6.2.11, page 165: This section refers back to previous tables, illustrating that ROV work has a frequency of less than 11 times a year. Does this number reflect the frequency of actual maintenance from past experience? How often are ROV's used for observation purposes?	Yes, the frequency rating of 1 (<11events/year) does accurately reflect annual ROV use for maintenance purposes. Even if the frequency of ROV use increased to 11-50 events/year, the same residual effect assessment in terms of significance would be predicted.
No. 86	Section 7.6.3, page 165: The report appears to provide an accurate assessment of the fisheries and harvesting activities in the project area. However, there is no mention of potential effects on species under moratorium (Cod, American Plaice, etc.) and how the proposed activities might impact on recovery efforts for these species.	Given the results of the assessment of the effects of routine activities on fish habitat, fish and Species-at-Risk, the potential effects on fish species under moratorium would also be *not significant*. The proposed activities would unlikely cause serious negative impact on the recoveries of the moratorium species, especially given that the Project Area does not overlap with habitat that is unique to or essential for the recovery of the moratorium species.
No. 87	Section 7.6.4.3, page 181: In the second paragraph, Storm-petrels should read Storm-Petrels.	'Storm-petrels' is correct because the sentence is addressing a family of birds, not a particular species.
No. 88	Section 7.6.4.3, page 181: The report states that birds in one area would not be attracted to other areas where offshore operations would be present. The proponent should indicate if there is any evidence to support the claim that birds present in one area are not attracted to others. The draft EA also indicates that the extent of the effects of light on birds is 1-10km^2. The rationale for using this range should be explained, as it is likely that flares and lights would be visible at distances greater than 10km.	Remove the following sentence from the text in Section 7.6.4.3: "The sites of other activities are separated geographically so birds present in one area will not be attracted to the lights at another site". In Table 7.15, change the geographic extent rating for lights and flaring from 2 (1-10 km^2) to 2-3 (1-100 km^2).
No. 89	Section 7.6.4.4, page 183, 4th paragraph: The effect of flaring during the drilling phase is rated but what about the effect of flaring during the production phase?	See revised text in Section 7.6.4.4
No. 90	Section 7.6.4.14, page 188: The Canadian Wildlife Service (CWS) of EC has developed a pelagic seabird monitoring protocol that is recommended for all offshore oil and gas projects. One version of the protocol is for individuals who have experience conducting seabird surveys. A guide sheet to the pelagic seabirds of Atlantic Canada is available through the CWS office in Mount Pearl. The protocols are a work in progress and the CWS would appreciate feedback from the observers using them in the field. A report of the seabird monitoring program, together with any recommended changes, should be submitted to CWS upon completion.	Husky has a seabird and marine mammal monitoring program that operates on all drilling platforms. All seabird and marine mammal observation data is included in annual end of well reports submitted to the C-NLOPB and CWS has been informed that all observation data can be accessed by CWS directly from Provincial Airlines Limited as required. CWS will receive direct feedback on seabird monitoring protocols from observers during scheduled visits to the platforms to audit the program.

No. 91	Section 7.6.4.14, page 188, 2nd paragraph, line 2: "Husky has" should be changed to "Husky will".	See revised text in Section 7.6.4.14
No. 92	Page 189. Will a seabird and marine mammal observation program be undertaken?	Husky currently conducts a daily marine mammal/seabird observation program on drilling rigs and will continue to do so during the new drill centre Project. Only the Storm-Petrel mitigation program is conducted on the FPSO.
No. 93	Section 7.6.5 & 7.6.6, pages 189 & 203: In light of a vessel-strike incident associated with offshore oil production in 2004, DFO would like to reiterate the necessity to estimate potential impacts of ship strikes on marine mammals and sea turtles. There are computer models for these impacts which are freely-available and which would allow some assessment of the risk caused by the increased number of larger vessels moving through the study area. Geohazard and VSP surveys will collect high resolution seismic, side scan sonar, sub bottom profiler, and multi-beam bathymetric data as needed during well operation. This variety of sound sources could output sound energy at a variety of frequencies and amplitude such that more than one species of marine organism might be impacted. For instance, higher frequency sources would be a concern for the beaked whales, whereas airgun sounds would be more of a concern for baleen whales. Each type of sound source should be considered separately. Additionally, trailing suction dredge vessel and operations will produce significant and long-duration underwater noise due to propeller cavitation and thruster operations, plus propagated dredge pump noise and material passage up and down pipes. These sound sources should be considered and reflected in the document.	DFO (Dr. J. Lawson) was contacted concerning this comment. Ship strikes pose a risk to cetaceans but the risk is likely low given that most marine mammals will exhibit some localized avoidance of ships and that supply ships in the Study Area typically do not exceed cruising speeds of 11 knots (Wiese and Montevecchi 1999) Collision modeling software is available (see <u>http://www.chelonia.co.uk/html/collisions.html</u>) and requires several input parameters including "whale population density – animals per sq. km. in a survey area including the ship transect". Suitable density estimates of marine mammals (and sea turtles) are lacking for the Study Area thereby precluding any meaningful calculations of collision risk. Estimating risk from ship collisions may be useful in future EAs if density estimates for marine mammals and turtles are available. VSP (and geohazard) activities were assessed for Jeanne d'Arc Basin in LGL and Canning and Pitt (2005). Each sound source and its overlap with marine mammal hearing abilities and potential impacts were reviewed. Section 7.6.5.8.2 of the EA reviews available (albeit limited) information on dredging activity on marine mammals.
No. 94	Section 7.6.5.3, Table 7.17, page 190: Why is there a question mark in this table for frequency of BOP Fluid? In Figure 7.9, the frequency shows: 6-continuous.	Frequency of BOP fluid release should be '1' or < 11 events/year.
No. 95	Section 7.6.5.8, page 197 (and relevant sections following): DFO would like to emphasize previously expressed concerns about the potential for displacement and temporary hearing sensitivity changes possible from activities such as seismic profiling, large-scale DSP thrusters, and well severance explosives. In all cases the DFO recommends that standard mitigation measures be adopted, and that these measures account for <u>all</u> marine mammal species and sea turtles.	DFO's concern is noted. Mitigation measures are not a requirement or suggested for use by the CNLOPB for DP thrusters. As indicated in Section 7.6.5.8.7 of the EA: "Mitigation measures will also be employed to minimize the potential for effects on marine mammals. An observer will follow the C-NLOPB guidelines for geophysical activities (C-NOPB 2004) and prevent the start up of airgun(s) if a marine mammal (or sea turtle) is sighted within 500 m of the airgun(s) 30 minutes prior to ramp up. Ramp up involves gradually

		increasing the volume of the array over a 20-40 min period before VSP work begins. [If VSP surveys involve the use of one airgun, then ramp up is not possible.] Also, ramp up will be stopped if a marine mammal (or sea turtle) is sighted within 500 m. During surveying, the airgun(s) will be shut down if an endangered marine mammal is sighted within 500 m of the airgun(s)." The last sentence in the above paragraph should read: "During surveying, the airgun(s) will be shut down if an endangered marine mammal *or sea turtle* is sighted within 500 m of the airgun(s)." The primary choice of wellhead removal would be to mechanically cut the casing strings and retrieve the assembly with an appropriate retrieval tool. Efforts will be made to facilitate an efficient mechanical severance using a milling tool. However, if the internal configuration of the wellhead and casings do not facilitate mechanical removal then the alternative measure is to explosively severe all casing strings. For well severance explosives Husky will employ the following mitigation measures: A ROV camera will inspect the area around the wellhead for marine life before explosives are actuated. Also, observers aboard supply vessels will conduct watches for marine mammals and turtles within a one-mile zone around the rig installation prior to wellhead severance. Observers will begin these watches at least 30 minutes before the scheduled actuation of the charge(s). If a marine mammal or sea turtle was sighted near the wellhead site (i.e., within the one-mile zone), the explosive charge would not be actuated until the animal was well clear from the area.
No. 96	Section 7.6.5.8.5, page 201, 2nd paragraph, line 3: A reference should be provided for the statement "It is highly unlikely that there will be overflights of seals that are pupping or moulting as few, if any, seals will be hauled out (either on ice or land) along the flight route to the Project Area during these critical times or at other times of the year".	Lavigne and Kovacs (1988) provide a description of harp and hooded seal whelping and moulting locations. These sites occur well north of the Study Area.
No. 97	Section 7.6.5.8.6, paragraph 2, page 202: There is a recent paper that studies construction-related noise on ringed seal (responses to helicopter sound, Blackwell et al., 2004) that should be referenced and included.	Observations were made of ringed seal (*Phoca hispida*) behaviour in response to industrial noise (pipe-driving, helicopter overflights) at an artificial island (Northstar Island) in the Alaskan Beaufort Sea (Blackwell et al. 2004). During 55 h of observation, 23 observed ringed seals exhibited little or no reaction to any industrial noise except approaching Bell 212 helicopters; 10 seals looked at the helicopter, one seal departed from its basking site, and one seal showed no reaction.

No. 98	Section 7.6.7 – the discussion of environmental effects on SAR is insufficient. The Scoping Document, section 5.3.11, clearly indicates that the EA report provide an assessment of effects, including cumulative effects. This has not been undertaken in this EA Report.	See revised text in Section 7.6.7.
No. 99	Section 7.6.7, page 204: The Ivory Gull is listed as a species of special concern on Schedule 1 of *SARA*. However, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has recently assessed the Ivory Gull as endangered. In the event that the Ivory Gull is uplisted to endangered on Schedule 1 of *SARA* during construction or operation of the proposed new drill center, the applicable *SARA* requirements and regulations must be considered.	So noted. See revised text in Section 7.6.7.
No. 100	Section 8.0. The discussion of accidental events, including dispersion modelling, probability assessments, and impact assessment are primarily focused on drilling activities (blowouts, small spill from rigs, fuel transfer operations, etc.). This section must include all project phases and activities (construction, tie-back/hook-up to FPSO, drilling, production and abandonment) in its discussion and in the assessment of effects.	Accidental events could potentially occur during any of the five Project Phases. Section 8.0 considers a range of accident spill size scenarios which adequately represents any accidental event that might occur during any of the Project Phases. Small transfer spills and oily residue discharges during tie-back are considered in Section 7.0 on Routine Project Activities.
No. 101	The 2004 spill at Terra Nova was not included. Why?	See additional text and Table 8.3 in Section 8.1.4
No. 102	The CWS report regarding the estimated bird mortality from the Terra Nova Spill was not referenced. Why?	The CWS report regarding the estimated bird mortality from the Terra Nova Spill was not available at the time of submission. See additional text in Section 8.7.4
No. 103	Section 8.3.4, page 232: It is stated that a "detailed discussion of pack ice distribution" is found in Appendix 1. No reference to ice can be found in Appendix 1.	See revised text in Section 8.3.4
No. 104	Effects assessment sections – statements such as "…it is predicted that these will be no significant effects…from an accidental release…at exploration drilling sites." This is not an effects assessment of accidental events from exploratory drilling operations. It is supposed to be an assessment of effects from all project activities (see comment 96). Section 8 requires revisions.	See response to Comment No. 4

No. 105	Section 8.7.2, page 236: Should this be Section 8.7.1?	Section 8.7.1 was skipped in the EA. Numbering in Section 8.7 has been revised.
No. 106	Section 8.7.3.2, paragraph 3, 3rd sentence, page 250: The effects of polycyclic aromatic hydrocarbons on fish have been reviewed more recently (Payne et al., 2003).	See revised text in Section 8.7.2.2
No. 107	Section 8.7.4, page 251: The section mentions mitigation of an oil spill only in the context of financial compensation for fishers. This is most certainly a short-term solution and does not include the potential harm of a major accidental event to the future fishery in the area. Please revisit and revise accordingly.	This comment needs to be considered in the context of the analysis contained in Section 8.7.4. That analysis clearly addresses the effects of an oil spill on all fish life stages and the benthic community. It also recognizes the potential responses of the market place to a spill in terms of perceived or real concerns over taint of fish flesh or shell fish meat. Direct mortality on the various life stages of fish is demonstrated to be *not significant* based on laboratory and population biology analyses and outcomes from large spills elsewhere in the world. This in the context that the concentration of the water soluble fraction of crude oil in the first 10 m of the water column is anticipated to be lower than levels that demonstrate taint effects in the laboratory. As noted in the assessment, Husky has a compensation plan on file with the Board that exceeds the terms of the C-NLOPB guidelines on this subject. It addresses direct effects (i.e., physical damage to fishers' vessels and gear, loss of catch and income, and to a reasonable extent, the impact on fish plant workers directly affected by the loss of catch due to the incident. The compensation plan sets reasonable limits on the nature and extent of claim that can be handles by either negotiation between Husky and a fisher demonstrated to be affected by a spill or by an independent, mutually binding arbitration process that would be accessible during a significant spill. In this context, it is important to note that the fisher can chose to use the processes provided by the plan or seek direct recourse to the legal system. The concern expressed in the comment reflects on the idea of effects on the "future fishery in the area". It is clear from the assessment that the direct biophysical effects of a spill in the area, recognizing that based on various modeling exercises that it is extremely unlikely oil will enter the near shore or affect the shoreline, will be short term. The oil will disperse and be biodegraded and any fish that do ingest or absorb oil fractions to which they are exposed will depurate in a matter of days to weeks. The concern

		with respect to market perception of taint will be mitigated by the implementation of a spill environmental effects monitoring program, a procedure on file with the C-NLOPB. The data and information from this program will address the extent and intensity of effects from the spill on fish and other receptors in the area. These data will contribute to the process of deciding whether or not to close the fishery which is a decision that rests exclusively within the jurisdiction of Fisheries and Oceans Canada.
No. 108	Section 8.7.5, page 253: Even small spills of oil can have very serious effects on migratory birds. Therefore, every effort should be taken to ensure that no oil spills occur in the area. The proponent should ensure that all precautions are taken by the contractors to prevent fuel leaks from equipment, and that a contingency plan in case of oil spills is prepared. Furthermore, the proponent should ensure that contractors are aware that Section 5.1 of the *Migratory Birds Convention Act* prohibits persons from depositing harmful substances in waters or areas frequented by migratory birds.	Husky has in place an Environmental Protection Plan (EPP) and an Oil Spill Response Plan (OSRP). All contractors working for Husky are required to adhere to Husky's EPP and OSRP requirements. Vessels under contract by Husky are required to have an EPP and OSRP approved by Husky.
No. 109	Section 8.7.5.4, page 255: In the third paragraph, it should be noted that adult alcids are also flightless during moult.	See revised text in Section 8.7.4.4
No. 110	Section 8.7.5.7, page 258, 5th paragraph: Do you mean the "New Drill Centre Construction and Operations Program" instead of the "delineation/exploratory drilling program"?	See revised text in Section 8.7.4.7
No. 111	Section 8.7.6.1.5, page 265, 1st paragraph after Table 8.29, last line: Should it be "exploratory drilling sites"?	See revised text in Section 8.7.5.1.5
No. 112	Section 8.7.6.1.5, Table 8.31, page 267: Regardless of the intended interpretation of this table (i.e. the likelihood of occurrence of an event factored into the significance rating), the lack of data and uncertainty presented in the accompanying text does little to justify a rating of 3 (high level of confidence) to a significance rating of NS (Not Significant). This is particularly relevant for potential impacts to species at risk. A discussion regarding how this level of confidence is derived is warranted.	A detailed summary discussion of the potential effects of oil on marine mammals and sea turtles is contained in the 10 pages of text that surround Table 8.31. The prediction of *no significant effect* from an offshore oil spill at White Rose can be made with a high level of confidence for a number of reasons. These reasons include: General Most of these animals, particularly the *SARA* species, are scarce in the Project Area and thus the potential for encountering spilled oil is limited. In addition, many of them have at least some ability to detect and avoid oil on the surface.

		Cetaceans Of the three groups of animals, cetaceans are probably of least concern from an oil spill perspective. After extensive surveys associated with major oil spills such as the ExxonValdez and Santa Barbara (and others), it has been concluded that no direct mortalities can be attributed to these spills. At least some species are known to have the ability to detect and avoid surface oil. Oil on their surfaces does not create thermoregulatory problems (as with seabirds) because cetaceans use blubber for insulation. Ingested oil can be depurated. Confidence in the prediction is clearly high. Seals Seals, especially young seals, may be more sensitive to oiling than cetaceans but again hair seals do not lose thermoregulation due to oiling and they have shown depuration ability. Some individuals may be able to detect and avoid oil but the key feature in terms of interaction is that virtually all Grand Banks oil spill modeling from Hibernia through the White Rose studies has shown the oil to move to the east away from concentrations of seals inshore or at the Front. Studies of major oil spills such as the ExxonValdez (a much worse case than a spill at White Rose would be because of contact with the shore and other factors) have lowered initial direct mortality estimates. Confidence in the prediction is high. Sea Turtles Information on sea turtle abundance and distribution on the Grand Banks is scarce (largely, but not entirely, due to their scarcity) but they are likely rare and they are known to occur only seasonally. As such, the likelihood of their encountering an oil spill is correspondingly low. In addition, no one, to our knowledge, has ever attributed sea turtle mortalities in any significant numbers to an offshore oil spill. Thus, while the confidence in the prediction may be somewhat lower than for marine mammals because of the scarcity of data, it is still high that there will be no significant effects on sea turtle populations from an oil spill at White Rose.
No. 113	Section 8.7.8, page 271: The level of detail is not consistent with the rest of the report.	See revised text in Section 8.7.7

No. 114	Section 8.7.8, page 271: Further to a point previously mentioned, the conclusion of the effects of an accidental event on species at risk as Not Significant, (even in keeping within the definition of high magnitude, greater than one year and over 100 km^2), given with a high level of confidence, is questionable considering the sensitivity to harm for some of these species. As well, it also debatable whether the definition of Significant Effect, as applied throughout the report is even appropriate for the assessment of potential impacts on species at risk. DFO recommends a more thorough discussion of the potential for harm due to accidental events on species at risk.	See revised text in Section 8.7.7.
l5	Section 8.7.8, page 272: The document states that any effects of an accidental spill event on the Ivory Gull may be significant, but will be reversible over time at the population level. Evidence or a reference for this statement should be provided.	Ivory Gull data are scarce but their overall numbers are believed to be low and declining. They are known to travel singly or in small groups and to be highly associated with sea ice. As such their potential for interaction with oil spilled at White Rose is somewhat limited. Nonetheless, a significant effect due to a large oil spill, similar to other seabirds, was predicted in the EA on a precautionary basis using a reasonable "worst case" scenario approach. One could just as easily have predicted no significant effect due to the potential for lack of interaction. In light of the above, coupled with the very low likelihood of a major spill, it seems reasonable to predict that very few (if any) Ivory Gulls would suffer mortality, and thus the population could sustain the loss of a few animals as it would be well within the variability of natural mortality rates. Nonetheless, with or without the loss of a few individuals, the population could still be declining. It is agreed with the reviewer that in the light of the apparent few and declining numbers, it may be premature to conclude that the population will perpetuate. In the event of an oiled Ivory Gull, Husky will attempt to rehabilitate the individual.
No. 116	Section 9.1, page 273: *SARA* is not discussed.	See additional text in Section 9.1.
No. 117	Section 9.2, page 273: Cumulative effects estimations cannot be expressed with such certainty as we know very little about effects of industry on marine mammal distribution and abundance – or even basic information on marine mammal distribution and abundance itself. Given these two sources of uncertainty, DFO would like to see cooperation, in the future, on large-scale baseline surveys to assess abundance and distribution of marine megafauna over larger areas of the region.	So noted. Husky is interested in cooperating with DFO and other East Coast operators in joint efforts to assess abundance and distribution of marine megafauna.

No. 118	Section 9. This section indicates the proponent's commitment to conduct a spill-specific EEM program to test specific hypothesis as part of the oil spill response plan (OSRP). However, the latest version of the OSRP on file at EC (dated 2004 05 20) contains the following elements: • the use of aerial surveys (although these were found to be inadequate based on responses to recent actual spill events); and • activation of the full EEM sampling program for spills >20 m^3 (the annex, which describes that program, contains only a note that the emergency EEM is to be completed before production). Therefore, if there is a more recent version of the OSRP, please provide a copy including the EEM annex for review and any revisions in light of recent experience.	Husky's White Rose Spill Environmental Effects Monitoring Procedure (WR-HSE-PR-4021) is on file with the C-NLOPB and is part of Husky's overall suite of plans, policies and procedures that address emergency and spill response. Husky recognizes that recent experience with the Terra Nova spill response indicated that the placement of seabird observers on vessels provided more useful data than aerial over flights. The above noted procedure does call for aerial over flights but does not preclude placing observers on vessels. Notwithstanding this, Husky concurs that the spill effects monitoring procedure and the OSRP should be revised to incorporate lessons learned to date. Husky would be pleased to meet with Canadian Wildlife Service to review and amend the portions of the procedure that directly address or affect seabirds and migratory birds. The OSRP itself is currently undergoing revision for resubmission to the C-NLOPB.
l9	Appendix 1, TOC: The appendices are not listed for this document.	The appendices were listed in the Table of Contents of the EA. The appendices are now included.

Appendix 2. List of People Consulted

The following agencies and persons were consulted on Husky's proposed development of new drill centres Project.

Environment Canada (Environmental Protection Branch)

Glenn Troke, EA Co-ordinator
Fredricka Kirstein, EA Coordinator (Halifax Office)
Rick Wadman, Manager, Ocean Disposal

Fisheries and Oceans

James Meade, Senior Regional Habitat Biologist
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Bill Brodie, Senior Science Coordinator/Advisor, NAFO

Natural History Society

Dr. Len Zedel, MUN

One Ocean

Maureen Murphy, Research Assistant

Fish, Food and Allied Workers Union

Sherry Glynn, Fisheries Biologist
Keith Sullivan, Fisheries Biologist

Association of Seafood Producers

E. Derek Butler, Executive Director

Fishery Products International

Derek Fudge, Manager, Fleet Administration and Scheduling
William Savory, FPI Offshore Captain

Icewater Harvesting

Michael O'Connor, Fish Harvesting Consultant

Clearwater Seafoods Limited Partnership

Christine Penney, Director of Corporate Affairs

Groundfish Enterprise Allocation Council (Ottawa)

Bruce Chapman, Executive Director

Appendix 3: Climate of the Husky New Drill Centre

by

Oceans Ltd.
December 2006

CLIMATE OF THE HUSKY NEW DRILL CENTRE

Submitted to

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December 2006

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1 Introduction

This report has been prepared as part of an Environmental Assessment for the development of new drill centers in Husky Energy's White Rose Field. The climatology presented has been prepared from three data sources:

- AES-40 wind and wave hindcast dataset covering the North Atlantic Ocean developed by Oceanweather Inc. of Cos Cob, Connecticut under contract to the Meteorological Service of Canada (MSC), and
- The International Comprehensive Ocean-Atmosphere Data Set (ICOADS) consisting of marine weather and sea state observations from vessels, buoys and platforms.
- 3-hourly MANMAR observations taken at White Rose from July 2003 to December 2006.

In its earlier versions, the AES-40 data set consisted of 40, then 42, continuous years of hindcast wind and wave data. The results of the NCEP/NCAR (U.S. National Centers for Environmental Prediction) global re-analysis for 1958-97 wind fields were used as input to a third generation deep water wave model (Berek et al., 2000). The winds were first modified by adding measured winds from buoys and platforms. Tropical cyclone wind fields were generated and added to the background winds. The wind fields were then refined using Oceanweather's Interactive Objective Kinematic Analysis System. The model grid spacing was 0.625º latitude by 0.833º longitude.

Currently, the AES-40 hindcast dataset provides wind velocity and sea state parameter data at 6-hour intervals for the 50 year period from July 01, 1954 through June 30, 2004. Wind speeds are one-hour mean values at a height of 10 metres above sea level. The wind and wave statistics presented in this report are based on the hindcast data for AES-40 grid point 5622, at location 46.88° N, 48.33° W. Data were extracted from the dataset using Oceanweather's OSMOSIS software. Some of the statistics presented were output directly by OSMOSIS, others were computed using in-house developed software. No quality control of this dataset was necessary.

The Husky wind and wave data comes from a 3-hourly MANMAR observation dataset from Husky Energy's White Rose field covering the period July 2003 to December 2006. The dataset contains 10-minute mean wind speeds measured at 82.5 metres above sea level and wind sea and primary and secondary swell heights reported to the nearest half-metre.

The temperature and visibility statistics presented in this report were derived from the International Comprehensive Ocean-Atmosphere Data Set (ICOADS) for the 50-year period 1956 through 2005. Reports from the area bounded by latitudes 46.50° N and 47.25° N and longitudes 47.50° W and 48.50° W were incorporated in the statistics. The ICOADS dataset is noisy and contains observation and position errors, as well as coding mistakes. For this work, positions were assumed to be correct. Otherwise, both on-line and in-house software filters were used to quality control the data in an effort to reduce the number of erroneous reports.

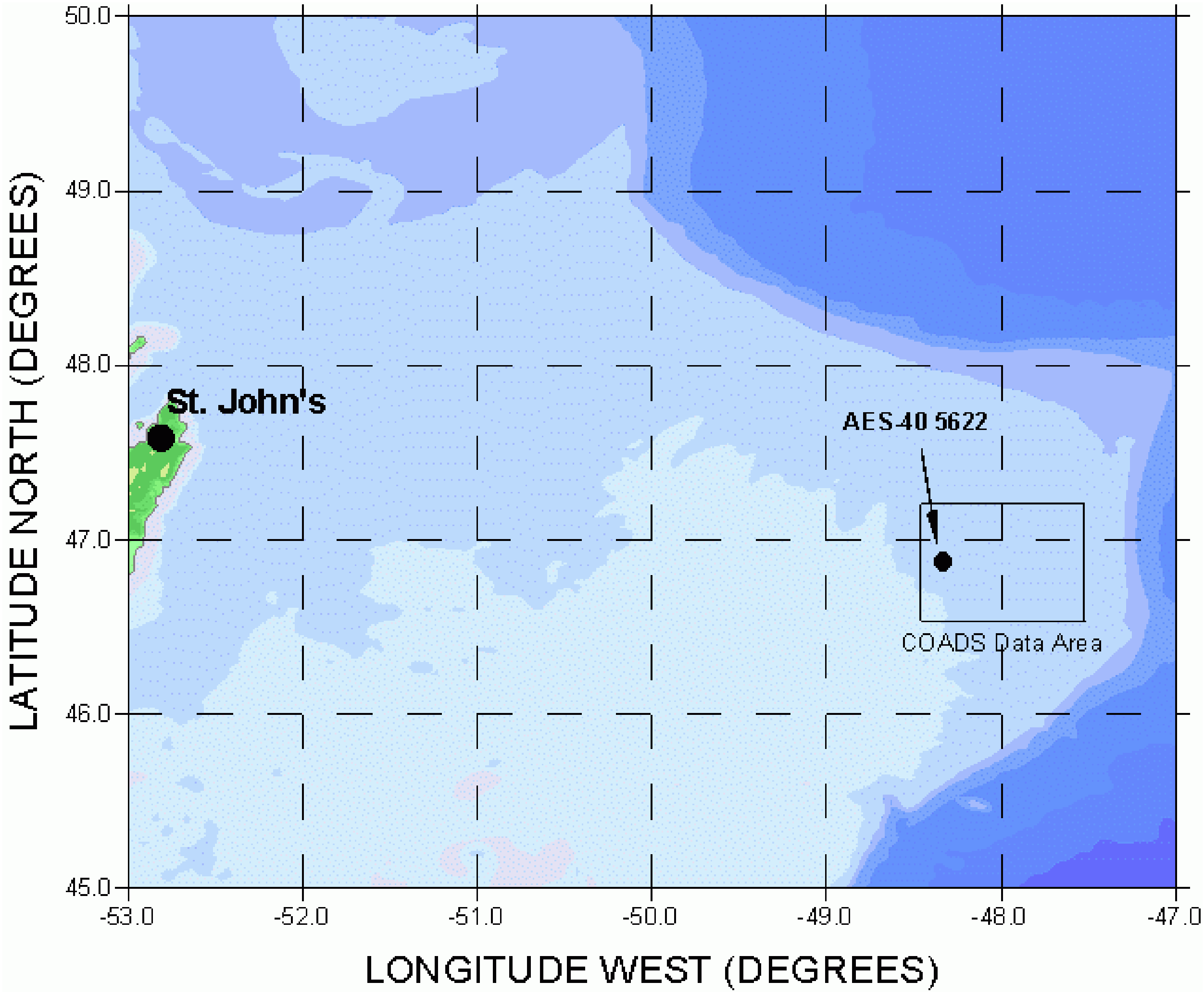


Figure 1. General Location Map showing the position of AES-40 grid point 5622 and the ICOADS data area.

2 Wind Climatology

The wind climatology for AES-40 grid point 5622 is summarized below in a series of tables and plots. Table 1 provides basic descriptive statistics for one-hour mean wind speeds at a 10 metre level above the surface on a monthly basis and for the full 50-year period. The table shows that the mean or most frequent wind direction is from the west to west-southwest during the winter season, while southwesterly winds prevail during the summer months. Monthly wind speeds are lowest during the months of June, July, and August as expected. Average wind speeds are notably higher during the winter months, with maximum monthly winds having exceeded 30 m/s in February. The non-exceedance columns show that 99% of the hindcast values did not exceed 22.6 m/s in February. Standard deviations, a measure of the variability about the monthly means, are smallest during the summer and larger in the cold season, typical of the Grand Banks climatology.

Table 1. Monthly 10 metre Wind Direction and Speed Statistics.

Monthly and Annual 10m Wind Statistics at AES-40 Grid Point 5622								
Month	Wind Direction (degrees True)	Wind Speed (m/s)					Non-exceedance	
	Mean	Min	Max	Mean	Std Dev.	Median	90%	99%
January	260	0.5	26.9	10.8	4.6	10.5	16.9	22.0
February	264	0.8	30.1	10.7	4.5	10.5	16.6	22.6
March	266	0.4	28.9	9.7	4.3	9.6	15.3	19.9
April	248	0.4	26.8	8.2	3.9	7.9	13.5	18.4
May	238	0.2	21.1	7.0	3.5	6.7	11.7	16.3
June	230	0.3	21.8	6.6	3.2	6.3	10.7	14.7
July	222	0.2	20.2	6.2	2.9	6.1	9.9	13.9
August	229	0.3	21.6	6.5	3.1	6.2	10.5	15.3
September	251	0.3	23.3	7.4	3.6	7.1	12.1	17.9
October	258	0.3	26.3	8.7	3.9	8.4	13.7	18.8
November	255	0.5	25.9	9.4	4.2	9.0	15.1	20.1
December	260	0.6	29.3	10.4	4.5	10.2	16.4	21.4
Annual	246	0.2	30.1	8.5	4.2	8.0	14.2	19.9

Source: Grid Point 5622, AES-40 Wind and Wave Hindcast Dataset (July 1, 1954 through June 30, 2004)

Table 2 presents maximum wind speeds (at 10 metres above sea level) by direction for each month and for the full 50-year period. The highest winds are from the southwest through northern sectors. High wind speeds during the late summer months may be caused by tropical cyclones or their remnants, or by energetic extra-tropical low pressure systems.

Table 2. Monthly Maximum 10 metre Wind Speed Statistics by Direction.

Monthly and Annual Maximum 10m Wind Speeds at AES-40 Grid Point 5622 (metres / second)										
	True Wind Direction (centre of 45 degree sector)								All Directions	
Month	NE 45	E 90	SE 135	S 180	SW 225	W 270	NW 315	N 360	Lowest	Highest
January	20.0	23.1	24.2	26.9	26.0	26.7	25.2	22.7	20.0	26.9
February	26.4	21.7	25.7	25.1	30.1	26.7	26.7	29.3	21.7	30.1
March	21.5	20.8	23.5	21.6	23.5	24.2	28.9	26.1	20.8	28.9
April	22.4	21.0	21.1	26.8	22.6	21.6	23.6	23.9	21.0	26.8
May	16.6	16.7	18.1	19.3	20.1	19.0	21.1	20.6	16.6	21.1
June	15.0	18.7	19.0	20.0	19.0	21.5	21.8	16.4	15.0	21.8
July	15.6	19.1	15.9	18.2	20.2	17.0	16.4	14.8	14.8	20.2
August	18.3	17.0	18.7	21.2	17.9	19.8	18.1	21.6	17.0	21.6
September	21.9	20.5	18.6	23.3	22.3	22.1	22.7	22.1	18.6	23.3
October	21.5	18.1	20.4	23.9	25.5	26.3	22.5	25.0	18.1	26.3
November	23.0	22.0	20.9	25.8	21.5	24.2	24.8	25.9	20.9	25.9
December	20.5	21.5	23.7	21.6	26.7	28.6	29.3	28.2	20.5	29.3
Annual	26.4	23.1	25.7	26.9	30.1	28.6	29.3	29.3	14.8	30.1

Source: Grid Point 5622, AES-40 Wind and Wave Hindcast Dataset (July 1, 1954 through June 30, 2004)

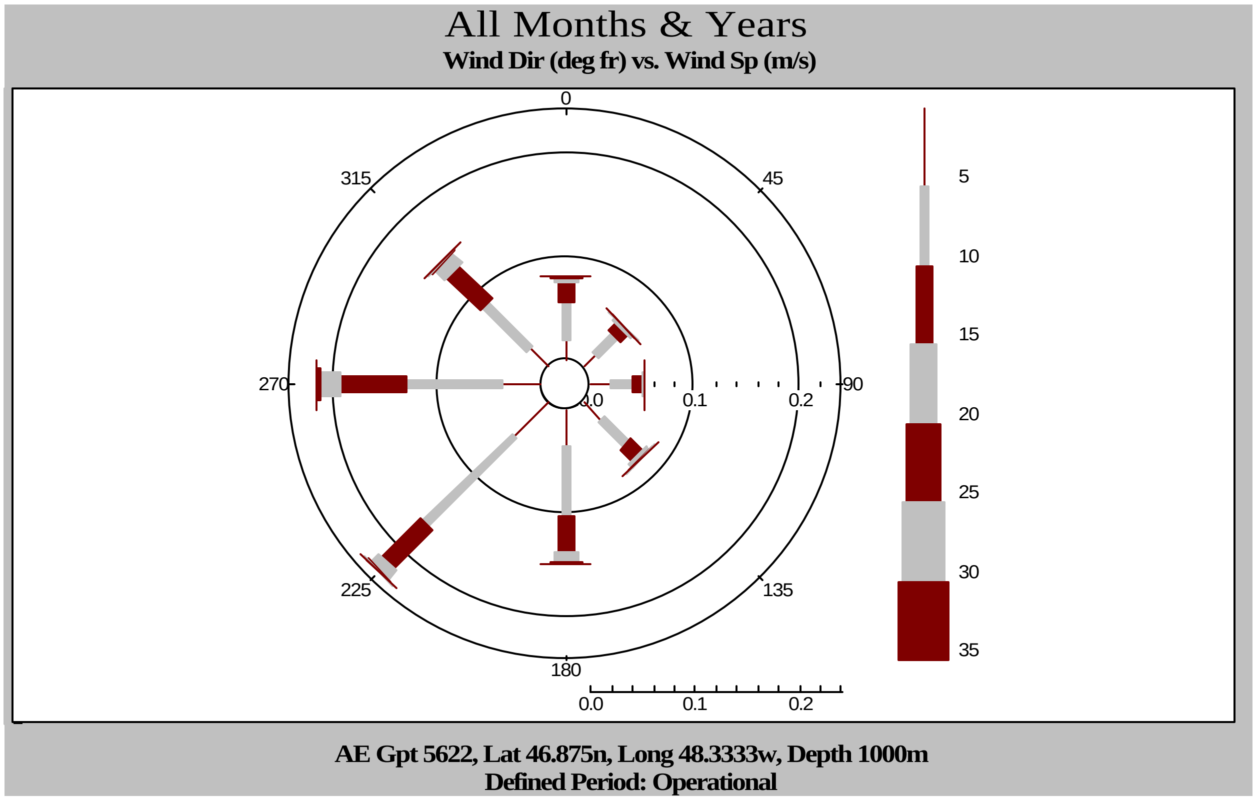
2.1 Wind Rose Plot

Table 3 shows the percent frequency of occurrence of wind speed by 45-degree direction sector for all months and years. Again, this shows the prevalence of southwest and west winds with the highest winds from the southwest and northwest quadrants. A graphic representation of these data in the form of a wind rose plot is shown as Figure 2.

Monthly tables of the percent frequency of occurrence wind speed by direction and corresponding wind rose diagrams are contained in Appendix A.

Table 3. Percentage Occurrence of Wind Speed by Direction for all Months and All Years.

All Months All Years									
Wind Speed Range (m/s)	Centre of 45 Degree Direction Bins 45	90	135	180	225	270	315	360	Totals
0.0 - < 5.0	1.65	1.78	2.37	3.55	4.6	3.71	2.44	1.89	22
5.0 - < 10.0	2.45	2.25	3.27	6.78	11.96	9.22	5.99	3.57	45.5
10.0 - < 15.0	1.04	0.87	1.57	3.42	5.19	6.32	4.53	1.91	24.85
15.0 - < 20.0	0.24	0.21	0.46	1.02	1.13	1.92	1.26	0.45	6.7
20.0 - < 25.0	0.04	0.02	0.04	0.1	0.12	0.29	0.18	0.08	0.88
25.0 - < 30.0	0	0	0	0.01	0.01	0.02	0.01	0.01	0.06
30.0 - < 35.0	0	0	0	0	0	0	0	0	0
Totals	5.44	5.13	7.71	14.88	23.02	21.5	14.42	7.92	100



Source: Grid point 5622, AES-40 wind and wave hindcast dataset (July 01, 1954 through June 30, 2004)

Figure 2. Wind Rose for All Months and Years, July 1954 through June 2004.

2.2 Monthly 10 metre Wind Speed Percentage Exceedance

Table 4 shows the percentage exceedance of the 10 metre wind speed for each month of the year computed from the entire 50-year dataset. Table 5 gives the exceedance in actual numbers of hindcast values. The exceedance values are plotted in Figures 3 and 4. Figure 3, which shows curves for the months of January through to July, illustrates the progression from winter conditions to the more benign summer conditions. Figure 4 shows the monthly progression from the summer (July) through to the winter season as conditions become more boisterous.

Table 4. Percentage Exceedances of 10 metre Wind Speeds

Wind Speed (m/s)	Percentage Exceedance of Wind Speed (%)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1	99.85	99.88	99.47	99.60	98.06	98.10	97.45	98.60	99.00	99.66	99.73	99.81
2	98.85	98.89	97.73	97.15	93.08	93.40	92.56	94.52	95.97	97.52	98.37	98.68
3	96.68	97.28	94.69	92.32	87.06	86.47	85.24	87.52	90.68	94.05	95.77	96.06
4	93.71	94.18	90.63	85.88	78.81	77.67	75.76	76.98	83.07	88.79	91.60	92.84
5	89.34	89.95	85.53	77.83	69.18	66.42	63.95	65.40	72.80	81.56	85.12	88.42
6	84.08	84.11	78.94	69.12	57.34	54.30	51.29	52.94	61.68	73.13	77.40	82.52
7	78.34	78.27	71.84	58.52	46.47	42.18	38.79	40.03	51.00	63.48	68.93	75.45
8	70.76	70.68	64.52	48.48	35.89	30.47	26.58	28.53	40.17	54.44	60.12	67.47
9	63.18	62.72	55.31	38.92	26.65	21.72	15.95	18.95	30.22	44.52	50.20	59.65
10	54.32	54.28	46.11	30.70	19.39	14.53	9.11	12.53	21.95	34.74	41.55	51.15
11	45.95	45.42	37.13	23.38	13.15	8.40	5.08	7.79	15.17	26.34	33.50	42.69
12	37.85	36.80	29.31	16.95	9.11	5.27	2.79	5.16	10.27	19.19	26.58	34.87
13	30.37	28.86	22.56	12.00	5.95	3.22	1.69	3.39	7.05	13.60	20.28	27.94
14	23.60	22.38	16.47	7.97	3.34	1.75	0.90	1.92	4.57	8.90	14.88	21.65
15	17.77	17.20	11.39	5.33	2.06	0.82	0.50	1.11	2.95	6.18	10.32	16.37
16	13.23	12.19	7.87	3.67	1.26	0.48	0.24	0.66	1.90	4.02	6.95	11.66
17	9.26	8.70	5.15	2.03	0.65	0.32	0.08	0.31	1.38	2.58	4.58	7.56
18	6.48	6.14	3.23	1.23	0.32	0.15	0.05	0.16	0.93	1.66	2.90	5.27
19	4.34	4.19	1.61	0.65	0.18	0.05	0.03	0.06	0.57	0.92	1.77	3.35
20	3.02	3.04	0.94	0.45	0.10	0.03	0.02	0.05	0.33	0.56	1.08	1.87
21	1.98	2.16	0.56	0.37	0.02	0.03		0.05	0.23	0.31	0.67	1.23
22	0.98	1.45	0.29	0.15					0.13	0.13	0.35	0.81
23	0.58	0.92	0.18	0.07					0.02	0.08	0.22	0.58
24	0.32	0.58	0.08	0.02						0.05	0.08	0.26
25	0.16	0.35	0.05	0.02						0.03	0.03	0.16
26	0.06	0.23	0.03	0.02						0.02		0.13
27		0.09	0.02									0.06
28		0.07	0.02									0.05
29		0.05										0.02
30		0.02										

Source: Grid Point 5622, AES-40 Wind and Wave Hindcast Dataset (July 1, 1954 through June 30, 2004)

Table 5. Exceedances of 10 metre Wind Speeds

Wind Speed (m/s)	Exceedance of Wind Speed (Number of hindcast values)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	6200	5652	6200	6000	6200	6000	6200	6200	6000	6200	6000	6200
1	6191	5645	6167	5976	6080	5886	6042	6113	5940	6179	5984	6188
2	6129	5589	6059	5829	5771	5604	5739	5860	5758	6046	5902	6118
3	5994	5498	5871	5539	5398	5188	5285	5426	5441	5831	5746	5956
4	5810	5323	5619	5153	4886	4660	4697	4773	4984	5505	5496	5756
5	5539	5084	5303	4670	4289	3985	3965	4055	4368	5057	5107	5482
6	5213	4754	4894	4147	3555	3258	3180	3282	3701	4534	4644	5116
7	4857	4424	4454	3511	2881	2531	2405	2482	3060	3936	4136	4678
8	4387	3995	4000	2909	2225	1828	1648	1769	2410	3375	3607	4183
9	3917	3545	3429	2335	1652	1303	989	1175	1813	2760	3012	3698
10	3368	3068	2859	1842	1202	872	565	777	1317	2154	2493	3171
11	2849	2567	2302	1403	815	504	315	483	910	1633	2010	2647
12	2347	2080	1817	1017	565	316	173	320	616	1190	1595	2162
13	1883	1631	1399	720	369	193	105	210	423	843	1217	1732
14	1463	1265	1021	478	207	105	56	119	274	552	893	1342
15	1102	972	706	320	128	49	31	69	177	383	619	1015
16	820	689	488	220	78	29	15	41	114	249	417	723
17	574	492	319	122	40	19	5	19	83	160	275	469
18	402	347	200	74	20	9	3	10	56	103	174	327
19	269	237	100	39	11	3	2	4	34	57	106	208
20	187	172	58	27	6	2	1	3	20	35	65	116
21	123	122	35	22	1	2		3	14	19	40	76
22	61	82	18	9					8	8	21	50
23	36	52	11	4					1	5	13	36
24	20	33	5	1						3	5	16
25	10	20	3	1						2	2	10
26	4	13	2	1						1		8
27		5	1									4
28		4	1									3
29		3										1
30		1										

Source: Grid Point 5622, AES-40 Wind and Wave Hindcast Dataset (July 1, 1954 through June 30, 2004)

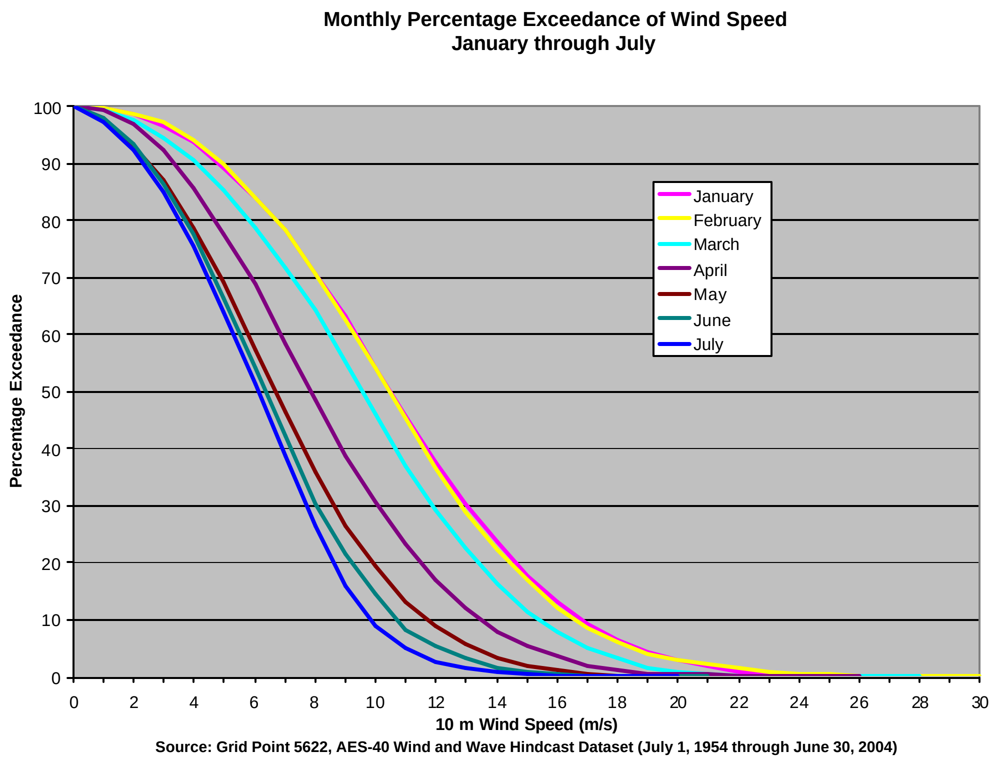


Figure 3. Monthly Percentage Exceedances of 10 metre Wind Speed - January through July

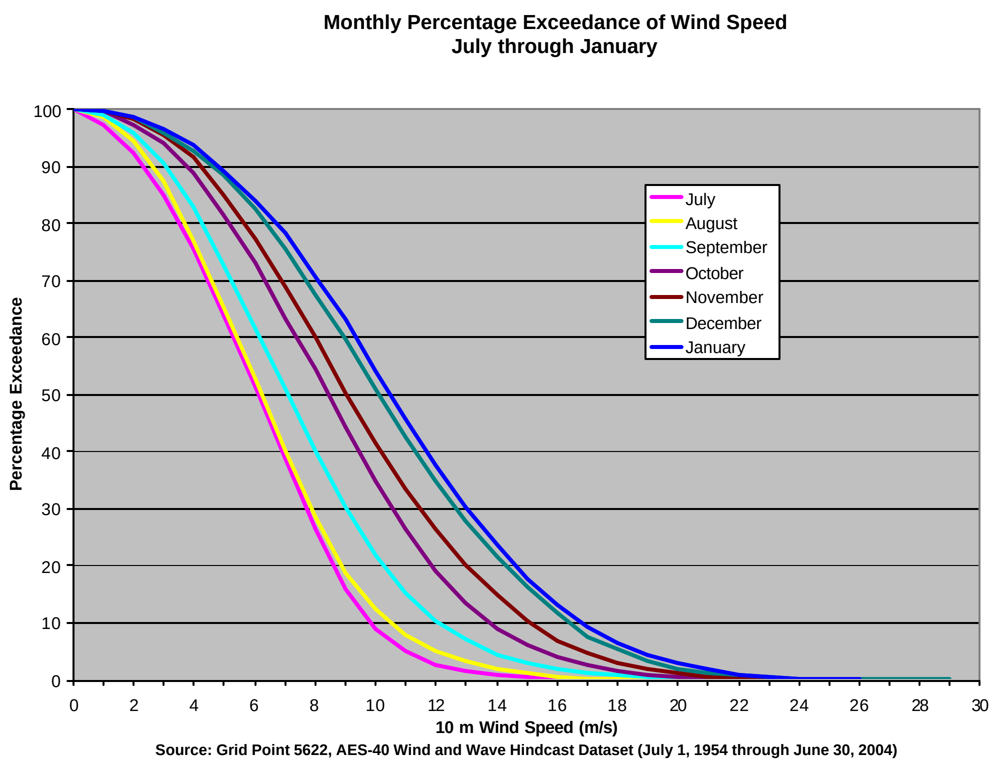


Figure 4. Monthly Percentage Exceedance of 10 metre Wind Speed – July through January

2.3 AES-40 vs. Observed Wind Speeds

Table 6 compares the monthly statistics from the AES-40 and Husky Manmar datasets. A factor of 1.06 (US Geological Survey, 1979) has been applied to the AES-40 wind speeds in order to convert the one-hour mean values to ten-minute means contained in the Manmar dataset. It must be noted that wind speed statistics derived from the AES-40 dataset are valid at 10 metres above sea level, while those derived from the Husky Manmar dataset were measured at 82.5 metres above sea level. Employing a marine wind speed profile model in order to reduce the Husky Manmar wind speeds measured at 82.5 metres above sea level down to the 10-metre reference level may have resulted in misleading values. Simple boundary layer profile models (logarithmic or power-law) do not take into account the effects of stability, which are often significant on the Grand Banks. Other models that do account for stability, such as those of Smith (1981) or Walmsley (1988), have been formulated for heights of 60 metres or below and tend to break down at higher levels under stable conditions whereupon the higher level winds effectively become 'decoupled' from those at the 10-metre reference level.

The maximum Husky Manmar wind speed of 34 m/s in August is significantly higher than the AES-40 maximum of 21.6 m/s. The 34 m/s event took place on 28 August 2006, which is not covered by the AES-40 dataset.

Table 6. Comparison of AES-40 hindcast winds and Husky Manmar winds

Comparison of Monthly Wind Speed Statistics (m/s)						
AES40 Gridpoint 5622 hindcast data vs Husky Manmar data						
	AES40 (10m ASL)			Husky Manmar (82.5m ASL)		
Month	Max	Mean	Std Dev.	Max	Mean	Std Dev.
January	28.5	11.4	4.8	32.9	14.1	6.7
February	31.9	11.4	4.8	35.5	13.4	6.2
March	30.6	10.3	4.5	31.4	12.9	5.6
April	28.4	8.7	4.1	29.8	13.3	6.1
May	22.4	7.4	3.7	25.7	11.2	5.6
June	23.1	6.9	3.4	23.1	10.5	4.4
July	21.4	6.6	3.1	23.1	9.7	4.4
August	22.9	6.9	3.3	34.0	9.3	4.8
September	24.7	7.9	3.8	26.8	10.3	5.1
October	27.8	9.2	4.1	27.3	12.1	5.4
November	27.4	10.0	4.4	29.3	12.6	6.0
December	31.0	11.0	4.8	31.4	13.6	6.3

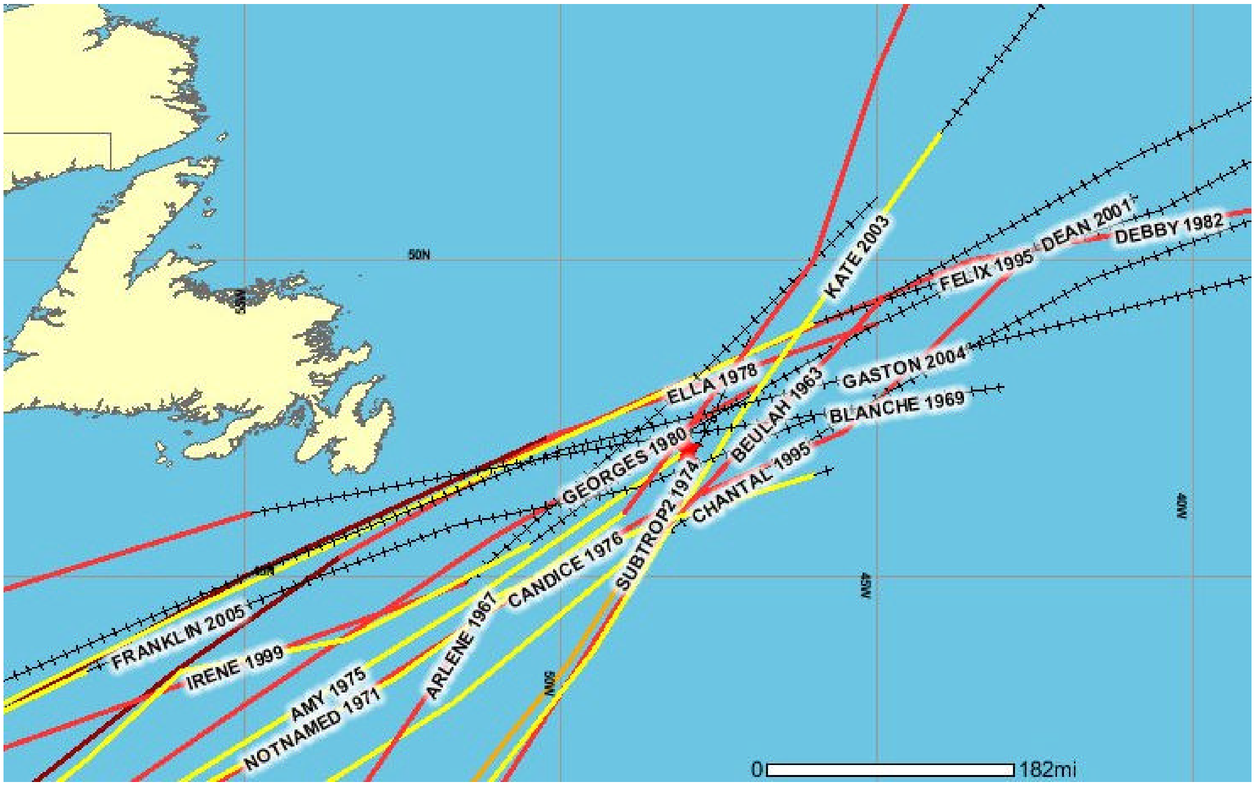
Sources:
AES40 Grid Point 5622 Wind and Wave Hindcast (July 1, 1954 to June 30, 2004)
Husky Manmar Observations (July 12, 2003 through December 1, 2006)

2.4 Tropical Systems

The hurricane season normally extends from June through November. While the incidence of tropical depressions, storms, hurricanes or the remnants of such systems is infrequent, the risk of occurrence is greatest between August and October. The frequency of occurrence from tropical systems that have originated in equatorial regions to affect the Northern Grand Banks region in any particular year is low, and varies from none to a few. These systems normally approach the region from the south or southwest.

Once formed, a tropical storm or hurricane will maintain its energy as long as a sufficient supply of warm, moist air is available. Tropical storms and hurricanes obtain their energy from latent heat of vapourization that is released during the condensation process. Since the capacity of the air to hold water vapour is dependent on temperature, as the hurricanes move northward over the colder ocean waters, they begin to lose their tropical character, often transforming into vigorous, fast moving extra-tropical cyclones. Conditions on the Northern Grand Banks associated with tropical cyclones and their remnants vary widely from relatively minor events to major storms producing windy wet weather and high waves.

Figure 5 shows the historical track of tropical systems that passed within 65 nautical miles of 47 degrees N, 48 degrees W from 1956 to 2005. Table 7 gives the statistical data on these systems. It must be noted a direct comparison should not be drawn between wind speeds given in Table 7 and those in Table 1. The values in Table 7 are the maximum 1-minute mean winds speeds occurring in any sector of the tropical system at the 10-metre reference level as it passes within 65nm of the site and therefore may not be representative of the actual winds that occurred at the site.



Source: NOAA Coastal Services Center

Figure 5. Historical tracks of Tropical Systems passing within 65 nm of 47 degrees N, 48 degrees W, 1956 to 2005.

Table 7. Data for Tropical Systems passing within 65 nm of 47 degrees N, 48 degrees W, 1956 to 2005.

Record	Year	Month	Day	Storm Name	Wind Speed m/s (kts)	Pressure (mb)
1	1963	8	28	BEULAH	36.0 (70)	
2	1967	9	4	ARLENE	30.9 (60)	
3	1969	8	12	BLANCHE	30.9 (60)	
5	1971	8	6	NOTNAMED	38.6 (75)	974
7	1974	7	20	SUBTROP2	20.6 (40)	
8	1975	7	4	AMY	25.7 (50)	986
9	1976	8	24	CANDICE	41.2 (80)	
10	1978	9	5	ELLA	41.2 (80)	975
11	1980	9	8	GEORGES	35.0 (68)	993
12	1982	9	19	DEBBY	38.6 (75)	979
13	1995	7	20	CHANTAL	25.7 (50)	1000
14	1995	8	22	FELIX	25.7 (50)	985
16	1999	10	19	IRENE	41.2 (80)	968
18	2001	8	29	DEAN	23.1 (45)	999
19	2003	10	7	KATE	30.9 (60)	987
21	2004	9	2	GASTON	23.1 (45)	997
22	2005	7	30	FRANKLIN	20.6 (40)	1005

Source: NOAA Coastal Services Center

3 Wave Climatology

The wave climate of the area includes the effects of locally generated wind-waves and swell that propagates into the area from both nearby and distant locations. The highest sea states occur during severe storm systems that track through the region, mainly during October through March. Occasionally, severe storms may occur outside these months. Storms of tropical origin occur most often from late August through October. Hurricanes are usually reduced to tropical storm strength or evolve into extra-tropical storms by the time they reach the Grand Banks, but occasionally these storms still retain hurricane force winds and hence produce high waves.

Sea state conditions at AES-40 grid point 5622 in the area are described in terms of significant wave height and spectral peak period statistics. Table 8 contains basic descriptive statistics for significant wave height on a monthly basis. The lowest monthly mean significant wave height occurs in July (1.7 m), while the highest average occurs in December and January (3.9 m). Standard deviations are smaller in the summer months than during the winter months. Monthly maximum values of significant wave height have ranged from near 6 metres in July and August to 13 to 14 metres in the winter months. The non-exceedance columns show that 99% of the hindcast values did not exceed 9.7 metres in February when the highest wave height of 13.7 metres occurred.

Table 8. Monthly Statistics of Significant Wave Height.

Monthly Statistics of Significant Wave Height							
Month	Significant Wave Height (metres)					Non-Exceedance	
	Min	Max	Mean	Std Dev.	Median	90%	99%
January	0.0	13.0	3.9	1.8	3.7	5.9	9.9
February	0.0	13.7	3.6	1.8	3.4	5.7	9.7
March	0.0	11.1	2.9	1.8	2.9	5.1	7.7
April	0.0	10.8	2.7	1.2	2.6	4.3	6.4
May	0.0	10.1	2.2	0.9	2.0	3.3	5.1
June	0.6	9.0	1.9	0.7	1.8	2.7	4.2
July	0.6	6.0	1.7	0.6	1.6	2.4	3.7
August	0.4	5.8	1.8	0.7	1.6	2.7	4.2
September	0.8	10.1	2.3	1.0	2.1	3.5	5.7
October	0.9	11.1	2.9	1.2	2.6	4.2	6.9
November	0.6	11.7	3.3	1.4	3.0	5.0	8.1
December	1.1	13.4	3.9	1.5	3.6	5.8	9.2
Annual	0.0	13.7	2.7	1.5	2.4	4.6	7.8

Source: Grid Point 5622, AES-40 Wind and Wave Hindcast Dataset (July 1, 1954 through June 30, 2004)

Table 9 provides basic descriptive statistics for spectral peak period, the period at which wave energy is highest. Minimum values of zero correspond to months when sea ice was present at the grid point.

Table 9. Monthly Statistics of Spectral Peak Period.

Monthly Statistics of Spectral Peak Period							
Month	Peak Period (seconds)					Non-Exceedance	
	Min	Max	Mean	Std Dev.	Median	90%	99%
January	0.0	15.9	10.1	2.8	10.5	13.0	14.6
February	0.0	17.0	9.6	3.1	10.1	12.8	14.7
March	0.0	17.2	8.4	4.1	9.6	12.4	14.5
April	0.0	15.7	9.2	2.6	9.5	11.8	14.1
May	0.0	15.6	8.5	1.7	8.4	10.7	13.0
June	3.5	17.5	8.0	1.6	7.9	9.8	13.1
July	3.8	18.7	7.7	1.6	7.4	9.6	13.7
August	3.8	17.1	7.8	1.7	7.5	10.0	13.1
September	4.2	17.0	8.7	2.0	8.5	11.5	14.0
October	3.9	15.7	9.3	1.9	9.1	11.8	14.2
November	4.0	15.9	9.8	1.9	9.8	12.4	14.3
December	4.7	16.1	10.4	1.9	10.4	12.8	14.5
Annual	0.0	18.7	8.9	2.5	8.9	11.9	14.2

Source: Grid Point 5622, AES-40 Wind and Wave Hindcast Dataset (July 1, 1954 through June 30, 2004)

3.1 Monthly Percentage Exceedance of Significant Wave Height

Table 10 shows the percentage exceedance of significant wave height for each month of the year. Table 12 gives the exceedance in actual numbers of hindcast values. Figures 6 and 7 are exceedance plots of the data for January to July and for July to January, respectively, showing the progression through the seasons. During the winter and spring months, sea ice incursion at grid point 5622 is indicated in the dataset by zero values for significant wave height. Thus, exceedance values of less than 100 percent for zero significant wave height occur in the months of January through May. Table 11 shows the percent frequency of occurrence of sea ice during the winter and spring for the 50-year period from the AES-40 dataset.

Table 10. Monthly Percentage Exceedance of Significant Wave Height.

Percentage Exceedance of Significant Wave Height (Hs)												
Hs	(%)											
(m)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.00	96.00	94.04	83.98	95.88	99.97	100.00	100.00	100.00	100.00	100.00	100.00	100.00
0.50	96.00	94.04	83.98	95.87	99.95	100.00	100.00	99.89	100.00	100.00	100.00	100.00
1.00	95.94	93.95	83.50	95.45	97.95	95.98	94.19	95.92	98.62	99.82	99.77	100.00
1.50	95.16	91.93	80.94	89.55	78.74	68.38	57.55	59.06	83.65	94.52	96.63	99.31
2.00	92.13	86.34	73.65	73.68	48.97	34.87	24.82	27.76	54.93	77.53	85.97	95.00
2.50	84.77	75.90	60.52	53.88	28.23	15.43	8.73	12.52	30.98	55.87	69.37	85.42
3.00	72.05	62.47	46.21	35.52	14.77	6.88	3.35	6.13	16.68	36.42	51.62	70.32
3.50	55.79	47.58	32.94	22.37	7.52	3.52	1.47	3.05	9.42	22.05	35.48	52.42
4.00	41.21	33.78	23.47	13.53	4.18	1.50	0.68	1.60	5.75	12.58	23.48	37.58
4.50	29.61	23.78	15.74	8.28	2.32	0.65	0.34	0.69	3.20	7.45	15.48	26.02
5.00	20.23	16.74	10.40	4.67	1.23	0.33	0.19	0.27	1.90	4.74	10.08	18.13
5.50	13.77	11.25	6.55	2.28	0.58	0.12	0.03	0.10	1.12	3.06	6.88	12.58
6.00	9.55	7.59	4.21	1.33	0.29	0.05	0.02		0.80	2.00	4.75	8.69
6.50	6.73	5.13	2.61	0.93	0.16	0.05			0.53	1.32	3.12	6.06
7.00	4.94	4.02	1.71	0.60	0.10	0.05			0.40	0.89	2.05	4.11
7.50	3.77	3.26	1.18	0.40	0.06	0.05			0.28	0.65	1.43	3.06
8.00	2.87	2.65	0.81	0.28	0.05	0.03			0.20	0.53	1.08	2.29
8.50	2.42	2.07	0.53	0.12	0.05	0.02			0.18	0.32	0.82	1.56
9.00	1.94	1.59	0.37	0.10	0.03				0.12	0.23	0.58	1.18
9.50	1.42	1.15	0.31	0.05	0.03				0.08	0.13	0.42	0.77
10.00	0.92	0.81	0.10	0.03	0.02				0.02	0.06	0.27	0.58
10.50	0.60	0.48	0.03	0.03						0.03	0.18	0.35
11.00	0.40	0.32	0.02							0.02	0.10	0.23
11.50	0.19	0.32									0.03	0.13
12.00	0.16	0.18										0.05
12.50	0.05	0.09										0.03
13.00		0.04										0.03
13.50		0.02										
14.00												

Source: Grid Point 5622, AES-40 Wind and Wave Hindcast Dataset (July 1, 1954 through June 30, 2004)

Table 11. Percentage Frequency of Occurrence of Sea Ice at Grid Point 5622

Percentage Occrrence of Sea Ice	
Month	(%)
January	4.00
February	5.96
March	16.02
April	4.12
May	0.03

Source: Grid point 5622, AES -40 wind and wave hindcast dataset (July 01, 1954 through June 30, 2004

Table 12. Monthly Exceedance of Significant Wave Height.

Hs (m)	Exceedance of Significant Wave Height (Hs) (Number of hindcast values)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.00	5952	5315	5207	5753	6198	6000	6200	6200	6000	6200	6000	6200
0.50	5952	5315	5207	5752	6197	6000	6200	6193	6000	6200	6000	6200
1.00	5948	5310	5177	5727	6073	5759	5840	5947	5917	6189	5986	6200
1.50	5900	5196	5018	5373	4882	4103	3568	3662	5019	5860	5798	6157
2.00	5712	4880	4566	4421	3036	2092	1539	1721	3296	4807	5158	5890
2.50	5256	4290	3752	3233	1750	926	541	776	1859	3464	4162	5296
3.00	4467	3531	2865	2131	916	413	208	380	1001	2258	3097	4360
3.50	3459	2689	2042	1342	466	211	91	189	565	1367	2129	3250
4.00	2555	1909	1455	812	259	90	42	99	345	780	1409	2330
4.50	1836	1344	976	497	144	39	21	43	192	462	929	1613
5.00	1254	946	645	280	76	20	12	17	114	294	605	1124
5.50	854	636	406	137	36	7	2	6	67	190	413	780
6.00	592	429	261	80	18	3	1		48	124	285	539
6.50	417	290	162	56	10	3			32	82	187	376
7.00	306	227	106	36	6	3			24	55	123	255
7.50	234	184	73	24	4	3			17	40	86	190
8.00	178	150	50	17	3	2			12	33	65	142
8.50	150	117	33	7	3	1			11	20	49	97
9.00	120	90	23	6	2				7	14	35	73
9.50	88	65	19	3	2				5	8	25	48
10.00	57	46	6	2	1				1	4	16	36
10.50	37	27	2	2						2	11	22
11.00	25	18	1							1	6	14
11.50	12	18									2	8
12.00	10	10										3
12.50	3	5										2
13.00		2										2
13.50		1										
14.00												

Source: Grid Point 5622, AES-40 Wind and Wave Hindcast Dataset (July 1, 1954 through June 30, 2004)

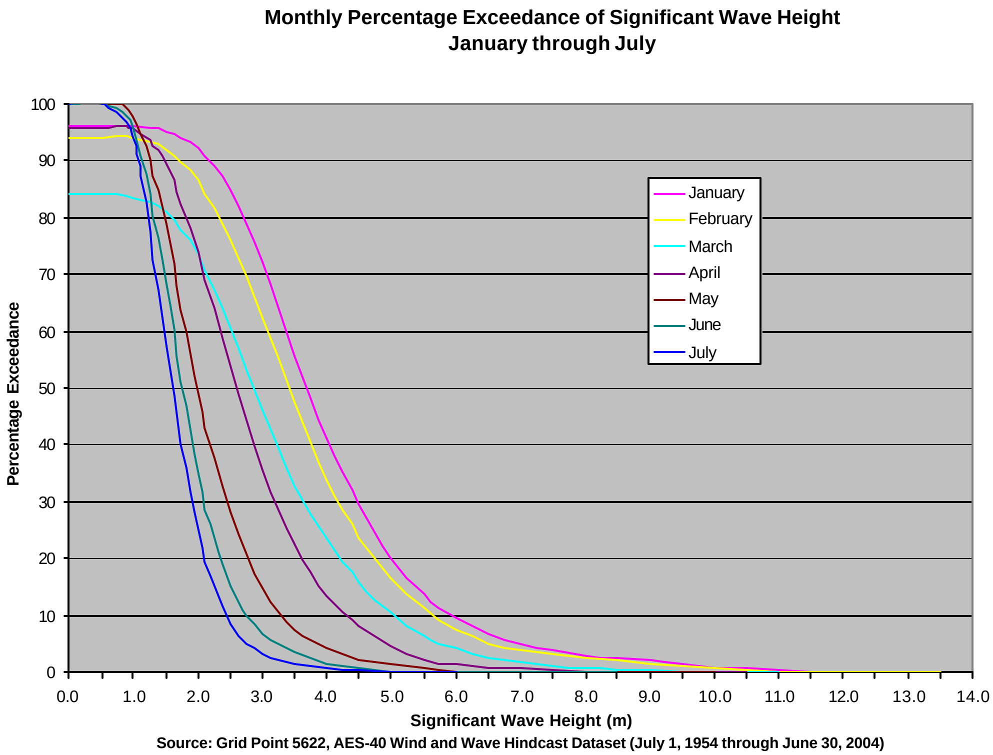


Figure 6. Monthly Percent Exceedance of Significant Wave Height - January to July.

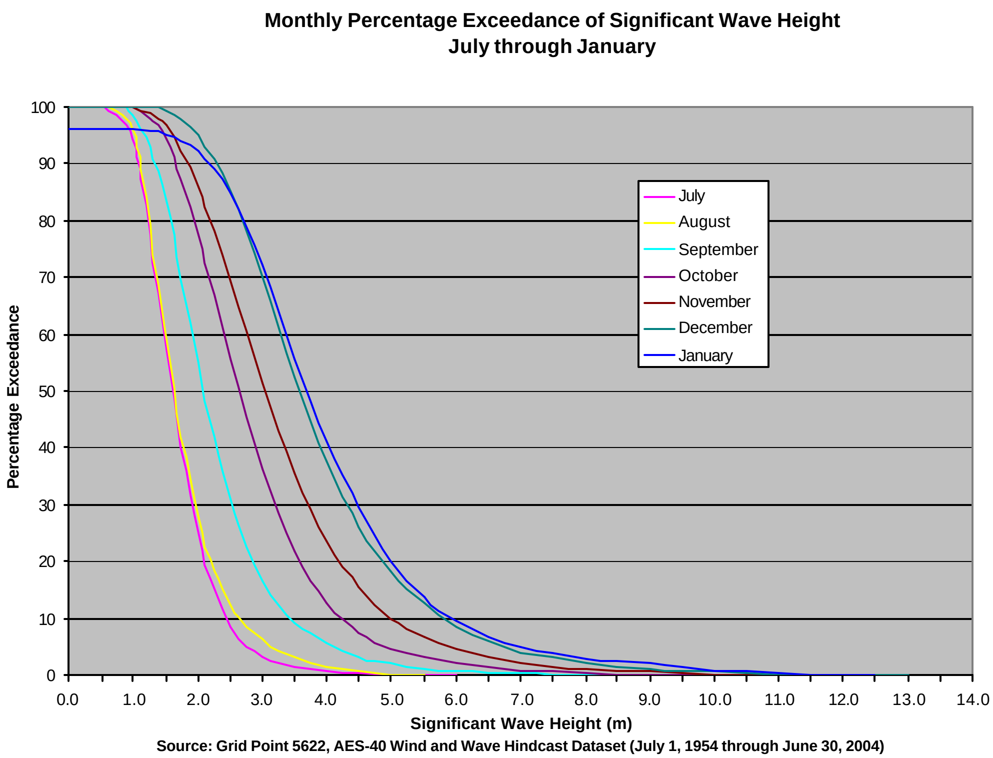


Figure 7. Monthly Percent Exceedance of Significant Wave Height - July to January.

3.2 Monthly Percentage Occurrence of Spectral Peak Period

Table 13 provides percent frequency of occurrence of spectral peak periods for each month of the year. Again, the percent frequency for zero peak periods indicates the occurrence of sea ice at the grid point location. During the warm season, the most frequent peak period is in the 7 to 8 second range; during the winter, the peak periods of the higher sea states are more frequent in the 9 to 12 second range.

Since the spectral peak periods are hindcast values, they may be slightly low-biased. Cardone et al. (1995) found a mean negative error of about 0.4 seconds in peak periods between hindcast and measured values from a study carried out off the US east coast. Cardone et al. (2000) attributed the low bias to being a characteristic of 3-G wave models.

Table 13. Monthly Percent Frequency of Occurrence of Spectral Peak Periods.

Monthly Percent Frequency of occurrence of Spectral Peak Period (Tp)												
Tp (s)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	4.00	5.96	16.02	4.12	0.03							
> 0 - < 1.0												
1.0 - < 2.0												
2.0 - < 3.0												
3.0 - < 4.0			0.02	0.02	0.08	0.02	0.03	0.06		0.02	0.02	
4.0 - < 5.0	0.05	0.14	0.37	0.23	0.74	0.92	0.90	1.16	0.40	0.34	0.18	0.08
5.0 - < 6.0	0.69	1.68	1.55	1.90	4.66	8.07	10.11	10.11	4.77	2.48	1.48	0.63
6.0 - < 7.0	3.06	4.71	4.79	6.00	12.21	18.88	24.31	23.73	14.27	8.03	5.68	2.82
7.0 - < 8.0	6.02	7.94	7.45	10.48	21.73	26.32	29.27	29.13	20.48	15.16	9.87	6.81
8.0 - < 9.0	11.27	12.79	11.03	18.85	26.24	24.35	19.31	18.18	21.23	22.29	17.30	12.89
9.0 - < 10.0	16.11	15.38	16.32	21.53	17.81	12.97	9.32	7.97	15.13	19.98	21.65	19.60
10.0 - < 11.0	18.97	17.60	16.27	17.72	9.32	4.83	3.56	4.92	10.38	13.50	19.50	21.76
11.0 - < 12.0	17.42	16.10	13.11	11.37	4.52	1.68	1.21	2.45	6.57	9.84	12.25	16.81
12.0 - < 13.0	12.68	9.38	7.66	4.07	1.66	0.85	0.69	1.27	3.42	4.37	6.17	10.26
13.0 - < 14.0	6.50	5.25	3.34	2.62	0.79	0.48	0.39	0.39	2.35	2.52	3.97	5.24
14.0 - < 15.0	2.69	2.32	1.50	1.05	0.19	0.43	0.32	0.45	0.80	1.19	1.58	2.55
15.0 - < 16.0	0.53	0.67	0.40	0.05	0.02	0.13	0.35	0.13	0.18	0.27	0.35	0.55
16.0 - < 17.0		0.07	0.13			0.02	0.08	0.03	0.02			0.02
17.0 - < 18.0			0.03			0.05	0.08	0.02				
18.0 - < 19.0							0.05					

Source: Grid Point 5622, AES-40 Wind and Wave Hindcast Dataset (July 1, 1954 through June 30, 2004)

3.3 Percent Frequency of Significant Wave Height and Spectral Peak Period

Table 14 presents the percent frequency of the joint occurrence of significant wave height and spectral peak period for the full 50-year period of the hindcast dataset. Ice is seen to be present at the location 2.50 percent of the time during this period.

Table 14. Percent Frequency of the Joint Occurrence of Significant Wave Height and Spectral Peak Period.

Spectral Peak Period (s)	Ice 0	>0.0 to < 1.0	1.0 to < 2.0	2.0 to < 3.0	3.0 to < 4.0	4.0 to < 5.0	5.0 to < 6.0	6.0 to < 7.0	7.0 to < 8.0	8.0 to < 9.0	9.0 to < 10.0	10.0 to < 11.0	11.0 to < 12.0	12.0 to <13.0	13.0 to <14.0	Totals
	Percent Frequency of Joint Occurrence of Significant Wave Height and Spectral peak Period — Significant Wave Height (m)															
0	2.50															2.50
> 0 - < 1.0																0.00
1.0 - < 2.0																0.00
2.0 - < 3.0																0.00
3.0 - < 4.0		0.01	0.02													0.03
4.0 - < 5.0		0.03	0.41	0.02												0.46
5.0 - < 6.0		0.20	3.27	0.54	0.02											4.03
6.0 - < 7.0		0.62	5.49	4.28	0.34	0.01										10.74
7.0 - < 8.0		0.46	7.59	5.35	2.37	0.16										15.93
8.0 - < 9.0		0.07	7.60	4.60	4.17	1.47	0.08									17.99
9.0 - < 10.0		0.10	3.85	5.95	2.96	2.38	0.82	0.06								16.12
10.0 - < 11.0		0.05	1.66	4.96	3.18	1.57	1.25	0.44	0.06	0.01						13.18
11.0 - < 12.0		0.02	0.80	2.23	3.16	1.49	0.79	0.57	0.26	0.09	0.01					9.42
12.0 - < 13.0		0.01	0.36	0.83	1.48	1.14	0.55	0.27	0.20	0.20	0.14	0.02				5.20
13.0 - < 14.0			0.19	0.42	0.57	0.63	0.41	0.21	0.08	0.07	0.11	0.09	0.02			2.80
14.0 - < 15.0			0.11	0.18	0.25	0.26	0.18	0.11	0.05	0.02	0.02	0.03	0.03	0.02		1.26
15.0 - < 16.0			0.05	0.04	0.04	0.06	0.04	0.04	0.01	0.01			0.01	0.01		0.31
16.0 - < 17.0					0.01	0.01										0.02
17.0 - < 18.0				0.01												0.01
Totals	2.50	1.57	31.40	29.41	18.55	9.18	4.12	1.70	0.66	0.40	0.28	0.14	0.06	0.03	0.00	100.00

Source: Grid Point 5622, AES-40 Wind and Wave Hindcast Dataset (July 1, 1954 through June 30, 2004)

3.4 AES-40 vs. Observed Wave Heights

Table 15 compares monthly significant wave height statistics from the AES-40 and Husky Manmar datasets. The mean wave height for both datasets is similar, although the maximum wave height values are noticeably higher in the AES-40 dataset. This can be attributed to the fact that the AES-40 data covers a 50 year period, which is significantly longer than the 3.5 years contained in the Husky Manmar dataset.

It must be noted that on February 11, 2003, a waverider buoy at the Terra Nova field measured at significant wave height of 14.66 metres at 2300 UTC. One hour later at 0000 UTC on February 12, wave heights had fallen slightly to 14.28 metres. This date falls outside the period covered by the Husky Manmar dataset, however it is included in the AES-40 data.

The AES-40 significant wave height value for grid point 5551 (the closest to Terra Nova) at 0000 UTC on February 12 was 12.84 metres, or almost 1.5 metres lower than was measured. The wave height at grid point 5622 at the same time was 12.99 metres. It is therefore suspected that the maximum wave height values derived from the AES-40 dataset may be somewhat lower than actual values.

Table 15. Comparison of AES-40 hindcast winds and Husky Manmar winds

Comparison of Monthly Significant Wave Height Statistics (meters)						
AES40 Gridpoint 5622 hindcast data vs Husky Manmar data						
	AES40			Husky Manmar		
Month	Max	Mean	Std Dev.	Max	Mean	Std Dev.
January	13.0	3.9	1.8	11.0	4.0	1.4
February	13.7	3.6	1.8	8.5	3.5	1.3
March	11.1	2.9	1.8	9.6	3.6	1.3
April	10.8	2.7	1.2	7.0	2.5	1.0
May	10.1	2.2	0.9	5.6	2.1	0.8
June	9.0	1.9	0.7	6.0	1.7	0.6
July	6.0	1.7	0.6	3.2	1.4	0.5
August	5.8	1.8	0.7	7.0	1.6	0.7
September	10.1	2.3	1.0	9.5	2.3	0.9
October	11.1	2.9	1.2	9.7	2.7	3.4
November	11.7	3.3	1.4	9.5	3.0	1.3
December	13.4	3.9	1.5	9.0	3.2	1.2

Sources:
AES40 Grid Point 5622 Wind and Wave Hindcast (July 1, 1954 to June 30, 2004)
Husky Manmar Observations (July 12, 2003 through December 1, 2006)

4 Air and Sea Surface Temperatures

Air and surface temperature data for the Husky exploration area were extracted from the ICOADS dataset as summarized above. Monthly mean values were computed and these statistics are presented in Figure 8. In the winter season, average sea surface temperatures are warmer than the mean air temperatures; the opposite is the case during the summer season. Because of this, the lower portion of the atmosphere is generally unstable during the winter months and stable in the spring and summer months. Monthly average air temperatures are evidently just below zero Celsius at the coldest time of the year and over 13°C in August, the warmest month. The range of sea surface temperatures is smaller than that for air temperatures, an artifact of the higher heat capacity of the ocean.

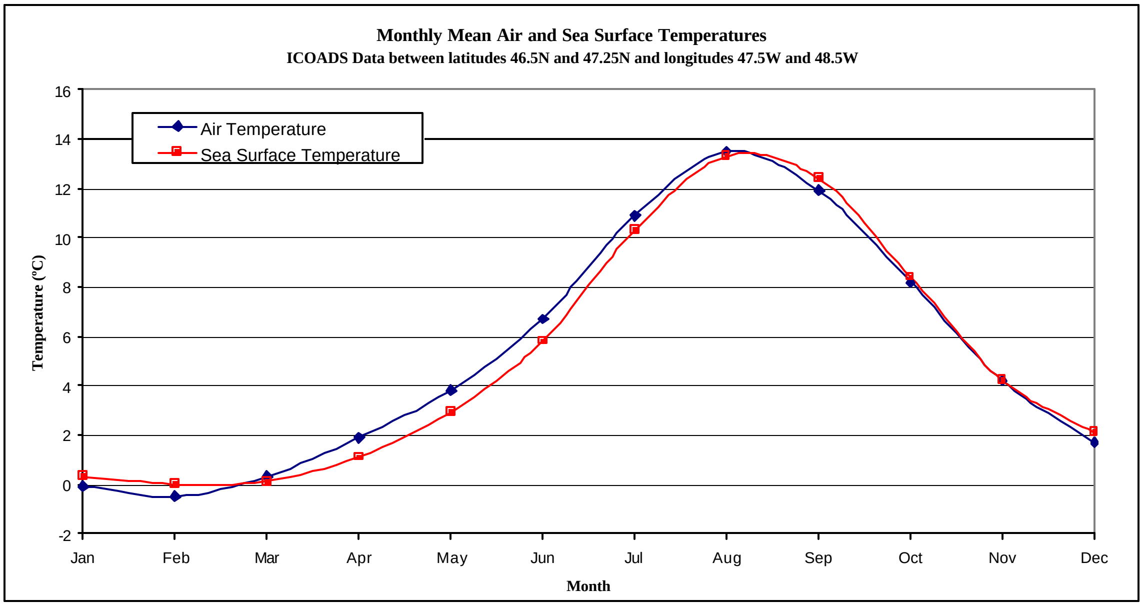


Figure 8. Monthly Average Air and Sea Surface Temperature.

Table 16 contains monthly mean air and sea surface temperatures along with the corresponding standard deviations for the specified ICOADS area.

Table 16. Monthly Air and Sea Surface Temperature Statistics.

Monthly Air and Sea Surface Temperature Statistics				
	Air Temperature (ºC)		Sea Surface Temperature (ºC)	
Month	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
Jan	-0.1	3.0	0.3	1.5
Feb	-0.5	3.1	0.0	1.2
Mar	0.3	2.6	0.1	1.4
Apr	1.9	2.3	1.1	1.6
May	3.8	2.5	2.9	1.9
Jun	6.7	2.9	5.8	2.0
Jul	10.9	3.6	10.3	2.1
Aug	13.5	3.3	13.3	2.0
Sep	11.9	3.4	12.4	2.4
Oct	8.2	3.3	8.4	2.5
Nov	4.2	2.8	4.2	2.1
Dec	1.7	3.2	2.1	2.0

5 Visibility

Visibility data were extracted from the ICOADS observational dataset for this report and summarized in Table 17. The data were partitioned to approximately correspond to visibility criteria used in marine weather forecasts, with the ranges expressed in kilometres. Figure 9 illustrates these statistics in the form of a bar chart. During the warmer months visibility is restricted by mist and fog; in the winter season snow or snow showers also cause reduced visibility.

The lowest visibility conditions occur in July with poor visibility being reported in 55.3% of reports. This is largely due to mist and fog that is formed as relatively warm, moist air is advected over the colder water surface. The reports for July indicate that visibility was reduced to either fair or poor in 66.6 % of the observations. Good visibility (no restriction) was reported in only 33.4 % of the observations. October has the highest percentage of good visibility reports with a value of 77.1%.

Table 17. Percentage Occurrence of Visibility Ranges.

Percentage Occurrence of Visibility Range			
Month	Poor Visibility < 2 km	Fair Visibility 2 km to <10 km	Good Visibility >= 10 km
Jan	14.4	13.6	72.1
Feb	16.8	16.0	67.3
Mar	20.4	16.0	63.7
Apr	29.1	13.2	57.7
May	36.5	14.3	49.2
Jun	41.6	12.7	45.7
Jul	56.9	11.1	32.1
Aug	31.6	12.0	56.4
Sep	16.8	11.5	71.8
Oct	12.2	10.8	77.1
Nov	15.5	12.7	71.8
Dec	14.5	16.0	69.5

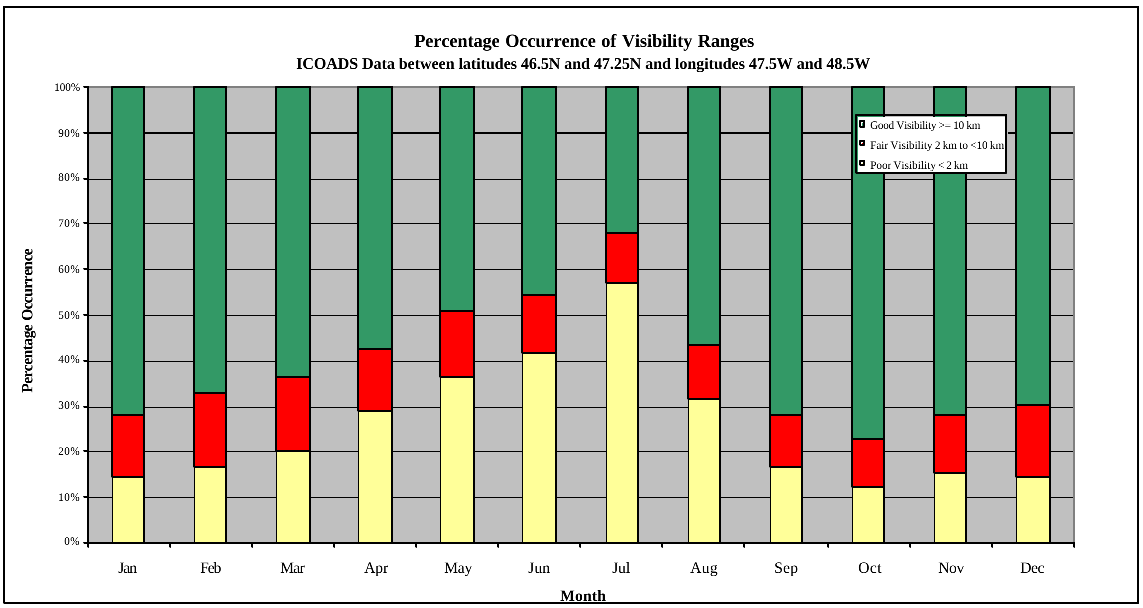


Figure 9. Percent Occurrence of Visibility Ranges.

6 Wind and Wave Extremal Value Analysis

The wind and wave extremal analysis was carried out from the AES-40 data set at grid point 5622 for 50 years of data between July 1, 1954 and June 30, 2004. Grid point 5622 is located at 46.88°N; 48.33°W, the closest grid point to the study area. The data has been generated using time steps of 6 hours. In some storms, particularly those of short duration, the peak winds may get missed due to the length of the sampling period. A shorter sampling period would be more desirable. However, the AES-40 data set has been a major improvement over previous data sets because of the many years of continuous data.

The extreme values for wind and waves were calculated using the peak-over-threshold method; and after considering four different distributions, the Gumbel Distribution was chosen as the most appropriate because it gave the best fit to the data. A sensitivity analysis was carried out to determine how many storms to use in the analysis, because the extreme values can vary depending on how well the data fits the distribution function. The sensitivity analysis showed that the Gumbel Distribution had a good fit using 228 storms when all the data was considered in calculating the yearly extremes. For monthly extremes the top 55 storms were used in the analysis. This number of storms was chosen in order to give a consistent threshold value for waves during the winter months as compared to all months combined. This represents a significant wave height threshold value of 8.0 m. A plot of the correlation coefficient versus the number of storms is shown in Figure 10.

6.1 Extreme Value Estimates for Winds from a Gumbel Distribution

The extreme value estimates for wind were calculated using Oceanweather's software programs for return periods of 1-year, 10-years, 25-years, 50-years and 100-years. The values calculated for each month and all months combined are given in Table 18. The extreme value analysis used hourly wind values for the reference height of 10-metres above sea level. The 10-minute and 1-minute winds were calculated from the 1-hour mean values using a constant ratio of 1.06 and 1.22 respectively (U.S. Geological Survey 1979). The 100-year extreme wind speed was 31.2 m/s. The 1-year, 10-year, 25-year, and 50-year extreme wind speeds were 24.4 m/s, 27.8 m/s, 29.2 m/s, and 30.2 m/s, respectively. These values may be slightly underestimated due to the 6-hour time interval in the data. It is highly probable that some of the peaks in the wind speed have been missed by the hindcasting methodology. The distribution fits for the wind data values using the 228 storms for the Gumbel distribution are presented in Figure 11.

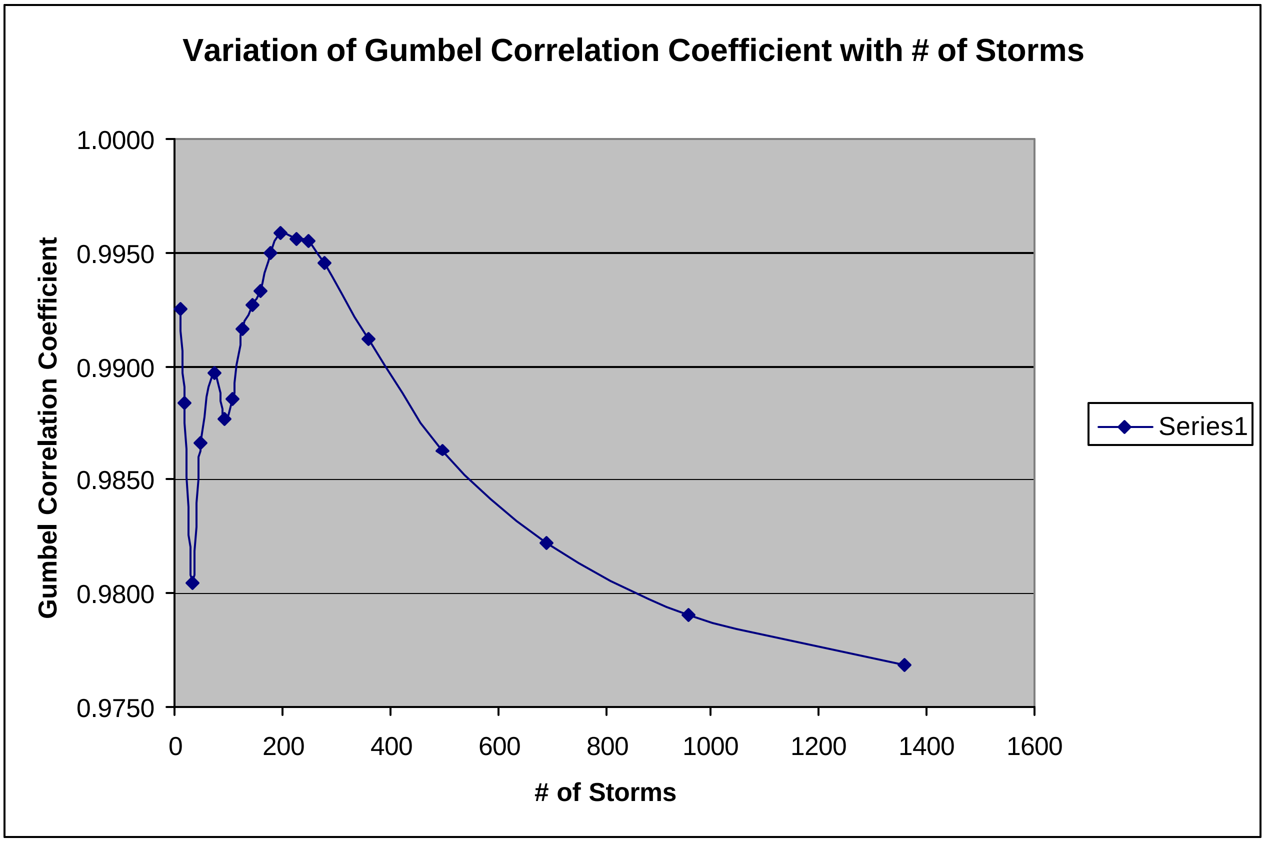


Figure 10. Correlation Coefficient for Significant Wave Height using a Gumbel Distribution.

Table 18. Extreme Wind Estimates for Return Periods of 1, 10, 25, 50 and 100 Years for Winds Corresponding to Different Averaging Periods, at a 10 metre Height.

Monthly Wind Speed Extremes at Grid Point # 5622 (46.88N 48.33W)

Wind Speed 1-hr (m/s)					
Month	**1.00**	**10.00**	**25.00**	**50.00**	**100.00**
JAN	21.24	25.39	26.61	27.51	28.41
FEB	21.24	26.82	28.45	29.66	30.87
MAR	18.78	23.97	25.50	26.63	27.75
APR	16.95	22.65	24.32	25.56	26.80
MAY	15.39	19.33	20.48	21.34	22.19
JUN	14.09	18.63	19.96	20.95	21.93
JUL	12.87	17.18	18.44	19.38	20.31
AUG	14.14	18.93	20.34	21.38	22.42
SEP	16.31	21.95	23.60	24.83	26.05
OCT	17.30	22.61	24.17	25.33	26.48
NOV	19.20	23.89	25.27	26.29	27.30
DEC	20.20	25.98	27.67	28.92	30.17
ALL	24.38	27.84	29.16	30.16	31.15
Wind Speed 10-min (m/s)					
Month	**1.00**	**10.00**	**25.00**	**50.00**	**100.00**
JAN	22.51	26.91	28.21	29.16	30.11
FEB	22.51	28.43	30.16	31.44	32.72
MAR	19.91	25.41	27.03	28.23	29.42
APR	17.97	24.01	25.78	27.09	28.41
MAY	16.31	20.49	21.71	22.62	23.52
JUN	14.94	19.75	21.16	22.21	23.25
JUL	13.64	18.21	19.55	20.54	21.53
AUG	14.99	20.07	21.56	22.66	23.77
SEP	17.29	23.27	25.02	26.32	27.61
OCT	18.34	23.97	25.62	26.85	28.07
NOV	20.35	25.32	26.79	27.87	28.94
DEC	21.41	27.54	29.33	30.66	31.98
ALL	25.84	29.51	30.91	31.97	33.02
Wind Speed 1-min (m/s)					
Month	**1.00**	**10.00**	**25.00**	**50.00**	**100.00**
JAN	25.91	30.98	32.46	33.56	34.66
FEB	25.91	32.72	34.71	36.19	37.66
MAR	22.91	29.24	31.11	32.49	33.86
APR	20.68	27.63	29.67	31.18	32.70
MAY	18.78	23.58	24.99	26.03	27.07
JUN	17.19	22.73	24.35	25.56	26.75
JUL	15.70	20.96	22.50	23.64	24.78
AUG	17.25	23.09	24.81	26.08	27.35
SEP	19.90	26.78	28.79	30.29	31.78
OCT	21.11	27.58	29.49	30.90	32.31
NOV	23.42	29.15	30.83	32.07	33.31
DEC	24.64	31.70	33.76	35.28	36.81
ALL	29.74	33.96	35.58	36.80	38.00

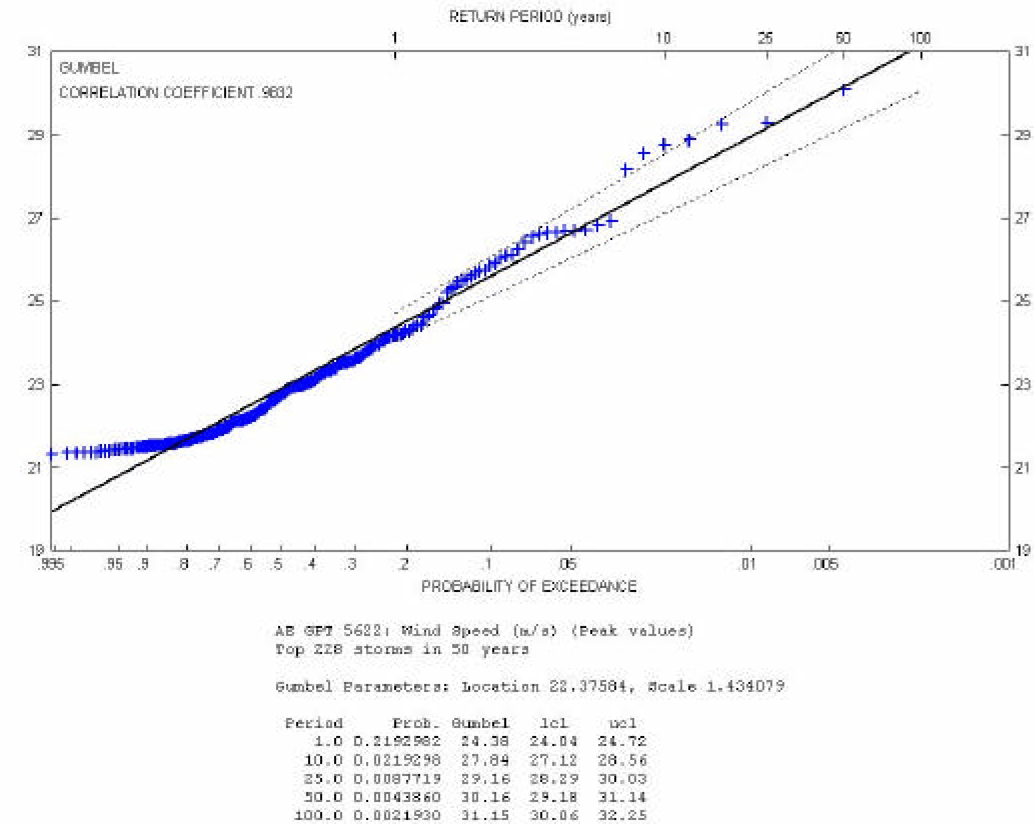


Figure 11. Distribution Fit for Wind Data Using 228 Storms.

6.2 Extreme Value Estimates for Waves from a Gumbel Distribution

The Extreme value estimates for waves for return periods of 1-year, 10-years, 25-years, and 50-years and 100-years are given in Table 19. Similar to winds, the values were calculated for each month considered separately and for all months combined. The 100-year extreme significant wave height was 15.1 m. The 1-year, 10-years, 25years, and 50-years extreme significant wave heights were 10.4 metres, 12.8 metres, 13.7 metres, and 14.4 metres respectively. The highest extreme significant wave height is expected to occur during February. Extreme value estimates were also calculated for the maximum wave heights and for the spectral peak periods associated with the significant wave heights. The maximum individual wave heights are calculated within the OSMOSIS software by evaluating the Borgman integral (Borgman 1973), which was derived from a Rayleigh distribution function. The variant of this equation used in the software has the following form (Forristall 1978):

$$\Pr\{H > h\} = \exp\left[-1.08311\left(\frac{h^2}{8M_0}\right)^{1.063}\right]; \quad T = \frac{M_0}{M_1}$$

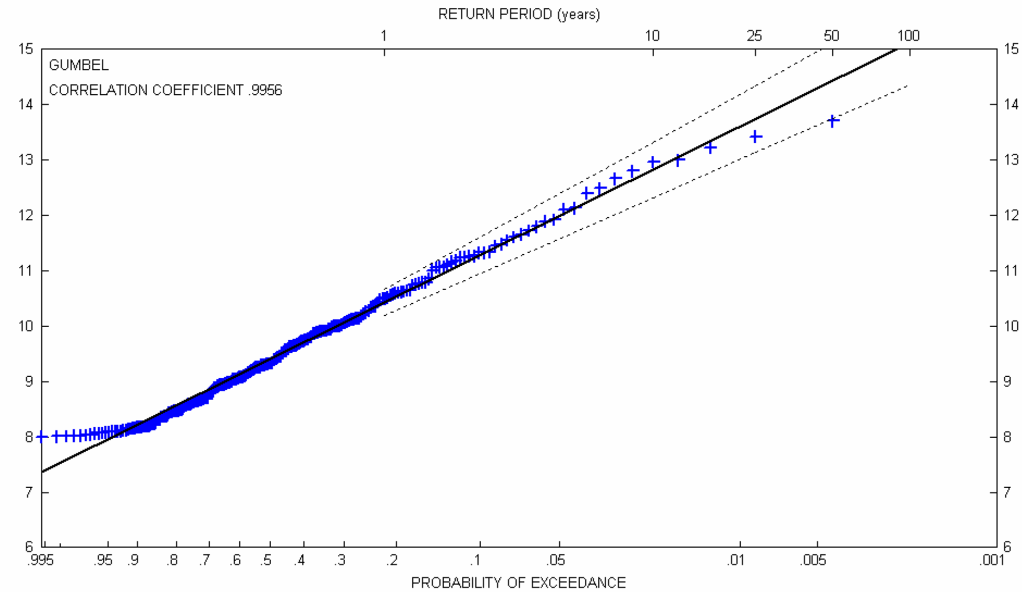
where h is the significant wave height, T is the wave period, M_0 and M_1 are the first and second spectral moments of the total spectrum. The associated peak periods are calculated by plotting the peak periods of the chosen storm peak values versus the corresponding significant wave heights. This plot is fitted to a power function ($y = ax^b$), and the resulting equation is used to calculate the peak periods associated with the extreme values of significant wave height. The extreme significant wave heights, maximum wave heights, and associated peak periods are presented in Table 19. A graph showing how well the Gumbel Distribution fit the significant wave height data for selected 228 storms is presented in Figure 12.

The calculated extreme values of significant wave height compare reasonably well to observed data. For example, the value of 14.4 metres for the 50-year extreme significant wave height was very close to the values observed during a recent extreme storm event. On February 11, 2003, a very intense storm moved across the Grand Banks. A waverider buoy in the area recorded a peak significant wave height of 14.66 metres. This is only slightly higher than 50-year return period derived from the Gumbel distribution in this report. A storm with a return period of 50 years means that the calculated significant wave height will occur once every 50 years, averaged over a long period of time. It is entirely possible that this event was a 50-year or even 100-year storm, as it was the highest recorded significant wave height in a near continuous waverider data set extending back to early 1999. The previous highest recorded value in this data set was 12.47 metres. If more occurrences of an event of this magnitude are observed, the calculated statistics would consequently begin to increase.

Table 19. Extreme Wave Estimates for Return Periods of 1, 10, 25, 50, and 100 Years.

Monthly Wave Extremes at Grid Point # 5622 (46.88N 48.33W)

Significant Wave Height (m)					
Month	**1.0**	**10.0**	**25.0**	**50.0**	**100.0**
JAN	8.4	11.8	12.8	13.5	14.3
FEB	7.8	11.9	13.1	13.9	14.8
MAR	6.2	9.5	10.5	11.2	11.9
APR	5.1	8.4	9.3	10.0	10.7
MAY	4.0	6.8	7.6	8.2	8.8
JUN	3.3	5.9	6.6	7.2	7.7
JUL	3.1	5.0	5.6	6.0	6.4
AUG	3.6	5.3	5.8	6.2	6.6
SEP	4.4	8.1	9.2	10.0	10.8
OCT	5.3	9.1	10.2	11.1	11.9
NOV	6.5	10.4	11.6	12.4	13.3
DEC	8.0	11.4	12.4	13.1	13.8
ALL	10.4	12.8	13.7	14.4	15.1
Maximum Wave Height (m)					
Month	**1.0**	**10.0**	**25.0**	**50.0**	**100.0**
JAN	15.9	22.1	24.0	25.3	26.7
FEB	14.7	22.6	25.0	26.7	28.4
MAR	11.9	18.2	20.0	21.4	22.7
APR	10.0	15.7	17.3	18.6	19.8
MAY	7.7	13.5	15.2	16.4	17.7
JUN	6.6	11.1	12.4	13.4	14.4
JUL	6.0	9.5	10.6	11.3	12.1
AUG	7.0	10.1	11.0	11.7	12.4
SEP	8.5	15.1	17.0	18.5	19.9
OCT	10.2	17.1	19.1	20.6	22.1
NOV	12.4	19.5	21.6	23.2	24.7
DEC	14.9	21.2	23.0	24.4	25.7
ALL	19.6	24.2	26.0	27.3	28.6
Associated Peak Period (sec)					
Month	**1.0**	**10.0**	**25.0**	**50.0**	**100.0**
JAN	12.3	14.3	14.9	15.3	15.6
FEB	11.8	14.2	14.8	15.2	15.6
MAR	11.9	13.0	13.3	13.5	13.6
APR	10.8	12.4	12.8	13.1	13.3
MAY	9.7	11.5	11.9	12.2	12.5
JUN	8.1	10.6	11.2	11.7	12.1
JUL	8.2	10.1	10.6	11.0	11.3
AUG	8.9	10.4	10.8	11.0	11.3
SEP	10.0	12.1	12.6	12.9	13.2
OCT	10.7	12.6	13.0	13.3	13.6
NOV	11.8	13.4	13.8	14.1	14.3
DEC	12.5	14.0	14.4	14.7	14.9
ALL	13.5	14.7	15.2	15.5	15.8



AE GPT 5622: Significant Wave Height (m) (Peak values)
Top 228 storms in 50 years

Gumbel Parameters: Location 9.040485, Scale 0.9922155

Period	Prob.	Gumbel	lcl	ucl
1.0	0.2192982	10.43	10.19	10.66
10.0	0.0219298	12.82	12.32	13.32
25.0	0.0087719	13.74	13.13	14.34
50.0	0.0043860	14.43	13.75	15.11
100.0	0.0021930	15.11	14.36	15.87

Figure 12. Distribution Fit for Wave Data Using 228 Storms.

7 Interannual Variability and Short-term Climate Trends

Marine weather conditions over the Northern Grand Banks vary over a large range of time scales from the very short term (hours to days), to seasonally, and to longer time periods in response to small and large scale changes of atmospheric circulation patterns. Short-term meteorological variations are largely a consequence of the passage of synoptic weather systems: low pressure systems and high pressure areas, and troughs and ridges. The energetics of these features varies seasonally in accordance with the changes in the strength of the mean south to north temperature gradient and the upper level circulation pattern. As a consequence, winter weather systems are more intense than during the summer season. Figure 13 illustrates winter and summer seasonal variations at grid point 5622 from the AES-40 wind and wave hindcast dataset. A time-series of seasonal mean wind speeds and mean significant wave heights are shown for both winter (December, January, and February) and summer (June, July, and August). As is typically the case, seasonal variability is greater during the winter than during the summer months for both wind speeds and wave heights.

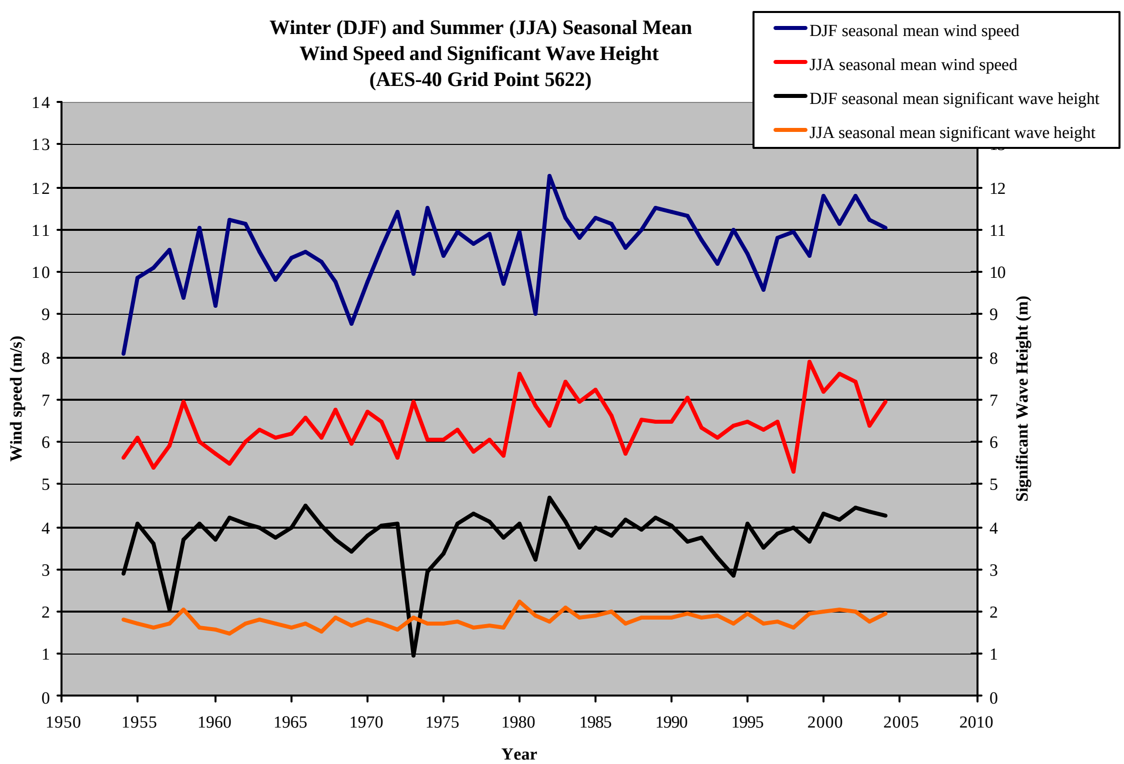


Figure 13. Winter and Summer Seasonal Variability of Mean Wind Speed and Mean Significant Wave Height at AES-40 Grid Point 5622

The AES-40 hindcast dataset is of sufficient length to carry out investigations of short-term wind and wave climate variability studies over the North Atlantic Basin (e.g., Wang and Swail, 2002) but validations must be made to ensure that the hindcast results accurately reflect true climatic variations. Swail et al. (2003) investigate several wind statistic trends for the Sable Island area using two hindcast datasets (including AES-40), measured wind data, and pressure field computed wind data. The results show trends varying from slowing decreasing, to no change, and to slowly increasing with time over the 40-year period. The authors suggest that wind and wave hindcast datasets may be affected by a 'creeping inhomogeneity' as a consequence of the increased data density and increasing anemometer heights on board ships with time but that the AES-40 hindcast 'should be truer indication of the more intangible creeping inhomogeneities in the reanalysis process, …'. They conclude that 'trends are generally consistent with the analysis measurements from weather ships, transient ships, and...,' and suggest that 'hindcasts may provide a good upper bound to true trends in the wind and wave climate'.

7.1 The North Atlantic Oscillation and Wind and Wave Trends over the Northern Grand Banks

The dominant features of the mean sea level pressure pattern in the North Atlantic Ocean are the semi-permanent area of relatively low pressure in the vicinity of Iceland and the sub-tropical high pressure region near the Azores. The relative strengths of these features vary with large scale dynamic and thermodynamic variations of the atmosphere-ocean system and the fluctuating pressure differences, which serve to indicate the strength of the average near zonal (approximately west to east) surface flow across the Northeast Atlantic Ocean, are known as the North Atlantic Oscillation (NAO). The NAO has been associated with marine climate variability over the North Atlantic Ocean generally (e.g., Marshall et al., 2001). Indices based on these surface pressure differences (e.g., Jones et al., 1997) are often used in an examination of the variability of marine weather and oceanographic condition variations throughout the North Atlantic Ocean. In general, over the northwest Atlantic / Labrador Sea during the winter season, a high NAO index value is associated with colder temperatures, relatively stronger winds, and typically greater ice cover, and vice versa.

Figure 14 is a plot of seasonal NAO indices for the period of the AES-40 wind and wave hindcast dataset. Seasonal average index values for the summer (June, July, and August) and winter (December, January, and February) are shown along with linear trend lines. In summer, the variability was relatively greater in the period 1985 - 2000, approximately, than previously or afterward, but the trend over the full period is seen to be flat. Larger variability is evident in the winter season data, with generally high positive values from the late 1980s through the late 1990s, leading to a positive slope of the linear tread line over the period.

Scatter plots of seasonally averaged NAO index against mean wind speed and mean significant wave heights for AES-40 grid point 5622 are shown in Figures 15 and 16 for summer and winter months, respectively. Linear trends lines are also shown on the plots. In the summer months, both wind speeds and wave heights generally increase with higher NAO index values. During winter, seasonal mean wind speeds evidently increase with increasing NAO index in accordance with general expectations. The trend for the seasonal mean significant wave heights is slightly decreasing however, perhaps indicating reduced fetch as a consequence of a larger ice cover over the northwest Atlantic, although this has not been investigated here.

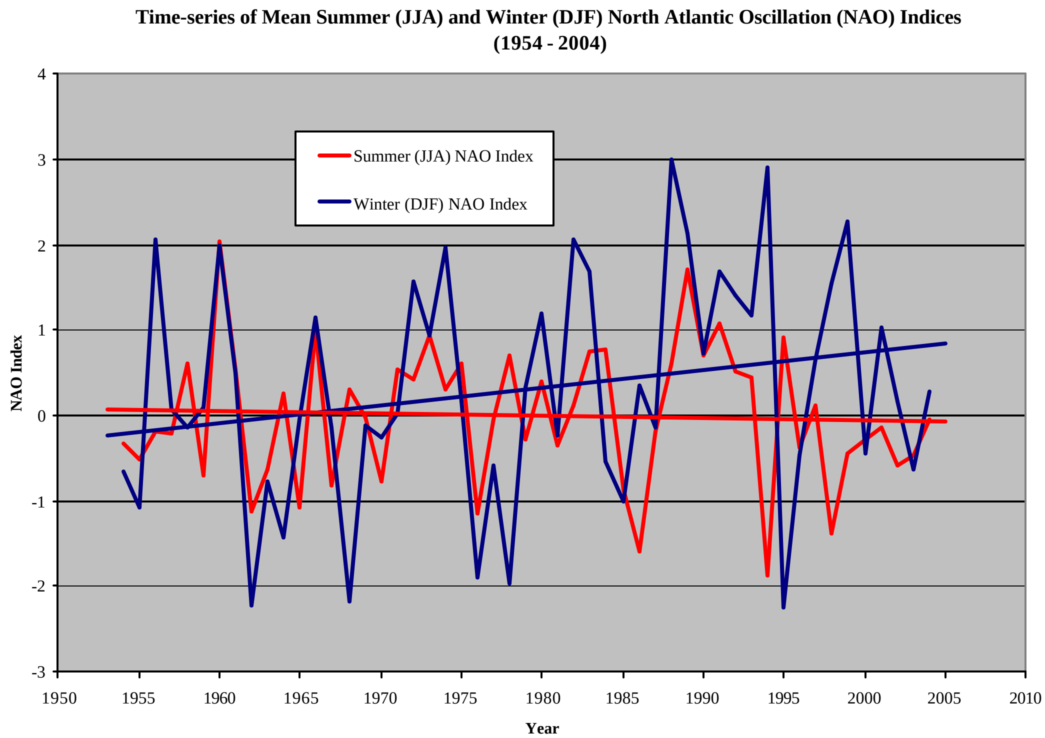


Figure 14. NAO Index in Summer and Winter Season

Time-series of seasonal wind speed and significant wave height statistics for summer and winter seasons are shown in Figures 17 through 20. The seasonal mean, along with the 90th and 99th percentile are shown for both wind speed and significant wave height. Linear trend lines are also shown for each statistic.

Summer mean wind speeds and significant wave heights (Figures 17 and 18) show a long term upward trend. For both winds and waves the trend for the seasonal means and the 90 percentile are similar with the 99 percentile showing a greater increase over time.

Winter mean wind speeds and significant wave heights (Figures 19 and 20) show a long term upward trend. For both winds and waves the trend for the seasonal means and the 90 percentile are similar. The wave height 99 percentile shows a greater increase over time with the wind speed 99 percentile showing only a slightly greater increase over time.

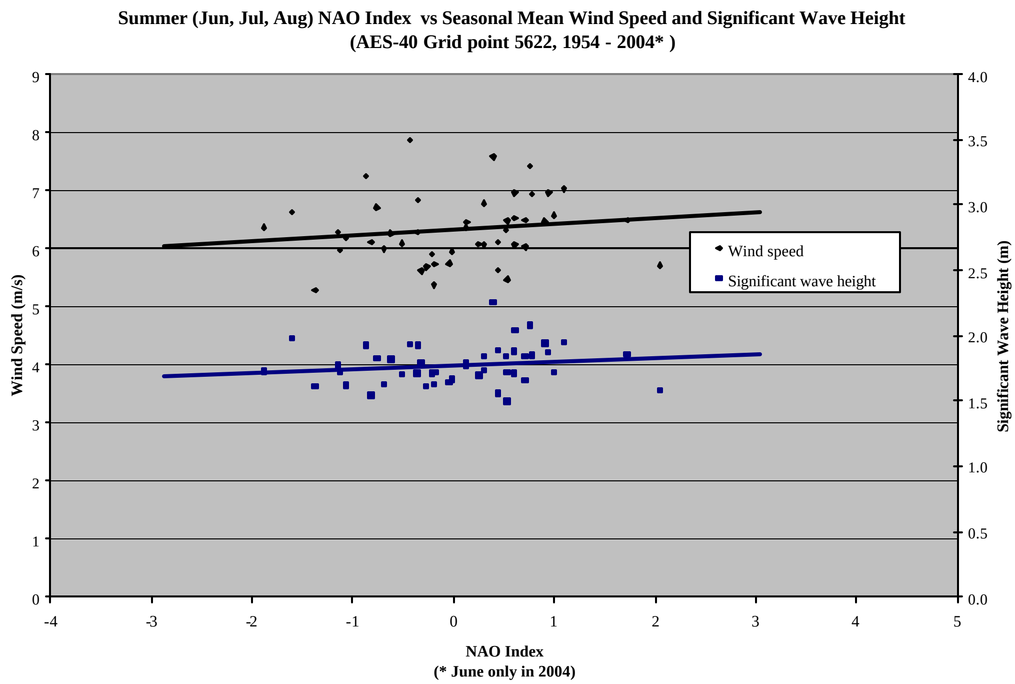


Figure 15. Scatter Plot of Summer NAO Index and Seasonal Mean Wind Speed and Significant Wave Height

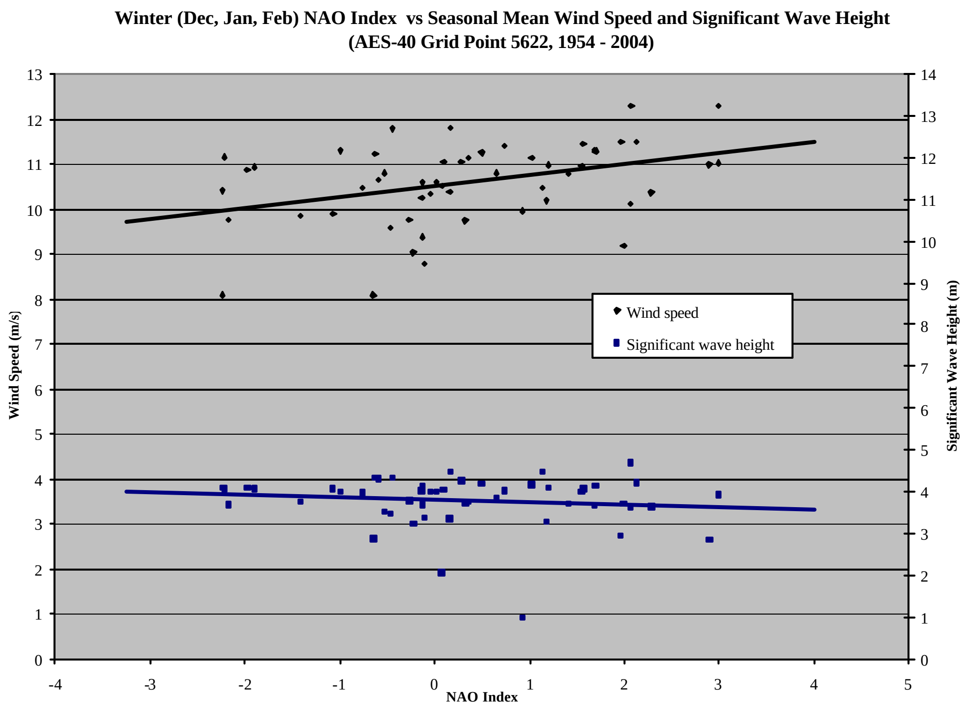


Figure 16. Scatter Plot of Winter NAO Index and Seasonal Mean Wind Speed and Significant Wave Height

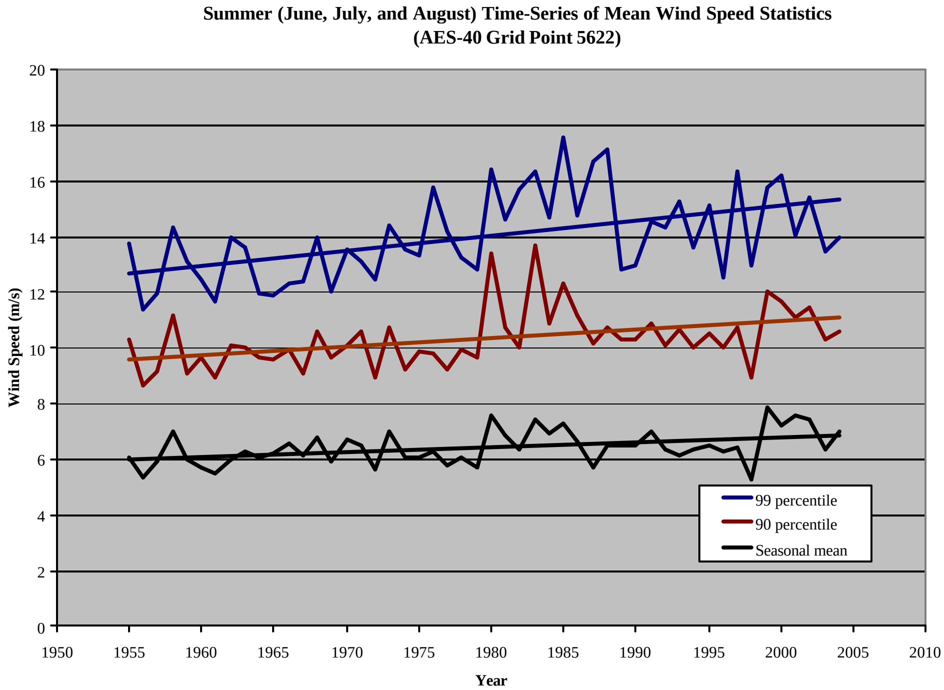


Figure 17. Summer Season Mean Wind Speed Time-Series

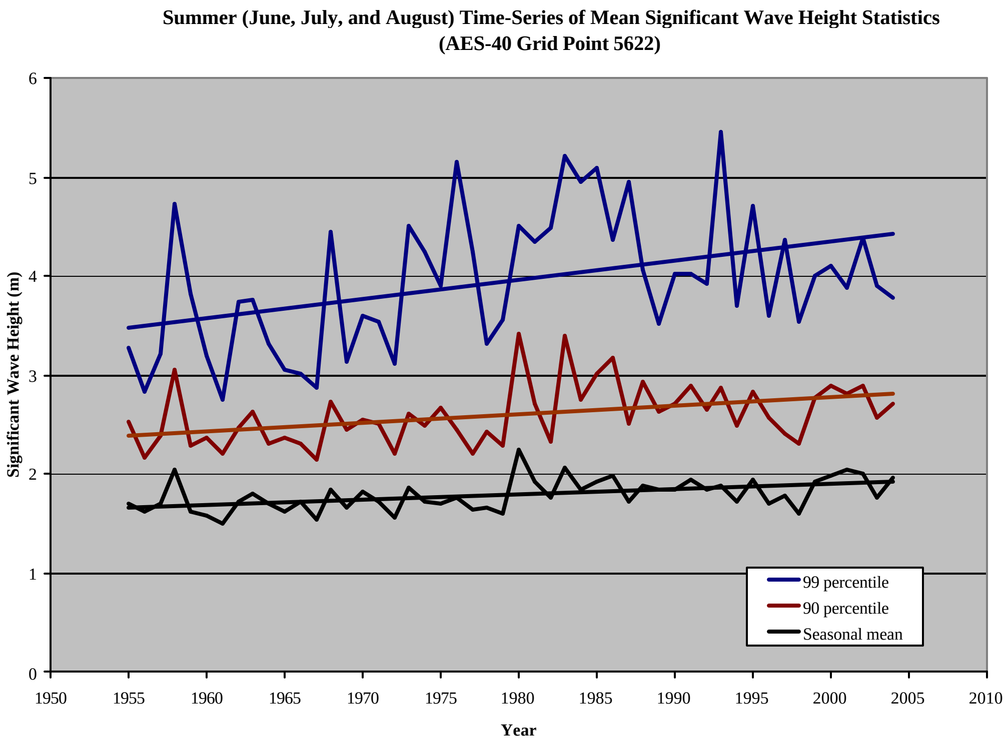


Figure 18. Summer Season Mean Significant Wave Height Time-Series

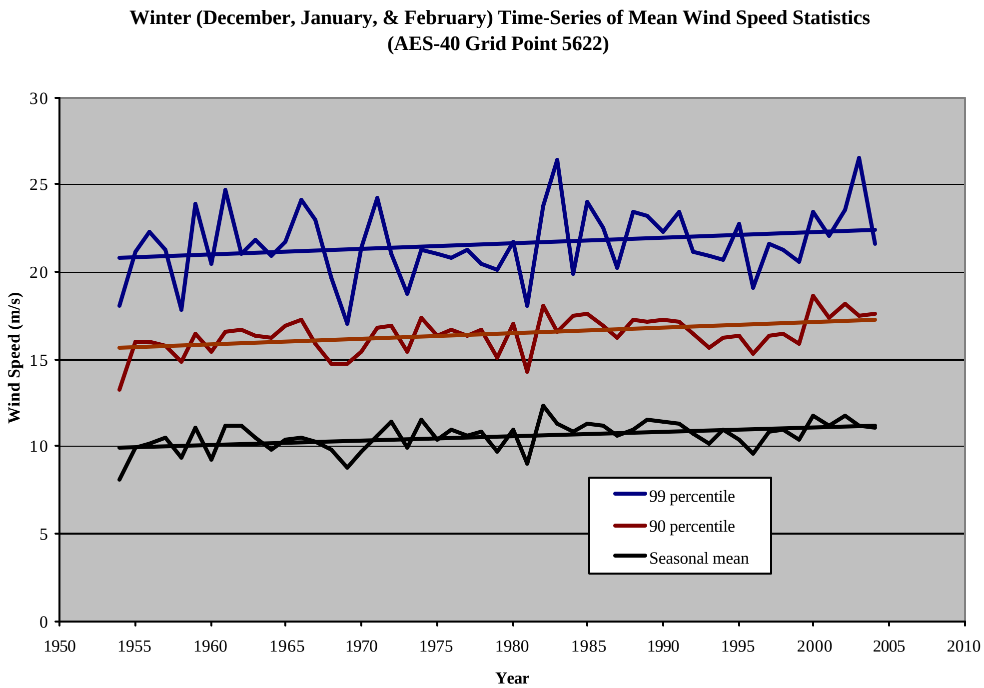


Figure 19. Winter Season Mean Wind Speed Time-Series

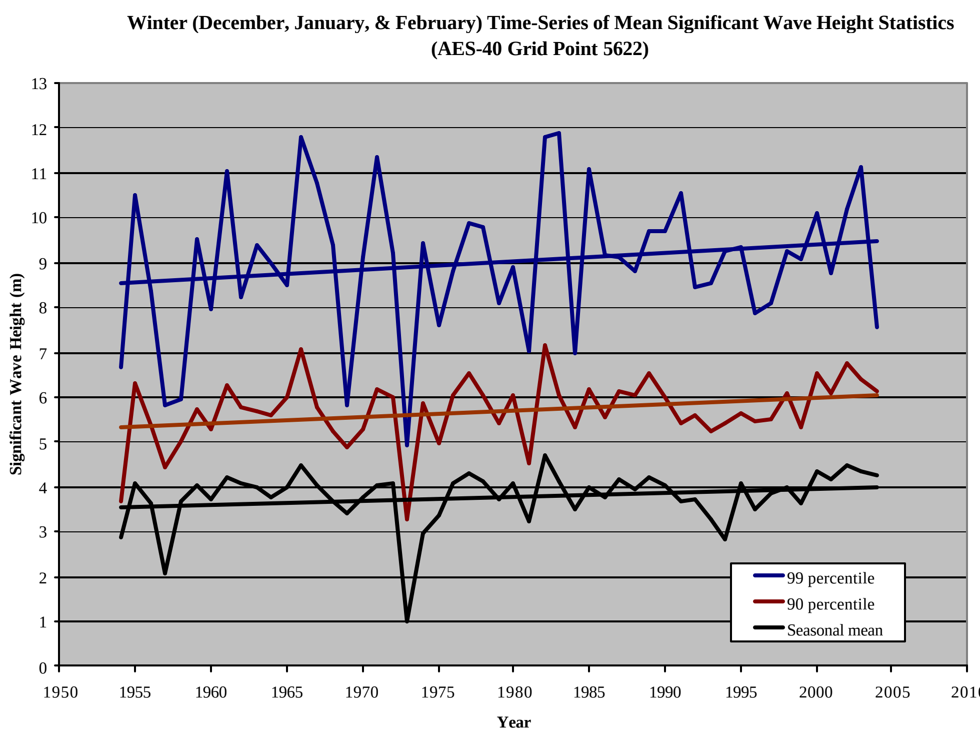


Figure 20. Winter Season Mean Significant Wave Height Time-Series

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Appendix A

Monthly Wind Roses for AES-40 Grid Point 5622

Latitude 46.875 N, Longitude 48.333 W

Table 20. Percentage Occurrence of Wind Speed by Direction for January.

January									
Wind Speed Range (m/s)	Centre of 45 Degree Direction Bins								Totals
	45	90	135	180	225	270	315	360	
0.0 - < 5.0	1.08	0.95	1.19	1.48	1.87	1.71	1.16	1.16	10.61
5.0 - < 10.0	2.27	2.05	2.65	3.89	6.4	8.31	6.55	2.89	35
10.0 - < 15.0	0.85	1.23	2.31	4.02	5.94	13.15	6.94	2.16	36.58
15.0 - < 20.0	0.35	0.39	1.11	2.13	3.08	4.76	2.35	0.61	14.79
20.0 - < 25.0	0.02	0.06	0.13	0.37	0.47	1.08	0.55	0.18	2.85
25.0 - < 30.0	0	0	0	0.02	0.03	0.1	0.02	0	0.16
30.0 - < 35.0	0	0	0	0	0	0	0	0	0
Totals	4.58	4.68	7.39	11.9	17.79	29.1	17.56	7	100

Source: Grid Point 5622, AES-40 Wind and Wave Hindcast Dataset (July 1, 1954 through June 30, 2004)

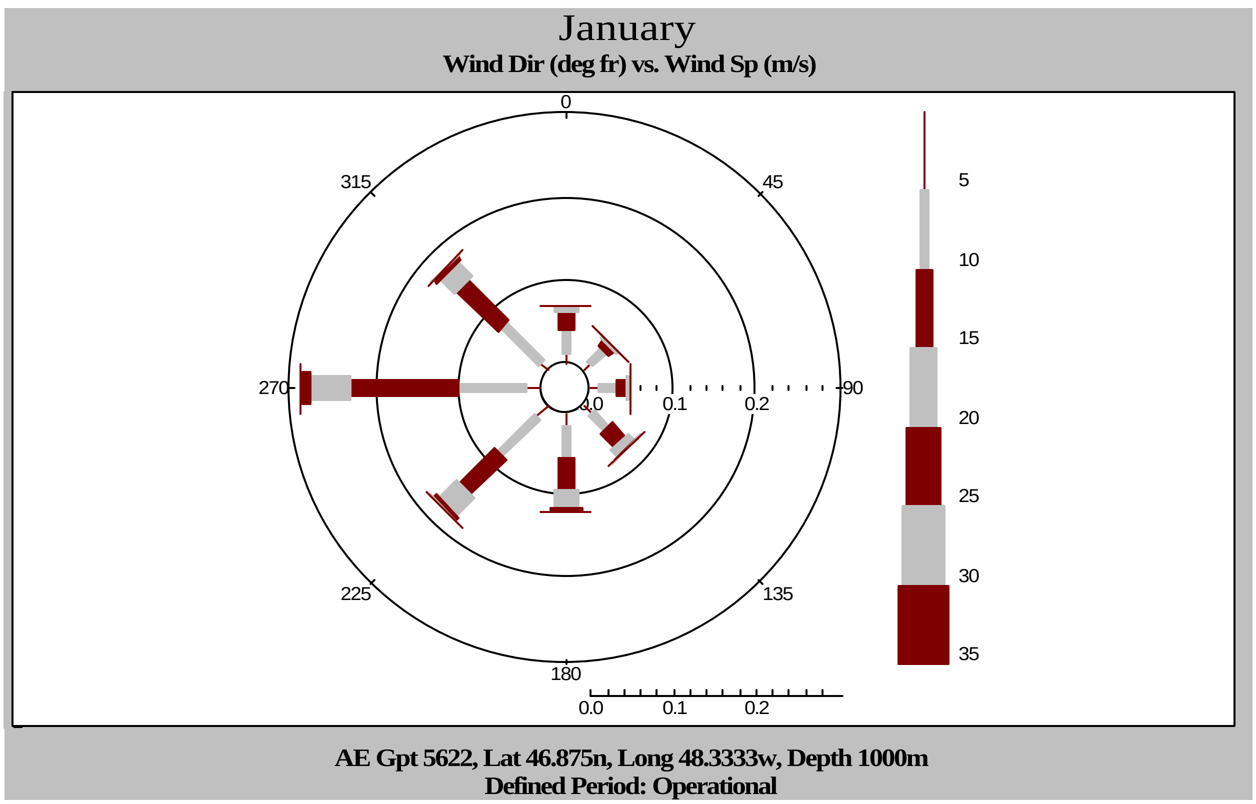

Figure 21. Wind Rose for January.

Table 21. Percentage Occurrence of Wind Speed by Direction for February.

February									
Wind Speed Range	Centre of 45 Degree Direction Bins								
(m/s)	45	90	135	180	225	270	315	360	Totals
0.0 - < 5.0	0.92	1.2	0.94	1.4	1.57	1.47	1.49	1.01	10
5.0 - < 10.0	2.49	2.28	3.27	4.09	5.84	7.98	6.05	3.66	35.67
10.0 - < 15.0	1.42	1.66	2.99	3.77	5.87	11.64	7.45	2.26	37.07
15.0 - < 20.0	0.32	0.39	0.97	1.98	2.11	4.85	2.92	0.69	14.23
20.0 - < 25.0	0.11	0.05	0.14	0.35	0.44	0.9	0.57	0.12	2.69
25.0 - < 30.0	0.02	0	0.02	0.02	0.05	0.11	0.07	0.05	0.34
30.0 - < 35.0	0	0	0	0	0.02	0	0	0	0.02
Totals	5.27	5.59	8.33	11.61	15.91	26.95	18.54	7.8	100

Source: Grid Point 5622, AES-40 Wind and Wave Hindcast Dataset (July 1, 1954 through June 30, 2004)

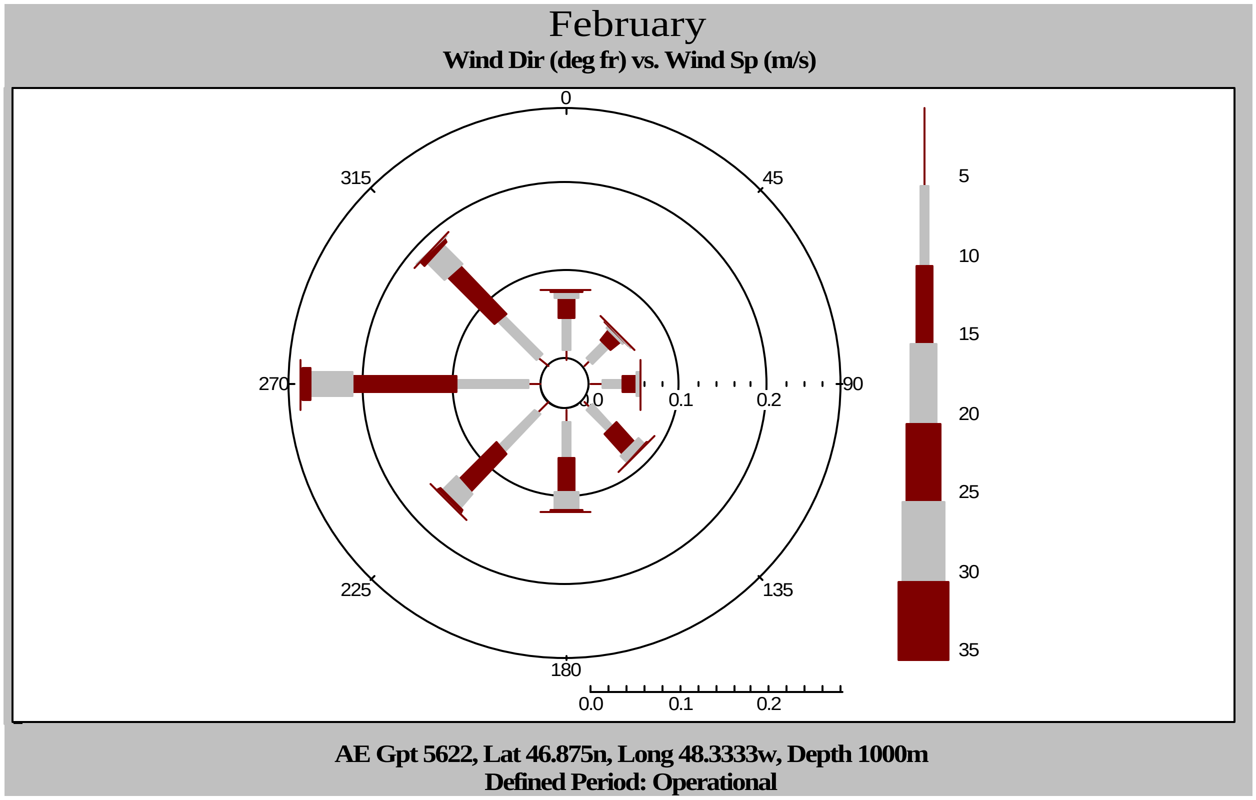

Figure 22. Wind Rose for February.

Table 22. Percentage Occurrence of Wind Speed by Direction for March.

March									
Wind Speed Range (m/s)	Centre of 45 Degree Direction Bins 45	90	135	180	225	270	315	360	Totals
0.0 - < 5.0	1.39	1.68	1.39	2.11	2.21	1.95	1.94	1.71	14.37
5.0 - < 10.0	3.32	2.71	3.23	4.16	7.1	8.16	6.13	4.61	39.42
10.0 - < 15.0	2.16	1.66	2.32	4.37	5.47	8.9	6.47	3.45	34.81
15.0 - < 20.0	0.6	0.47	0.65	1.55	1.82	3	1.52	0.87	10.47
20.0 - < 25.0	0.11	0.02	0.03	0.1	0.15	0.24	0.15	0.1	0.89
25.0 - < 30.0	0	0	0	0	0	0	0.02	0.03	0.05
30.0 - < 35.0	0	0	0	0	0	0	0	0	0
Totals	7.58	6.53	7.61	12.29	16.74	22.26	16.21	10.77	100

Source: Grid Point 5622, AES-40 Wind and Wave Hindcast Dataset (July 1, 1954 through June 30, 2004)

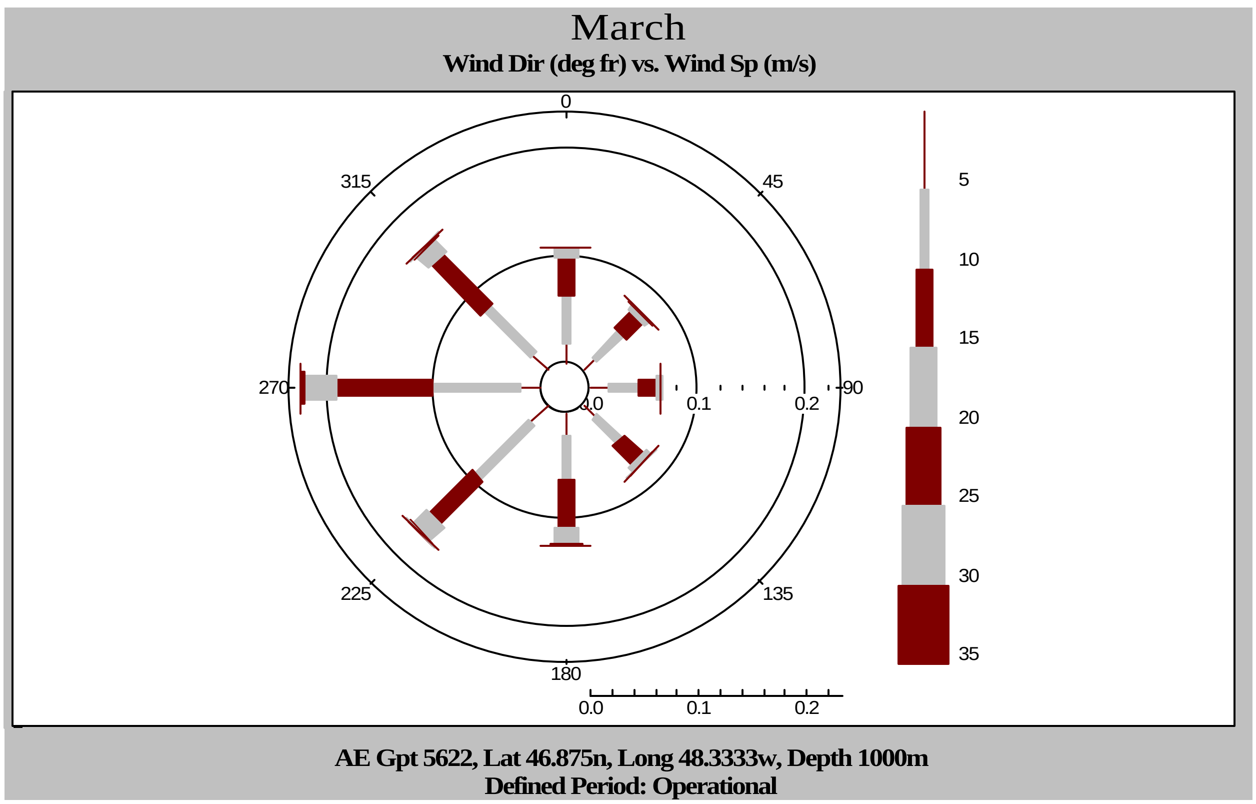

Figure 23. Wind Rose for March.

Table 23. Percentage Occurrence of Wind Speed by Direction for April.

April									
Wind Speed Range (m/s)	Centre of 45 Degree Direction Bins								
	45	90	135	180	225	270	315	360	Totals
0.0 - < 5.0	2.2	2.45	2.92	2.72	3.83	3.2	2.38	2.4	22.1
5.0 - < 10.0	3.28	4.05	5.1	5.93	9.32	9.08	6.22	4.15	47.13
10.0 - < 15.0	1.6	1.3	2.12	3.3	5.55	4.6	4.5	2.45	25.42
15.0 - < 20.0	0.28	0.28	0.28	0.78	0.68	1.02	1	0.57	4.9
20.0 - < 25.0	0.08	0.02	0.02	0.02	0.02	0.08	0.08	0.12	0.43
25.0 - < 30.0	0	0	0	0.02	0	0	0	0	0.02
30.0 - < 35.0	0	0	0	0	0	0	0	0	0
Totals	7.45	8.1	10.43	12.77	19.4	17.98	14.18	9.68	100

Source: Grid Point 5622, AES-40 Wind and Wave Hindcast Dataset (July 1, 1954 through June 30, 2004)

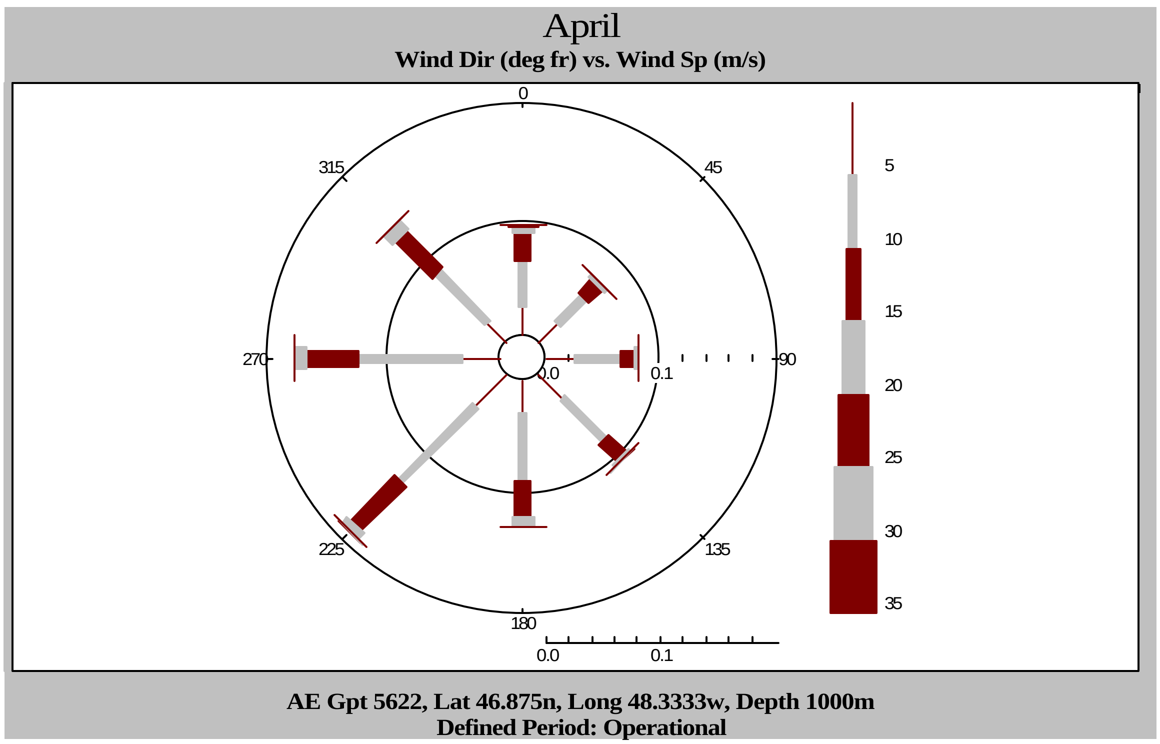

Figure 24. Wind Rose for April.

Table 24. Percentage Occurrence of Wind Speed by Direction for May.

May									
Wind Speed Range (m/s)	Centre of 45 Degree Direction Bins 45	90	135	180	225	270	315	360	Totals
0.0 - < 5.0	3.37	2.92	3.48	4.77	5.82	4.37	3.23	2.73	30.69
5.0 - < 10.0	3.37	3.11	3.89	8.39	11.31	9.16	6.24	4.42	49.89
10.0 - < 15.0	1.05	0.79	0.92	2.52	4.39	3.29	2.39	2.02	17.35
15.0 - < 20.0	0.03	0.1	0.06	0.4	0.52	0.31	0.37	0.18	1.97
20.0 - < 25.0	0	0	0	0	0.02	0	0.06	0.02	0.1
25.0 - < 30.0	0	0	0	0	0	0	0	0	0
30.0 - < 35.0	0	0	0	0	0	0	0	0	0
Totals	7.82	6.92	8.35	16.08	22.05	17.13	12.29	9.35	100

Source: Grid Point 5622, AES-40 Wind and Wave Hindcast Dataset (July 1, 1954 through June 30, 2004)

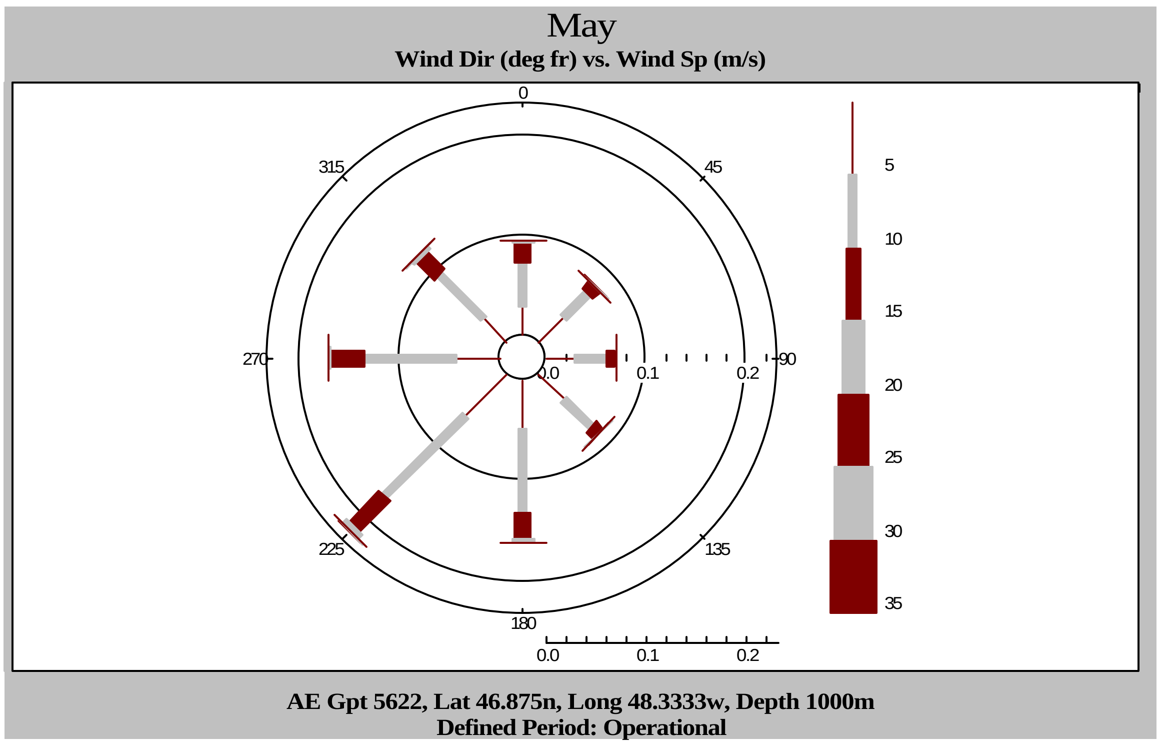

Figure 25. Wind Rose for May.

Table 25. Percentage Occurrence of Wind Speed by Direction for June.

June									
Wind Speed Range (m/s)	Centre of 45 Degree Direction Bins 45	90	135	180	225	270	315	360	Totals
0.0 - < 5.0	2.22	2.25	3.78	5.32	7.7	5.97	3.28	2.95	33.47
5.0 - < 10.0	1.87	2.08	2.6	8.62	19.43	9.02	4.93	3.4	51.95
10.0 - < 15.0	0.47	0.28	0.62	2.68	6.05	2.02	0.92	0.72	13.75
15.0 - < 20.0	0.02	0.05	0.08	0.2	0.22	0.12	0.1	0.02	0.8
20.0 - < 25.0	0	0	0	0	0	0.02	0.02	0	0.03
25.0 - < 30.0	0	0	0	0	0	0	0	0	0
30.0 - < 35.0	0	0	0	0	0	0	0	0	0
Totals	4.57	4.67	7.08	16.82	33.4	17.13	9.25	7.08	100

Source: Grid Point 5622, AES-40 Wind and Wave Hindcast Dataset (July 1, 1954 through June 30, 2004)

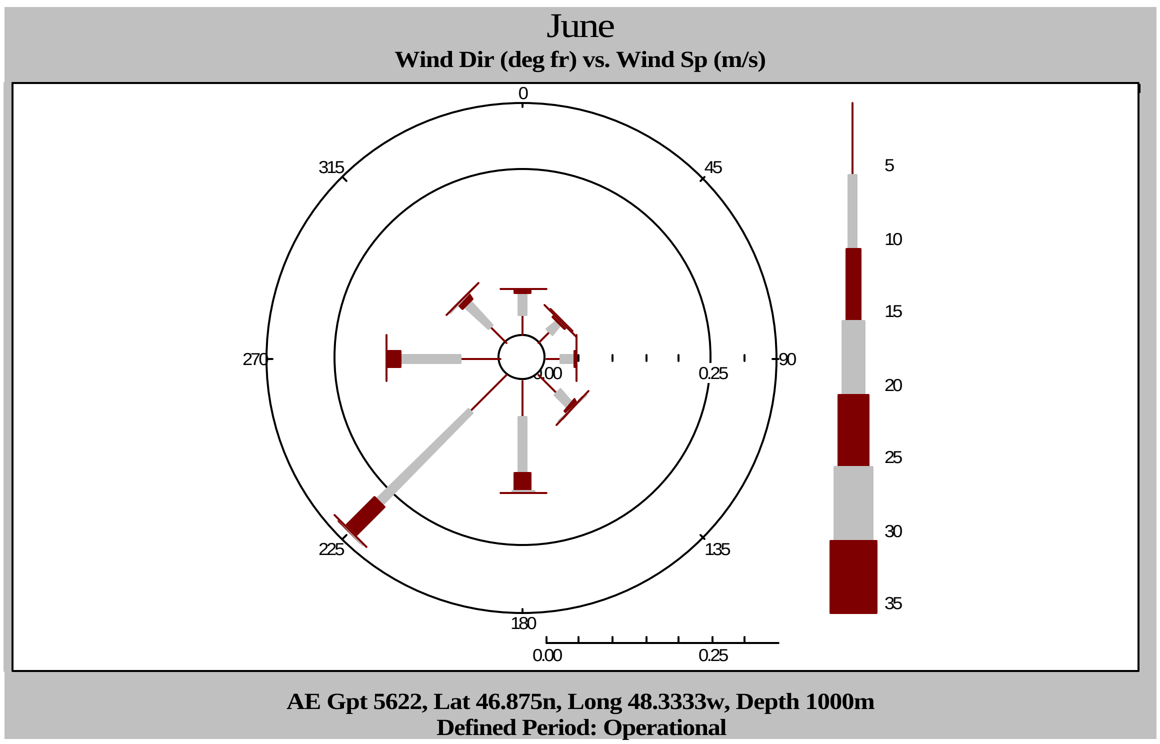

Figure 26. Wind Rose for June.

Table 26. Percentage Occurrence of Wind Speed by Direction for July.

July									
Wind Speed Range (m/s)	Centre of 45 Degree Direction Bins								Totals
	45	90	135	180	225	270	315	360	
0.0 - < 5.0	1.65	1.9	3.06	7.27	10.61	6.42	3.1	1.87	35.89
5.0 - < 10.0	1.11	1.03	2.84	11.26	26.31	8.4	2.37	1.61	54.94
10.0 - < 15.0	0.11	0.1	0.39	2.21	3.74	1.27	0.65	0.21	8.68
15.0 - < 20.0	0.03	0.02	0.03	0.24	0.08	0.02	0.06	0	0.48
20.0 - < 25.0	0	0	0	0	0.02	0	0	0	0.02
25.0 - < 30.0	0	0	0	0	0	0	0	0	0
30.0 - < 35.0	0	0	0	0	0	0	0	0	0
Totals	2.9	3.05	6.32	20.98	40.76	16.11	6.18	3.69	100

Source: Grid Point 5622, AES-40 Wind and Wave Hindcast Dataset (July 1, 1954 through June 30, 2004)

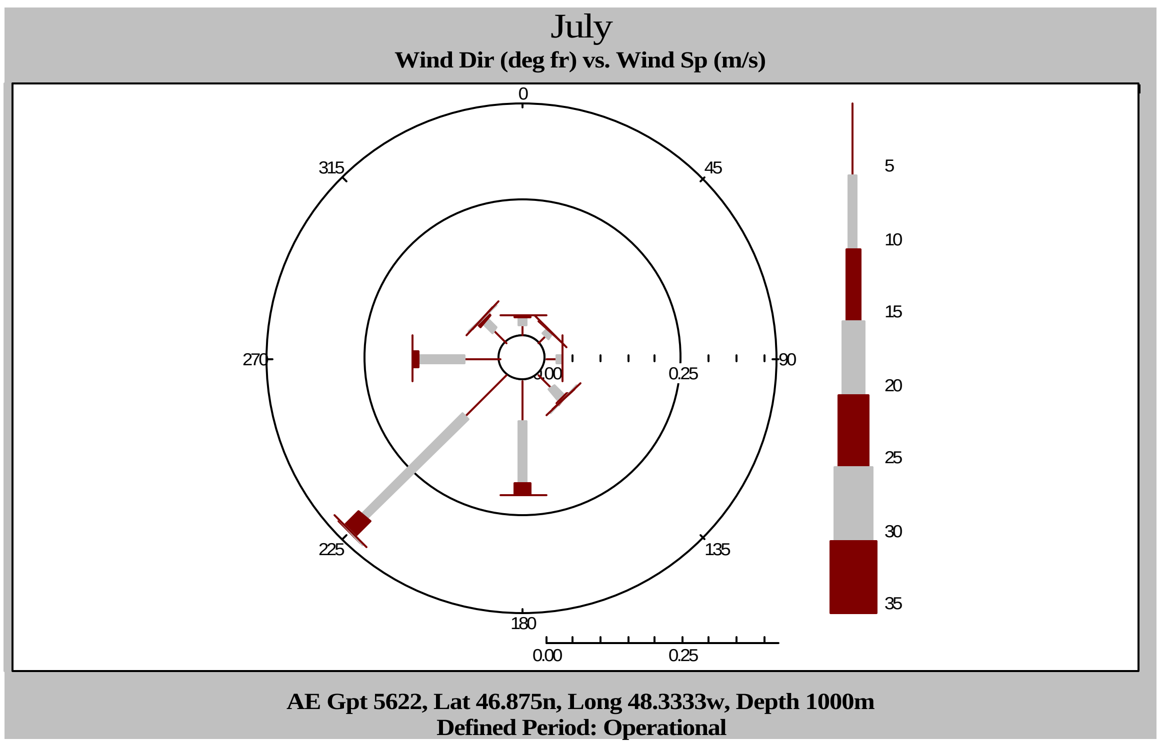

Figure 27. Wind Rose for July.

Table 27. Percentage Occurrence of Wind Speed by Direction for August.

August									
Wind Speed Range (m/s)	Centre of 45 Degree Direction Bins 45	90	135	180	225	270	315	360	Totals
0.0 - < 5.0	1.68	2.08	4	6.23	8.16	6.34	3.4	2.48	34.37
5.0 - < 10.0	2.03	1.16	2.95	10.06	19.85	10	3.87	3.05	52.98
10.0 - < 15.0	0.55	0.24	0.53	2.31	4.18	1.98	1.13	0.6	11.52
15.0 - < 20.0	0.1	0.05	0.08	0.13	0.26	0.19	0.15	0.13	1.08
20.0 - < 25.0	0	0	0	0.02	0	0	0	0.03	0.05
25.0 - < 30.0	0	0	0	0	0	0	0	0	0
30.0 - < 35.0	0	0	0	0	0	0	0	0	0
Totals	4.35	3.53	7.56	18.74	32.45	18.52	8.55	6.29	100

Source: Grid Point 5622, AES-40 Wind and Wave Hindcast Dataset (July 1, 1954 through June 30, 2004)

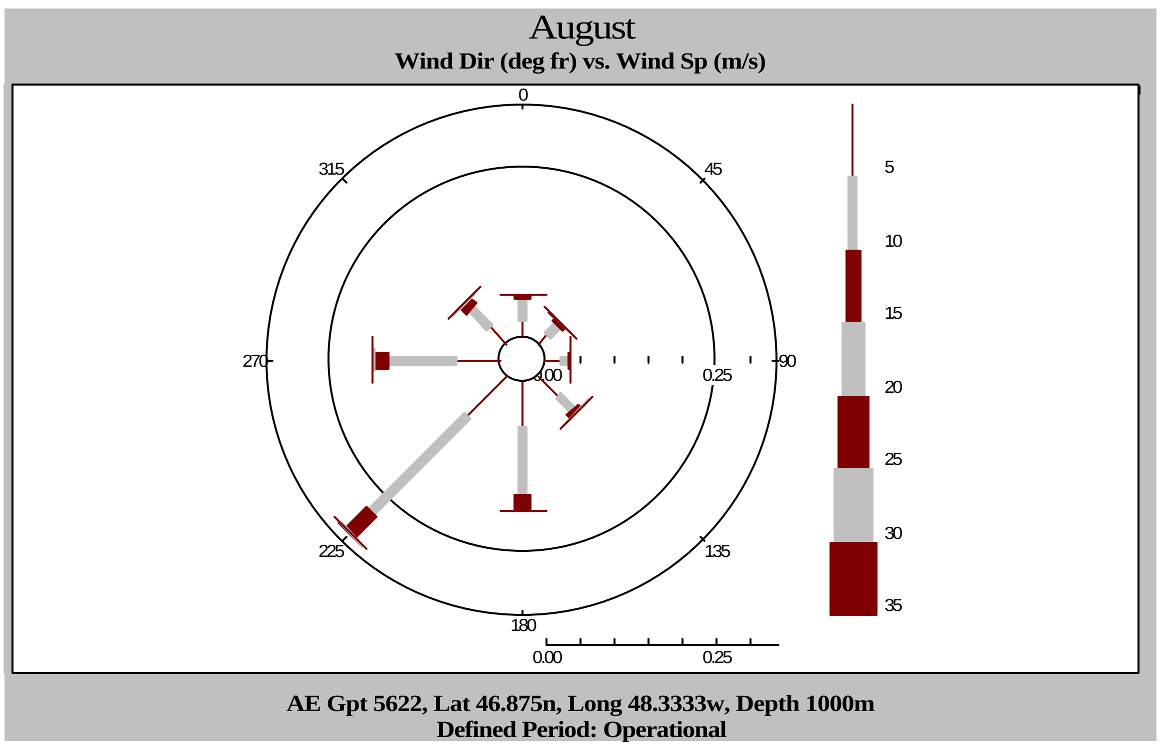

Figure 28. Wind Rose for August.

Table 28. Percentage Occurrence of Wind Speed by Direction for September.

September									
Wind Speed Range (m/s)	Centre of 45 Degree Direction Bins								Totals
	45	90	135	180	225	270	315	360	
0.0 - < 5.0	1.93	1.95	2.5	3.97	5.32	5.3	3.53	2.53	27.03
5.0 - < 10.0	3.23	1.9	2.85	7.43	12.75	11.33	7.42	4.05	50.97
10.0 - < 15.0	0.83	0.52	0.82	2.83	4.48	4.18	3.5	1.88	19.05
15.0 - < 20.0	0.18	0.13	0.15	0.48	0.48	0.47	0.55	0.17	2.62
20.0 - < 25.0	0.02	0.02	0	0.07	0.07	0.12	0.03	0.02	0.33
25.0 - < 30.0	0	0	0	0	0	0	0	0	0
30.0 - < 35.0	0	0	0	0	0	0	0	0	0
Totals	6.2	4.52	6.32	14.78	23.1	21.4	15.03	8.65	100

Source: Grid Point 5622, AES-40 Wind and Wave Hindcast Dataset (July 1, 1954 through June 30, 2004)

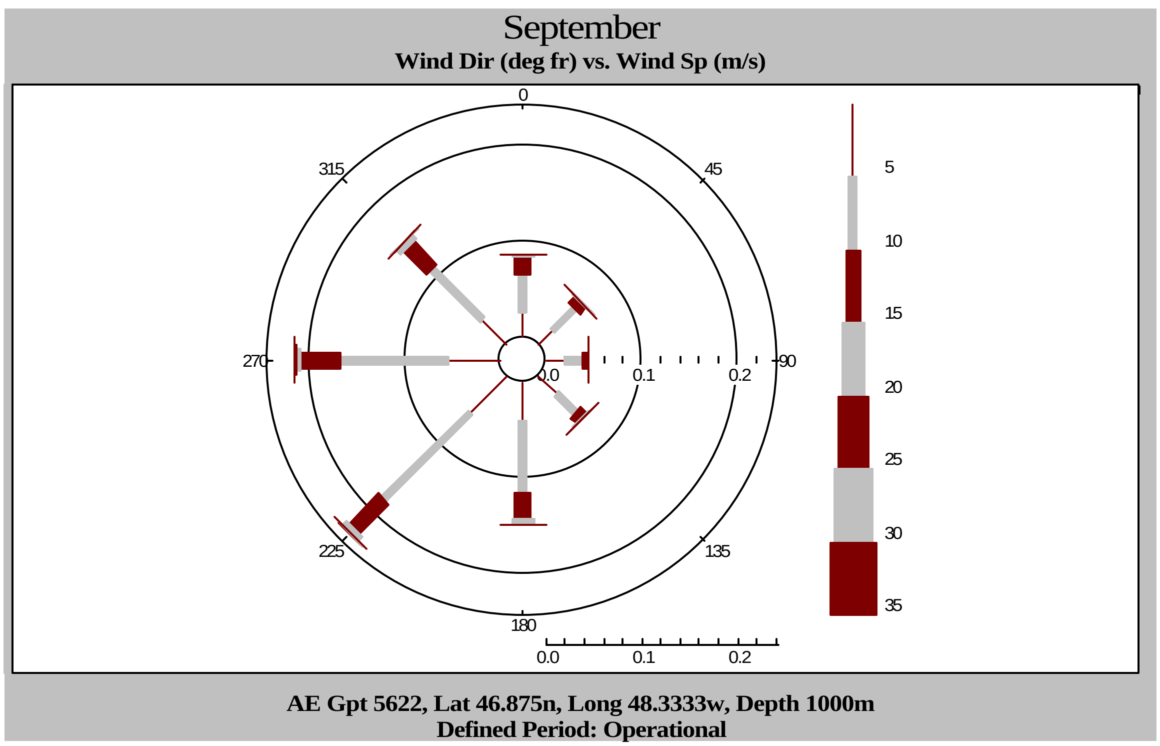

Figure 29. Wind Rose for September.

Table 29. Percentage Occurrence of Wind Speed by Direction for October.

October									
Wind Speed Range (m/s)	Centre of 45 Degree Direction Bins								Totals
	45	90	135	180	225	270	315	360	
0.0 - < 5.0	1.34	1.48	1.87	2.89	3.69	3.37	2.18	1.56	18.39
5.0 - < 10.0	1.95	2.11	3.13	6.56	9.6	11.29	7.87	4.23	46.74
10.0 - < 15.0	1.05	0.6	1.47	3.98	5.58	6.92	6.81	2.27	28.68
15.0 - < 20.0	0.29	0.13	0.34	0.85	0.71	1.16	1.5	0.65	5.63
20.0 - < 25.0	0.06	0	0.02	0.05	0.05	0.06	0.16	0.13	0.53
25.0 - < 30.0	0	0	0	0	0.02	0.02	0	0	0.03
30.0 - < 35.0	0	0	0	0	0	0	0	0	0
Totals	4.69	4.32	6.82	14.34	19.65	22.82	18.52	8.84	100

Source: Grid Point 5622, AES-40 Wind and Wave Hindcast Dataset (July 1, 1954 through June 30, 2004)

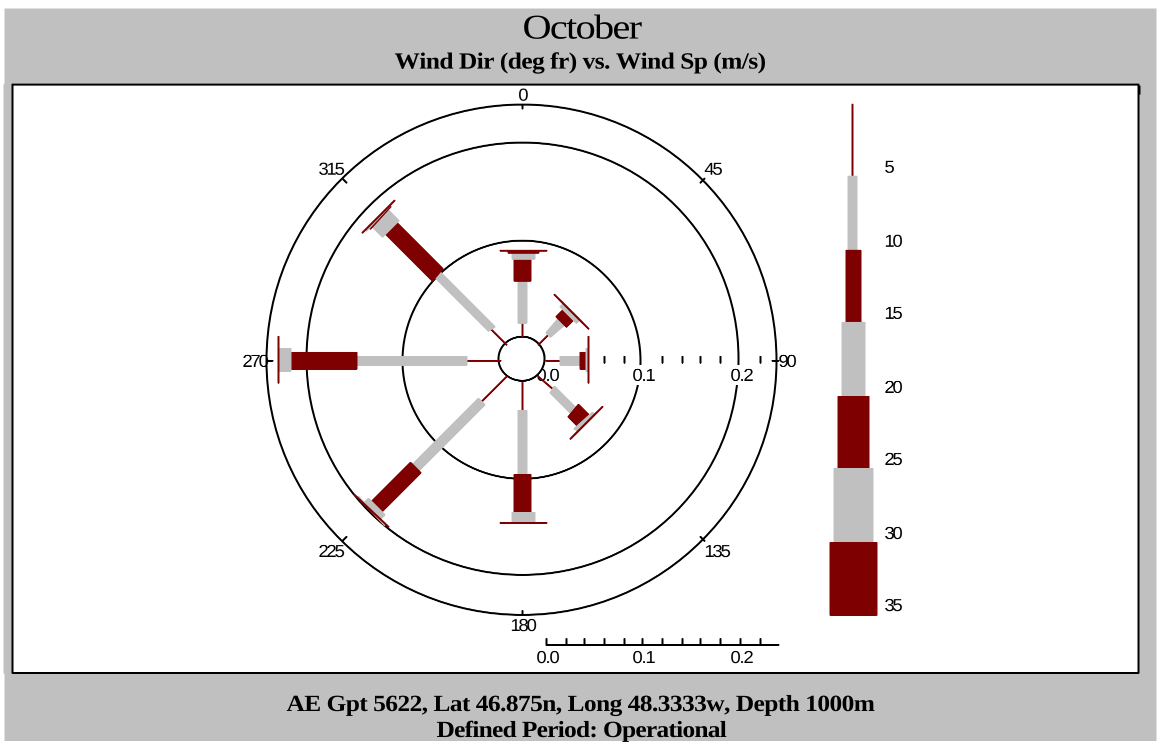

Figure 30. Wind Rose for October.

Table 30. Percentage Occurrence of Wind Speed by Direction for November.

November									
Wind Speed Range (m/s)	Centre of 45 Degree Direction Bins 45	90	135	180	225	270	315	360	Totals
0.0 - < 5.0	1.07	1.2	1.9	2.5	2.52	2.27	2	1.35	14.8
5.0 - < 10.0	2.62	2.53	3.8	5.75	8.57	8.98	7.85	3.42	43.52
10.0 - < 15.0	1.22	1.17	2.2	4.58	5.57	7.98	6.58	2.03	31.33
15.0 - < 20.0	0.37	0.2	0.67	1.47	1.32	2.43	2.13	0.68	9.27
20.0 - < 25.0	0.08	0.02	0.05	0.1	0.1	0.25	0.38	0.07	1.05
25.0 - < 30.0	0	0	0	0.02	0	0	0	0.02	0.03
30.0 - < 35.0	0	0	0	0	0	0	0	0	0
Totals	5.35	5.12	8.62	14.42	18.07	21.92	18.95	7.57	100

Source: Grid Point 5622, AES-40 Wind and Wave Hindcast Dataset (July 1, 1954 through June 30, 2004)

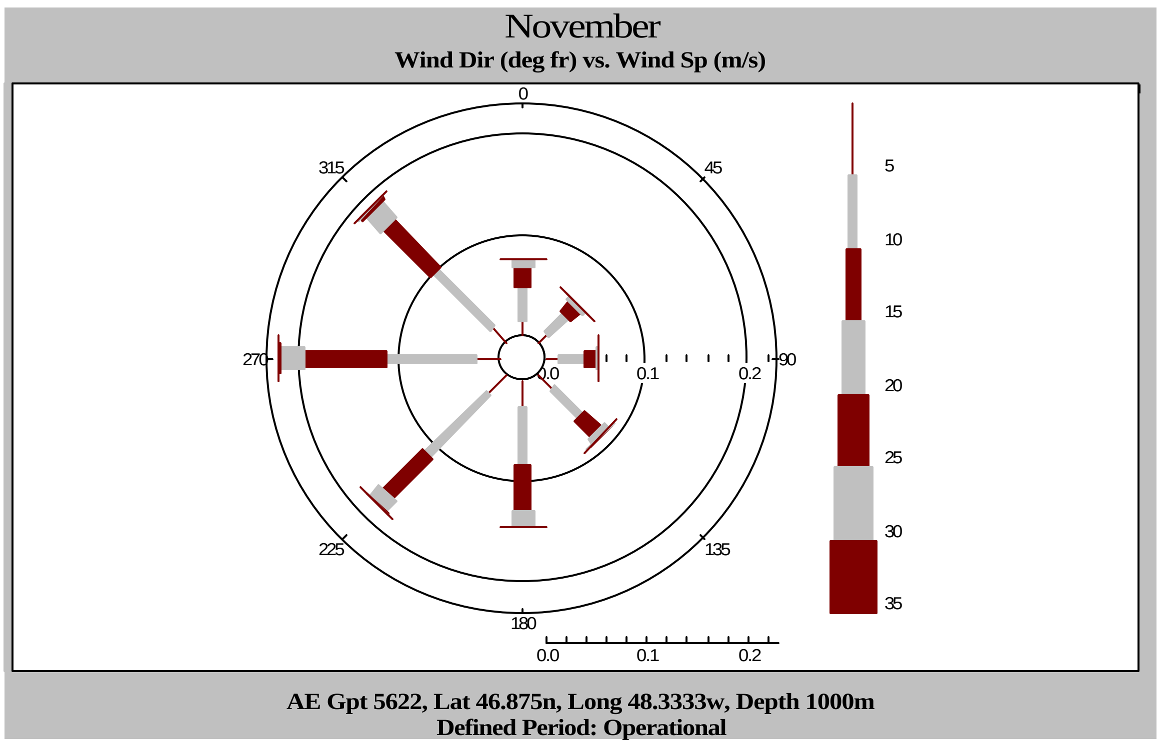

Figure 31. Wind Rose for November.

Table 31. Percentage Occurrence of Wind Speed by Direction for December.

December									
Wind Speed Range (m/s)	Centre of 45 Degree Direction Bins								Totals
	45	90	135	180	225	270	315	360	
0.0 - < 5.0	0.95	1.24	1.37	1.73	1.71	2.06	1.52	0.95	11.53
5.0 - < 10.0	1.9	2.06	3	4.98	6.63	8.9	6.44	3.35	37.27
10.0 - < 15.0	1.26	0.92	2.26	4.52	5.53	10.19	7.19	2.9	34.77
15.0 - < 20.0	0.35	0.34	1.06	2.06	2.29	4.92	2.63	0.89	14.55
20.0 - < 25.0	0.03	0.03	0.1	0.18	0.19	0.77	0.24	0.16	1.71
25.0 - < 30.0	0	0	0	0	0.02	0.05	0.06	0.03	0.16
30.0 - < 35.0	0	0	0	0	0	0	0	0	0
Totals	4.5	4.6	7.79	13.47	16.37	26.9	18.08	8.29	100

Source: Grid Point 5622, AES-40 Wind and Wave Hindcast Dataset (July 1, 1954 through June 30, 2004)

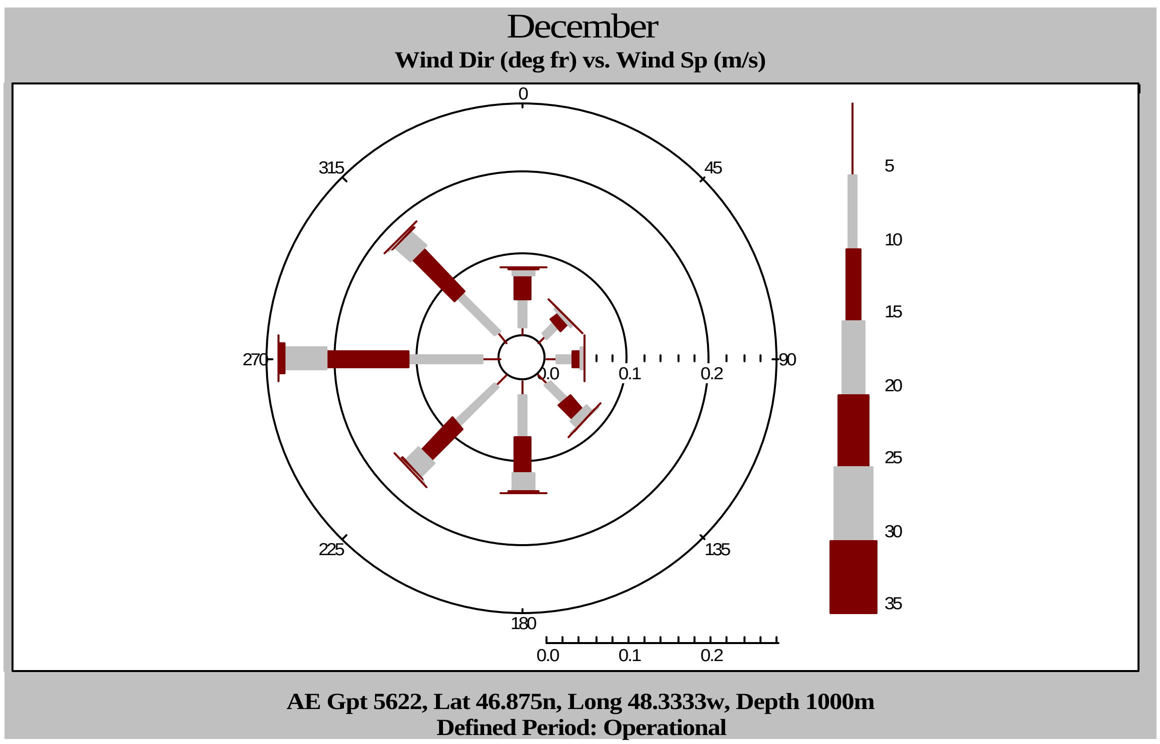

Figure 32. Wind Rose for December.