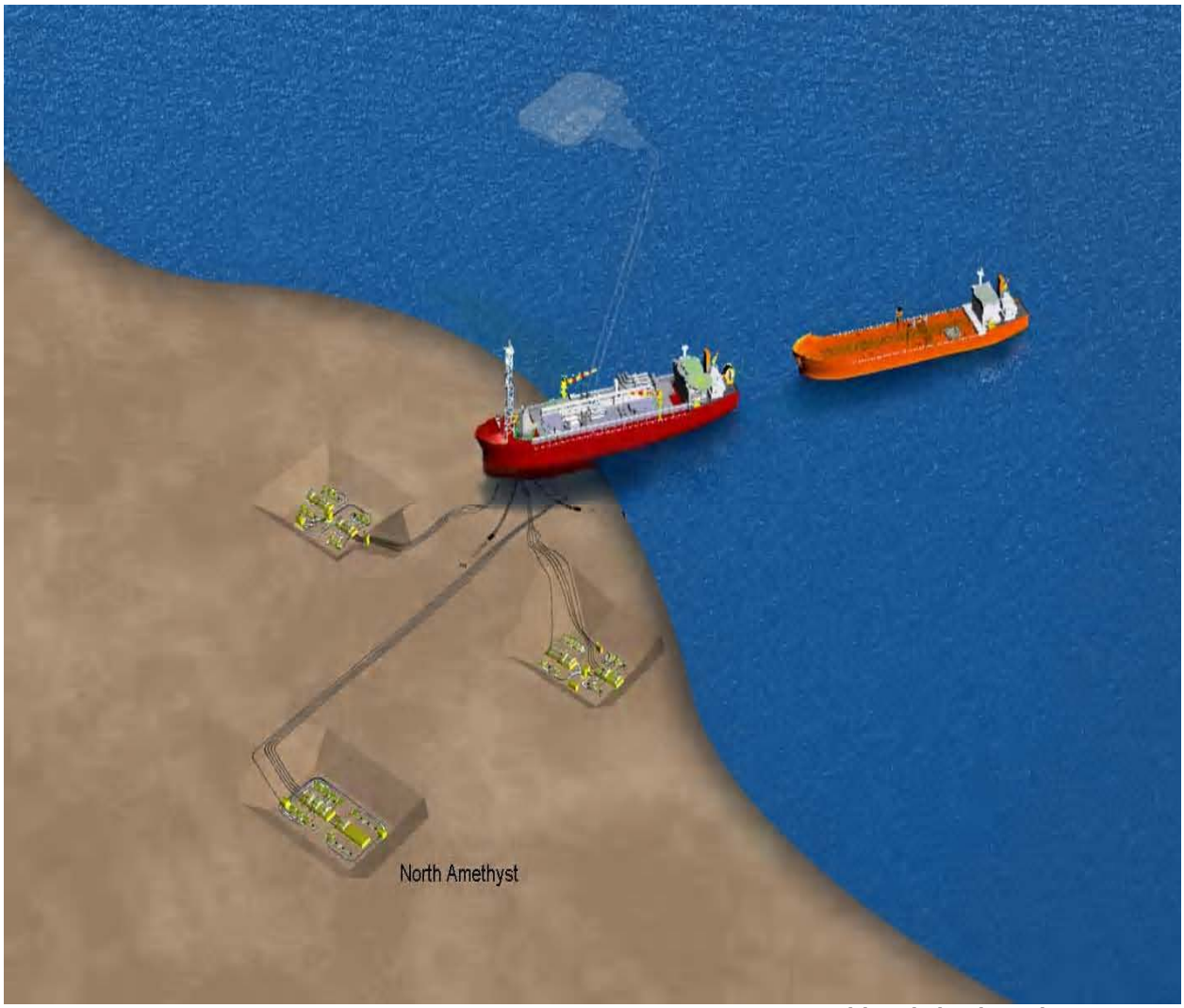
Husky Energy

North Amethyst Satellite Tie-back

Development Application

Project Summary



Cover graphic: Tie-back Option A

August 2007

Husky Document No. SR-SRT-RP-0007

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1.0 Introduction

Husky Oil Operations Limited (Husky), as the Operator and in joint-venture with Petro-Canada, submitted a Development Application (DA) for the White Rose Development to the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) in January 2001. The DA was prepared pursuant to the *Canada-Newfoundland Atlantic Accord Implementation Act* and the *Canada-Newfoundland and Labrador Atlantic Accord Implementation Newfoundland and Labrador Act*. The C-NLOPB approved the White Rose DA in December 2001. The Production License PL 1006 applies to the existing White Rose Development.

This Project Summary document provides an overview of various aspects of the North Amethyst Satellite Tie-back Development Application related to a proposed tie-back of a satellite field to the *SeaRose FPSO*. Husky and its co-venturer Petro Canada propose to undertake development of the North Amethyst field in the Jeanne d'Arc Basin on the Grand Banks within the Significant Discovery Licences (SDL) 1024 and 1044, Production Licence (PL) 1006 and Exploration Licence (EL) 1045. Specifically, the tie-back will consist of construction of a new glory hole with a capacity of up to sixteen wells. The tie-back is expected to require from seven to ten wells consisting of four production and three to six water injection wells. Further field optimization and planning will determine the final well count.

The flow line routing for the tie-back is subject to FEED (Front End Engineering and Design) engineering, flow assurance studies, and further economic evaluation. The results of these studies will determine the exact routing from the North Amethyst glory hole to the *SeaRose*. The field will, therefore, either be tied back from the glory hole directly via new flow lines and new dedicated riser systems (Option A) or via new flow lines to the existing subsea infrastructure (Option B).

Details of the North Amethyst reservoir and depletion planning, glory hole construction, and subsea installation activities are provided in the document *North Amethyst Satellite Tieback to the SeaRose FPSO Development Plan* (Husky Document No. SR-SRT-RP-0002). Required modifications to the *SeaRose* FPSO in support the North Amethyst Satellite Tie-Back are detailed in *White Rose Development Plan Amendment SeaRose FPSO Modifications* (Husky Document No. SR-SRT-RP-0003). These documents have been submitted to the C-NLOPB concurrently with this Project Summary.

The location of the North Amethyst field is indicated in Figure 1.1.

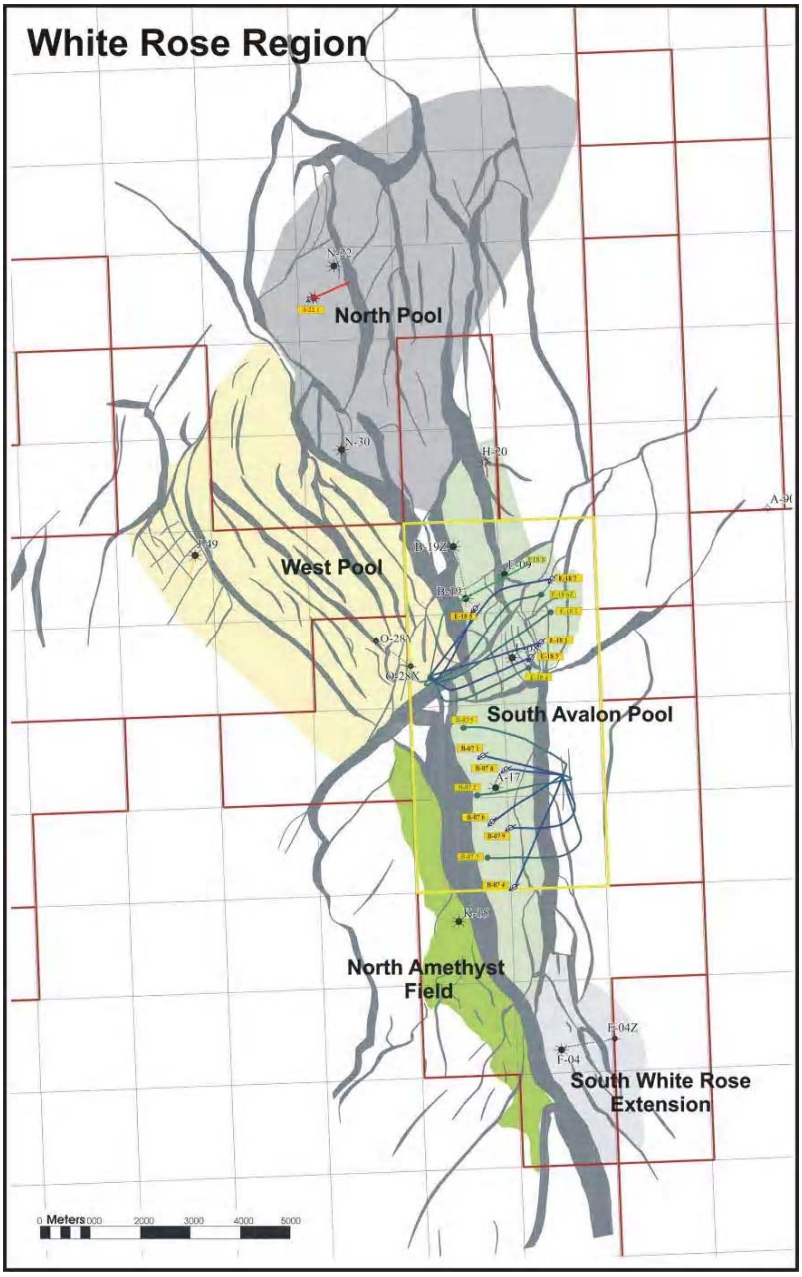

Figure 1.1 Location of North Amethyst Field

2.0 Development Plan

2.1 Geology, Geophysics and Petrophysics

The North Amethyst field is located on the eastern margin of the Jeanne d'Arc Basin. The Jeanne d'Arc basin is one of a series of interconnected sedimentary basins which were formed on the Grand Banks of Newfoundland as a result of

the Early Mesozoic break-up of the Pangea continental mass and the birth of the Atlantic Ocean.

The Jeanne d'Arc basin is a fault-bounded basin trending north-north-west to south-south-east encompassing an area of roughly 10,500 km^2. The North Amethyst field, on the eastern margin of the basin, lies in close proximity to the Voyager Fault, which forms the southeastern edge of the basin.

Development and delineation drilling has provided penetrations of the Ben Nevis reservoir and based on the results, no material changes have been made to the depositional framework for the Ben Nevis Formation as proposed in 2001. The K-15 well was drilled into the North Amethyst structure confirming the presence and quality of the reservoir to the west of the main producing pool. The K-15 well encountered Ben Nevis sandstone approximately 600 m shallower then the main producing White Rose field. The higher porosity and permeability values evident in the K-15 well were largely attributed to less compaction.

2.1.1 Geology

Current geological understanding places the Ben Nevis reservoir in North Amethyst in a region of shallow marine lower shoreface deposition trending southwest-northeast.

The North Amethyst field is situated on a large rotated fault block adjacent to the Terrace portion (A-17 block) of the White Rose South Avalon Pool. The principal reservoir is the Lower Cretaceous Ben Nevis Formation, which consists of predominantly very fine-grained quartzose sandstones deposited in a shallow marine shoreface setting. The North Amethyst field is separated from the Terrace by the West Terrace Fault. This fault occurred after the deposition of the Ben Nevis sands and exhibits around 600 m of throw. The difference in the overall stratigraphic thickness between the Terrace and North Amethyst is almost entirely seen within the Nautilus shales as the Ben Nevis reservoir is similar in thickness to South Avalon Pool wells.

The gross sandstone thickness exceeds 200 meters while the net to gross ratio exceeds 90% in some areas of the field.

2.1.2 Geophysics

Seismic Data Processing

Three different seismic surveys cover the White Rose area: 1) PGS 1997; 2) Breton 1990 and 3) GSI 1985. The three surveys were processed together in

2000 to get a complete picture over the White Rose field and this cube was used for the North Amethyst interpretation.

The main wells used to correlate the seismic markers in North Amethyst were the Fortune G-57 and North Amethyst K-15. An excellent fit was seen between the synthetics generated from the sonic and density logs and the seismic data.

Seismic Markers

A large number of wells from the White Rose area provided correlation points with the stratigraphy over the North Amethyst area. The ties between the synthetic seismograms, corridor stack VSPs, and marine seismic data are generally good.

Shallow Hazards

No significant shallow drilling hazards have been encountered over the White Rose Field during exploration, delineation, or development drilling. Hazards such as high-amplitude, shallow events were not identified during the inspection, study and reporting on various 2-D and 3-D high-resolution geophysical data vintages. A new high resolution survey is being planned for the North Amethyst glory hole in 2007.

2.1.3 Petrophysics

One well, North Amethyst K-15, defines the North Amethyst field. The results from K-15 indicate an average porosity of 22.7% and average permeability of 340 md within the oil leg.

The North Amethyst well at K-15 illustrated a fairly sound seismic interpretation and velocity model in this area as predictions of the top and base of the reservoir were fairly accurate, typically within 5 to 10 m. The net to gross or reservoir quality of the Ben Nevis Sandstone in this well is slightly better than that seen in the adjacent Terrace wells of the South Avalon Pool as a result of under-compaction and a decrease in the amount of carbonate cement. Other than this aspect, the Ben Nevis sandstone, as predicted, is identical to the reservoir seen in the Terrace.

2.2 Reservoir Engineering

2.2.1 Basic Reservoir Data

Reservoir Pressures and Temperatures

The reservoir pressure observed at the K-15 well was 23,800 kPa @ 2,333 mTVDss. The reservoir temperature detected during logging the K-15 well was approximately 88 ^{o}C. The gas-oil and oil-water contact depths are interpreted as 2,333.9 mTVDss and 2,386.39 mTVDss, respectively.

The gas, oil and water gradients observed at the K-15 well were 1.83 kPa/m, 7.01 kPa/m and 9.90 kPa/m, respectively. These values are similar to the fluid gradients seen elsewhere in the White Rose area.

The reservoir permeability is interpreted to be in the range of 155 to 450 md. Tests also indicated that the ratio of vertical permeability to horizontal permeability is higher than 0.12.

Fluid Characterization

Tests indicate a bubble point pressure between 20,830 and 21,100 kPa. Since the North Amethyst structure is shallower than the South White Rose Pool, the saturation pressure of the oil at North Amethyst is lower than the saturation pressure of 29,400 kPa observed in the South White Rose Pool. Extrapolation of the bubble point pressure observed at the K-15 well, down to the depth of the South White Rose Pool, indicates that the bubble point pressure of the fluids appear to be consistent.

The PVT properties of the gas zone at K-15 are very similar to other gas samples in the White Rose field. Water compositional analysis was also conducted on two of the water samples taken from the K-15 well. The PVT analysis results from the K-15 well indicate an average initial gas-oil ratio and formation volume factor of approximately 104 Sm^3/Sm^3 and 1.27 Sm^3/Sm^3, respectively.

2.2.2 Development Strategy

Displacement Strategy

The displacement strategy for the North Amethyst field will provide water injection for pressure support, however both gas flood and water flood options were considered. In terms of ultimate oil recovery and current *SeaRose* FPSO gas handling capacity, a comparison between the gas flooding and water flooding scenarios has recommended water flooding as the preferred secondary recovery mechanism.

The depletion plan for the North Amethyst field includes secondary recovery by water flood. Seawater will be injected from the *SeaRose* FPSO and will be sourced and treated in the same manner as water that is currently being injected into the South Avalon pool.

Development Scenario

A prediction model was run for development of the North Amethyst field found it to be best drained by four horizontal oil producers and five water injectors (1 horizontal and 4 deviated). Further optimization and well design work scope will be conducted and, as such, well counts and well plans may change.

Reservoir Management Plan

The reservoir management plan for the North Amethyst field will be incorporated into the existing criteria currently being used to manage the White Rose South Avalon pool. Each pool in the White Rose area is at the bubble point pressure with an overlying gas cap and underlying water leg. Therefore, a voidage replacement ratio between 1.0 and 1.2 will continue to be targeted. This will provide for long term pressure support in case of any unforeseen interruptions in water injection.

Produced gas from the North Amethyst field will be re-injected into the North Avalon pool for storage purposes in the same manner that excess produced gas from the South Avalon pool is currently being handled. The gas storage area capacity is currently under evaluation and the Northern Drill Center (NDC) has two spare drilling slots which are available for expansion.

2.2.3 Reservoir Simulation

Production/Injection Constraints

The base case North Amethyst simulation model was run together with South Avalon production and is assuming an annualized production rate of 19,081 m^3/d (120,000 bopd). The case considered involves a number of assumptions and presents one potential scenario but field optimization and management will be conducted on a field by field and on an integrated basis.

Production Injection Performance

The maximum oil production rate is expected to be between 10,000 m^3/d (62,900 bopd) and 12,000 m^3/d (75,500 bopd) for the North Amethyst group of wells. The maximum oil production rate will be refined based on further modeling, optimization, and actual drilling and production results.

The North Amethyst overall performance is predicted to exceed a GOR of 600 Sm^3/d and a watercut of 50% before producing 20% of its original oil in place. The GOR is expected to increase dramatically in the North Amethyst region due to the relatively high vertical sand continuity which translates into a high kv/kh ratio.

2.2.4 Production Forecasts

The ultimate recovery for the North Amethyst base case development by the end of 2020 is 11.25 million Sm^3 (70.7 million bbls).

2.3 Resource and Reserve Estimates

Reservoir modeling of the North Amethyst field indicates that there is between 200 and 300 MMbbls (32 and 48 e^6m^3) of oil in place with a most likely estimate being 256 MMbbls (41 e^6m^3). The range in gas cap gas in place is between 100 and 200 Bcf (3 and 6 e^9m^3) with the most likely estimate being 150 Bcf. (4 e9m3). Currently Husky is carrying a range of recovery factors for the North Amethyst field of 18-55%. The most likely recovery factor, which is currently used, is 27% which equates to approximately 70 MMBbl (11 e^6m^3) of recoverable oil (P50 recoverable oil) in the North Amethyst field.

2.4 Design Criteria

The North Amethyst facilities will be designed and fabricated such that they comply with codes and standards, and regulatory requirements of the authorities having jurisdiction in the Newfoundland and Labrador offshore area.

The facilities design will meet the following additional requirements that are consistent with the present White Rose design and operating philosophies:

- subsea installations designed for 20-year minimum service life;
- cathodic protection systems for subsea equipment;
- subsea equipment designed to withstand exposure to hydrogen sulfide; and
- facilities designed using the same environmental criteria developed for White Rose including data on wind, waves, currents, ice, seismic, and seawater properties and ambient temperature.

2.5 Alternative Modes of Development

Husky identified two options for development of the North Amethyst field: a subsea tie-back system to the existing *SeaRose* FPSO facility or a subsea system to a new steel ship-shaped FPSO facility. Husky investigated options for a new build FPSO versus a tanker conversion and compared key risks, schedule

impacts and development costs for each alternative. The investigation concluded that the North Amethyst field should be developed by subsea tie-back to the *SeaRose*. Oil production from the *SeaRose* is predicted to begin to decline in 2008. As spare production capacity becomes available in *SeaRose*, a subsea tie-back will make use of this future capacity, thereby maximizing utilization of the existing infrastructure and lowering the threshold for small field developments. This option is the more viable economic alternative for North Amethyst.

2.6 Production and Transportation System

The production and transportation system that will be used for the North Amethyst Satellite Tie-back project will be the same as that employed for the existing White Rose Development. Specifically, oil produced from the new North Amethyst wells will be brought back to the *SeaRose FPSO* for processing and storage. The oil will be offloaded from the *SeaRose* to tankers for transport to market as is currently done with White Rose oil.

2.7 Construction and Installation

2.7.1 Glory Hole Construction

The North Amethyst glory hole was constructed in 2007 using similar construction methods as those employed for development of the White Rose Development glory holes. A trailing suction hopper dredging vessel was used to dredge the glory hole. This type of dredger is a self-propelled ship which fills its hold or hopper during dredging while following a pre-set track. Dredged material was disposed of in the approved spoils disposal area used during construction of the glory holes for White Rose. The North Amethyst glory hole is slightly deeper and of different dimensions than the glory holes constructed for the White Rose Development in order to allow remotely-operated vehicles and divers easier access to equipment in the glory holes.

2.7.2 Subsea Equipment Installation

The subsea facilities at North Amethyst will include all equipment necessary for the safe and efficient operation and control of the subsea wells and transportation of production and injection fluids between the wells and the *SeaRose*. It is expected that two 10” oil production flowlines, one 9” water injection flowline, and one 4.25” gas lift flowline will be routed from the North Amethyst Drill Centre (NADC) either directly back to the *SeaRose* FPSO via new flow lines and new dedicated riser systems (Option A) or via new flow lines to the existing subsea infrastructure (Option B). If Option A is selected, SeaRose would likely be brought to shore in 2010 for the modifications.

Similar to the White Rose Development, flowlines for North Amethyst will be laid on the seafloor and will be insulated for temperature and flow assurance purposes. Although it is currently anticipated that the umbilical and flowlines utilized for North Amethyst will be of similar design to those installed during initial development of White Rose, a rigid pipeline option is under evaluation. Verification of the exact flowline design, internal diameters and length will be determined during the FEED process.

Procedures for installation of subsea facilities and subsequent operations for North Amethyst are anticipated to be similar to those currently employed for the initial phase of White Rose Development. Once installation is completed, the system will be fully tested prior to being brought into service through the *SeaRose FPSO* infrastructure.

Iceberg protection measures applied to the current White Rose Development will also be applied to North Amethyst including placement of equipment in glory holes, with the top of the equipment having a minimum clearance of 2 to 3 m below the seabed level and use of flowline and umbilical weak link technology. In addition to use of glory holes and weak link technology for subsea installations, active iceberg management will be employed.

2.7.3 Drilling and Completions

It is anticipated that Drilling and Completions activities will be carried out using existing White Rose processes and systems. The North Amethyst Satellite Tie-back will utilize well templates and wellhead systems similar to those used on the White Rose Development. At this time it is anticipated that the NADC will require seven to ten wells (four production and three to six water injection). The drill centre will be designed to hold up to sixteen wells.

Simulation modeling predicts a higher Gas Oil Ratio (GOR) over time. To accommodate the increased gas injection requirements for North Amethyst and any other future tie-backs, the two spare well slots (NG3 and NG4) in the Northern Drill Centre (NDC) are available. Development of these wells was approved as part of the core White Rose Development. If the NDC is expanded to accommodate North Amethyst gas, details of the final design of the NDC wells would be addressed in the individual Approval to Drill a Well (ADW) applications. Details of the completion design and installation plan would be outlined in the individual completion programs.

2.7.4 FPSO Modifications

Should North Amethyst be tied directly back to the SeaRose (Option A), modifications to the FPSO turret, spider buoy and topsides will be required. If

Option A is selected, SeaRose would likely be brought to shore in 2010 for the modifications. This scope would include installation of control valves, pipe work, and instruments and controls comprising two oil production flowlines, one water injection flowline, one gas lift flowline and chemical injection and subsea controls. Alternatively, if North Amethyst is tied back through existing infrastructure (Option B), onshore modifications to *SeaRose* will not be required to tie in North Amethyst.

There will be no requirement for modifications to the hull of the *SeaRose* to accommodate the North Amethyst Satellite Tie-back.

2.8 Production Operations

There will be a requirement to shut down production during installation and commissioning of the new NADC drill centre and for implementation of the *SeaRose* modifications if North Amethyst is tied directly back to *SeaRose*. Should onshore modifications be required, the *SeaRose* will be taken off station and brought to a shore-based facility. It is anticipated that the *SeaRose FPSO* would be at shore for a period of four months during which time there would be no production from the White Rose Development. However, installation activities in the NADC would proceed during the period that the *SeaRose* is at shore. Following return of the *SeaRose* to the White Rose field, the NADC drill centre would be commissioned and brought on line.

The existing organizational structure (offshore and onshore) will not be impacted as a result of development of the North Amethyst Satellite Tie-back. The existing Operating and Maintenance Procedures will be reviewed and revised as required to include the operation and maintenance requirements of North Amethyst.

The Ice Management Plan will also be reviewed and updated or modified as required to reflect the additional “target” for icebergs as a result of the development of the satellite drill center. Logistics, Communications and Contingency Plans should not be impacted as a result of development of the North Amethyst Satellite Tie-back.

2.9 Development Costs

The capital cost estimate for components of the North Amethyst Satellite Tie-back is approximately $1.3 billion.

The North Amethyst Satellite Tie-back will not significantly increase White Rose operating costs. However, in addition to fixed OPEX, the addition of a new drill centre, nine additional wells, and new flowlines and umbilical will result in additional costs for inspection, maintenance and repairs.

Subsea inspections will increase proportionately to the count of drill centres and flowlines. Also allowances must be made for well interventions and increased chemical usage due to the flow assurance challenges associated with the longer tie-back.

3.0 Environmental Impacts

The environmental effects of developing the North Amethyst Satellite Tie-back were assessed in the *Husky White Rose Development Project: New Drill Centre Construction and Operations Program Environmental Assessment* (Husky 2006) and the *Husky White Rose Development Project: New Drill Centre Construction and Operations Program Environmental Assessment Addendum* (Husky 2007), approved April 19, 2007. Following is a summary of the environmental impacts outlined in these documents. For detailed discussion, refer to the above noted documents.

3.1 Existing Environment

3.1.1 Physical Environment

Air and Sea Surface Temperatures

The marine climate at the White Rose oilfield is similar to that at the Hibernia and Terra Nova fields. Mean monthly air temperatures are typically just below 0ºC at the coldest time of the winter and approximately 13.5 ºC at the warmest time of the summer (i.e., August). Average wind speeds are highest during the winter, with maximum monthly winds speeds exceeding 30 m/s in February. Variability of wind speed on the Grand Banks is typically highest during the winter months.

Currents

Oceanic currents at White Rose are comprised of semi-diurnal and diurnal tidal currents, direct wind driven currents, inertial currents, geostrophic currents, and low frequency mesoscale currents. These result from such features as meteorological disturbances, meanders and eddies, and propagation of continental shelf waves. Monthly maximum near-surface current speeds range from 36 cm/sec (January) to 89.9 cm/sec (September), and there is no consistent direction for surface currents in the area.

Sea Ice and Icebergs

Sea ice cover in the White Rose area occurs for an average of four weeks once every three years. The peak period of occurrence is February to April. Ice

concentrations are typically low to moderate (20 to 60% coverage). Data indicate that floes larger than 100 m in diameter are present in the project Area only 10% of the time. Indications are that mean floe diameters in offshore areas south of 49°N are less than 30 m. 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. Mean sea ice drift speed is typically about 0.25 m/sec, primarily in a southeast direction.

During the last ten years, an average of 900 icebergs reached the Grand Banks each year. Of these, only a very small proportion passed through the general vicinity of the White Rose project. Iceberg numbers in the area are typically highest from March to early June, peaking in May. The majority of icebergs that reach the Grand Banks are rated as small when compared to known iceberg size. Iceberg drift speeds on the Grand Banks range from 0 to 1.3 m/sec, and average 0.25 to 0.3 m/sec.

3.1.2 Biological Environment

Commercial Fisheries and Fish Habitat

Plankton (that is, organisms that drift with water currents) found on the Grand Banks, include microrganisms, algae, juvenile and adult invertebrates, and many species of fish eggs and larvae. Aggregations of plankton are often exploited by feeding fish, seabirds, baleen whales and other predators.

Benthos refers to plants and animals that live in or on the sea bottom. At least 370 benthic species, including polychaete, echinoderm, crustacean (such as scallop, crab and lobster) and mollusc, occur on the Grand Banks. Benthic animals form an important food resource for many species of fish.

Fish are not only an important food source for humans, but are also important ecologically as predators and food for other species. A variety of fish species occur in the White Rose area. However, these species are not unique as they also occur in various other parts of the Grand Banks and elsewhere. The White Rose field area is located within the North Atlantic Fisheries Organization (NAFO) Unit Area 3Lt. The domestic harvest in the area around White Rose has been almost exclusively shrimp, snow crab and offshore clams in recent years. Other species that are or have been important to fishing activity in the project area and adjacent region include Iceland scallop, northern shrimp, Stimpton's surf clam, yellowtail flounder, Greenland halibut, Atlantic halibut, swordfish, bluefish and bigeye tuna.

Marine Birds

The Grand Banks shelf and slope have been identified as areas rich in abundance and diversity of seabirds. The highly productive Grand Banks support large numbers of marine birds (seabirds) at all seasons. Marine birds are not spread evenly over the ocean but tend to be concentrated over anomalies such as shelf edges and along currents. Mixing in the water column at these edges creates a productive environment for zooplankton. A branch of the Labrador Current flows south along the shelf edge off eastern Newfoundland including the Grand Banks. The combination of shelf edge and Labrador Current are prime conditions for high productivity of plankton, which is the base of marine food chains. Table 3.1 lists the species and months of occurrence and abundance expected in the region.

Table 3. 1 Bird Species Occurring in the White Rose Area and Monthly Abundances

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						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	*Sula bassanus*				S	S	S	S	S	S	S		
Red Phalarope	*Phalaropus fulicaria*					S	S	S	S	S	S		
Red-necked Phalarope						S	S	S	S	S			
Laridae													
Great Skua	*Catharacta skua*					R	R	R	R	R	R		
South Polar Skua	*Catharacta 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	*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.
Shaded months indicate most likely time for seismic exploration.

Marine Mammals

At least 20 species (Table 3.2) of marine mammals may occur in the White Rose area including 16 species of cetaceans (whales and dolphins) and three species of seals. Additional marine mammal species may occur rarely. Most marine mammals are seasonal inhabitants, the waters of the Grand Banks and surrounding areas being important feeding grounds for many of them.

Table 3. 2 Marine Mammals that are Known or Expected to Occur in the White Rose Area

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

[a] A COSEWIC status report was prepared and is being reviewed.

Sea Turtles

Sea turtles are probably not common in the White Rose area but are important to consider given that they are considered at risk, both nationally and internationally. The three species of sea turtle that may occur in the Study Area includes the leatherback (*Dermochelys coriacea*), loggerhead (*Caretta caretta*), and Kemp's ridley (*Lepidochelys kempi*) turtle. Of these three species, the leatherback turtle is most likely to occur in the Study Area. This species is listed under Schedule 1 of SARA as endangered.

The leatherback is the largest living turtle (2.2 m in length and over 900-kg) and it also may be the most widely distributed reptile, as it ranges throughout the Atlantic, Pacific, and Indian oceans and into the Mediterranean Sea. Adults engage in routine migrations between temperate and tropical waters, presumably to optimize both foraging and nesting opportunities.

3.1.3 SARA and COSEWIC-listed Species

The *Species at Risk Act* (*SARA*) was assented to in December 2002 with certain provisions coming into force in June 2003 (e.g., independent assessments of species by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)) and June 2004 (e.g., prohibitions against harming or harassing listed endangered or threatened species or damaging or destroying their critical habitat).

Species/populations that are legally protected under SARA and have potential to occur in the White Rose area are listed in Table 3.3 as are species that potentially occur in the area and are considered at risk but which have not received specific legal protection under *SARA*. Other non-*SARA* listed marine species which potentially occur in the area and are listed by COSEWIC as either endangered, threatened or species of special concern are also included in Table 3.3.

Table 3. 3 SARA-listed and COSEWIC-listed Marine Species Potentially Occurring in the White Rose Area

SPECIES		SARA[a]			COSEWIC[b]		
Common Name	**Scientific Name**	**Endangered**	**Threatened**	**Special Concern**	**Endangered**	**Threatened**	**Special Concern**
Blue whale	*Balaenoptera musculus*	Schedule 1			X		
North Atlantic right whale	*Eubalaena glacialis*	Schedule 1			X		
Leatherback sea turtle	*Dermochelys coriacea*	Schedule 1			X		
Northern wolffish	*Anarhichas denticulatus*		Schedule 1			X	
Spotted wolffish	*Anarhichas minor*		Schedule 1			X	
Atlantic wolffish	*Anarhichas lupus*			Schedule 1			X
Ivory Gull	*Pagophila eburnean*			Schedule 1	X		
Harbour porpoise	*Phocoena phocoena*			Schedule 2			X
Sowerby's beaked whale	*Mesoplodon bidens*			Schedule 3			X
Atlantic cod (NL[d] population)	*Gadus morhua*			Schedule 3	X		
Porbeagle	*Lamna nasus*				X		
White shark	*Carcharodon carcharias*				X		
Cusk	*Brosme brosme*					X	
Shortfin mako	*Isurus oxyrinchus*					X	
Blue shark	*Prionace glauca*						X

Sources: [a] *SARA* website (http://www.sararegistry.gc.ca/default_e.cfm)

[b] COSEWIC website (http://www.cosepac.gc.ca/index.htm)

[c] Scotian Shelf

[d] Newfoundland and Labrador

3.2 Effects Assessment

3.2.1 Fish and Fish Habitat

Presence of Structures

The safety zone would have a potential positive effect on all four fish habitat components (i.e., water, sediment, plankton, benthos) and on juvenile and adult fish by excluding other users from the area, including commercial fishers. The safety zone would provide some protection against damage to the seabed by trawlers and shellfish dredgers and perhaps lower fish mortality from commercial fisheries. The artificial reef effect would also have a potential positive effect on fish and fish habitat by increasing habitat complexity and, thereby providing increased food and shelter for a more diverse assemblage of marine organisms. Therefore, the overall effect of the presence of structures on fish and fish habitat will be *positive.*

Sediment Excavation

Sediment excavation will occur only during glory hole excavation of the new drill centres. Potential negative effects of sediment excavation on fish habitat include disruption of substrate, smothering of benthos and suspension of sediments in the water column. Sediment removal and deposition would interact primarily with eggs of some species, juveniles, adult pelagic fish, and adult groundfish due to disruption of substrate and suspension of sediment in the water column.

Considering the relatively small area of each glory hole (70 m x 70 m floor dimension), the reuse of the original spoil area for sediment deposition, and the sandy nature of the sediment (thus minimizing the amount and duration of sediment suspension in the water column), the potential effects of sediment excavation on fish and fish habitat are not significant.

No overlap of glory hole excavations is expected to occur during development of the new drill centres. Cumulative effects of sediment excavation on fish and fish habitat would be considered additive but are judged as being not large enough to change the overall residual effects rating.

Lights and Flaring

The dredging vessel, drill rig, FPSO, and supply and standby ships will all be equipped with navigation and warning lights. Working areas will be illuminated with floodlights. Some plankton and adult pelagic fish may be attracted to illuminated surface waters near the vessels but the potential effects on these biota would be minimal. Flaring may

may occur during operations. Other than the slight possibility of illumination attracting some zooplankton or pelagic fish to surface waters the effect of flaring on fish will also be minimal. Therefore, the potential residual effects of lights and flaring are *not significant.*

Considering that lights will be used during all project phases, there is potential for temporal overlap of this activity. However, despite these effects being additive, they are judged to not be large enough to change the overall effects rating. Cumulative effects with respect to other activities on the Grand Banks are considered to be not large enough to change the overall residual effects rating.

Drill Muds and Cuttings

The discharge of drilling muds and cuttings would occur during drilling of new wells. Drill muds and cuttings have the most potential to affect the sediment and benthos components of f ish habitat but could also affect water quality and plankton. To a much lesser degree, drill muds and cuttings could affect those fish occurring in the lowest part of the water column (i.e., eggs of some species, juveniles, adult groundfish).

The total quantity of mud and cuttings that would be deposited on the seabed would be on the order of 230 m^3 per well. This will cover an area of the seabed of about 0.8 km^2 to a thickness of one cm or greater. Recent modeling by Lorax Environmental indicates that the maximum thickness of approximately 10 mm (1 cm) occurs within a 25 m radius of the well. It is unlikely that any smothering effect would occur until thickness was about 10 mm or greater, all of which would occur well within a radius of 500 m of the well.

Both snow crab and American plaice were sampled as representative invertebrate and fish species of the benthos during the Husky Environmental Effects Monitoring Program in 2004 and 2005 and analysed for various health indices. Samples were collected up to 1.25 km from an active drill centre. Results of these analyses indicated no significance difference between crabs and plaice collected closest to the drill centres and those collected at reference stations more than 20 km away from the drill centres, indicating no project effects.

The potential effects of water-based and synthetic-based drill muds (SBM) and cuttings on fish and fish habitat are *not significant*. Similarly, the White Rose Oilfield Comprehensive Study analyzed the effects of the discharge of drilling wastes from development drilling of 25 wells using SBMs at multi-well drilling sites. The White Rose development drilling was deemed to create *no significant effect* on fish and fish habitat.

Produced Water

Produced water will be realised during production operations. Produced water could potentially affect the plankton components of fish habitat as well as fish eggs, larvae and adult pelagic fish. All produced water on the *SeaRose FPSO* will be treated to less than 30 mg/L and discharged as per the Offshore Waste Treatment Guidelines. Considering the proposed mitigation, the effects of produced water on fish and fish habitat would be *not significant*. Effects will be additive with other projects but the cumulative effect will not exceed this rating.

Atmospheric Emissions

Air emissions will occur during all project phases and have the potential to interact with water and plankton and near-surface eggs, larvae and pelagic fish. Sources of atmospheric emissions include flaring during operations, burning of fuels for power generation, and small amounts of fugitive emissions (hydrocarbon losses at valves and seals, open ended piping and particulate matter from cement and chemical powders).

In general, emissions of potentially harmful materials will be small and of short duration and they will rapidly disperse to undetectable levels. Based on this, the effects of air emissions on fish and fish habitat are *not significant*. Effects will be additive with other projects but the cumulative effect will not exceed this rating.

Noise

The sea is a naturally noisy environment. Natural ambient noise is often related to sea state. Ambient noise tends to increase with increasing wind speed and wave height. In many areas, shipping is a major contributor to ambient sound. Disturbance related to underwater and air-borne noise could be caused by more stationary sources such as the dredging vessel, drilling platforms, and FPSO or by mobile sources such as supply boats and helicopters. Noise would obviously occur during all project phases and it can potentially affect all life stages of fish as well as plankton (i.e., zooplankton).

Fish vary widely in their ability to hear sounds. Some fish have very good hearing capabilities. In many of these species, such as certain herring-like fishes, the swim bladder is connected directly to the inner ear. In contrast, cod do not have a direct connection between swim bladder and inner ear, and are less sensitive to sound than are some other species of fish. There are suggestions that fish horizontal and vertical distributions might be affected by exposure to sound. However, any apparent effect seems to be temporary in nature. The reactions of fish to ship sounds vary including swimming in the same direction as the ship and being guided ahead of it or avoidance of the ship by swimming away from the path. Avoidance reactions are quite variable and

depend on species, life history stage, behaviour, time of day, whether the fish have fed, and sound propagation characteristics of the water.

Little is known about invertebrate reactions to sound. It has been generally believed that seismic exploration has had little effect on important marine invertebrates such as lobster, shrimp and crab because these animals do not have hearing organs. Nonetheless, they are able to detect certain vibrations. Based on the available information, the residual effects of noise on fish and fish habitat are *not significant*.

Noise is produced by all activities occurring on the Grand Banks. The cumulative effects of all man-made noise sources on the Grand Banks are, at the moment, impossible to measure. It is likely that the cumulative effects of exposure to noise on fish and fish habitat is *negligible*, given the fact that most fish are able to move away from any noise source before any chance of physical impact. While eggs and larvae do not have the same capability of avoiding a noise source, it seems that exposure to very high sound energy levels is required before damage is done to these early life stages. Similarly, the cumulative effects of noise exposure on zooplankton is *negligible* given the apparent low sensitivities to sound of zooplankton compared to hearing specialist fish and higher vertebrate animals such as marine mammals.

Accidental Events

Effects of crude oil spills on plankton are short-lived, with zooplankton being more sensitive than phytoplankton. Hydrocarbons accumulated in zooplankton during a spill would be flushed from the animal within a few days after a return to clean water and thus, there is limited potential for transfer of hydrocarbons up the food chain. Individual zooplankton could be affected by a blowout or spill through mortality, sublethal effects, or hydrocarbon accumulation if oil concentrations are high enough. However, the predicted maximum concentrations for batch and blowouts are well below those known to cause effects.

Under some circumstances, oil spilled in nearshore waters can become incorporated into nearshore and intertidal sediments, where it can remain toxic and affect benthic animals for years after the spill. Oil from an offshore spill in Jeanne d'Arc Basin will not likely become incorporated in the nearshore sediments due to prevailing winds and currents on the Grand Banks. Oil released from an offshore blowout should quickly rise to the surface. Drilling will occur in open water and because of the depths involved, there is little chance of oil adhering to suspended sediments and being deposited on the bottom. Thus, oil released during an offshore spill or blowout in Jeanne d'Arc Basin is not likely to interact with the benthos.

Planktonic fish eggs and larvae (ichthyoplankton) are less resistant to effects of contaminants than are adults because they are not able to either detoxify them or actively avoid them. In addition, many eggs and larvae develop at or near the surface where oil exposure may be the greatest. Generally, fish eggs appear to be highly sensitive at certain stages and then become less sensitive just prior to larval hatching.

Approximately 45+ species of ichthyoplankton may occur in the Jeanne d'Arc Basin area. Their occurrence, abundance and distribution are highly variable by season and dependent on a variety of biological (e.g., stock size, spawning success, etc.) and environmental (temperature, currents, etc.) factors. In the unlikely event of a blowout or spill at Jeanne d'Arc Basin, there is potential for individual ichthyoplankters in the upper water column to sustain lethal and sublethal effects following contact with high concentrations of oil.

As in the case of fish larvae, the sensitivity of invertebrate larvae to petroleum hydrocarbons varies with species, life history stage, and type of oil. Generally, invertebrate larvae are more sensitive to effects of oil than are adult invertebrates. Sublethal and lethal effects on individual larvae are possible during a spill or blowout at Jeanne d'Arc Basin.

The magnitude of effects on fish eggs and larvae would be *negligible to low*. Based on modeling done for the White Rose Comprehensive Study, if the distance to 'loss of slick' and 'maximum slick' width are used to predict effects on water quality, geographic extent could range from 1,020 to 3,960 km^2. If 0.1 ppm is used as a 'cut-off' point for important biological effects, then geographic extent could range from 5 to 129 km^2. The geographic extent of actual measurable effects will likely be much less than the areas shown because concentrations of oil in the water column will likely be lower than those shown to produce demonstrable effects.

If exposed to oil in high enough concentrations, fish may suffer effects ranging from direct physical effects (e.g., coating of gills and suffocation) to more subtle physiological and behavioural effects. Actual effects depend on a variety of factors such as the amount and type of oil, environmental conditions, species and life stage, lifestyle, and fish condition.

Reported physiological effects on fish have included abnormal gill function, increased liver enzyme activity, decreased growth, organ damage, and increased disease or parasites loads. Behavioural effects include avoidance of contamination and altered natural behaviours related to predator avoidance or feeding.

Juvenile (i.e., those past the egg and larval stages) and adult fish can and probably will avoid any crude oil by swimming from the blowout/spill region. Effects of oil spills on adult and juvenile fish are predicted to be *negligible*.

Considering that magnitude ratings are considered *negligible to low*, all negative environmental effects on fish and fish habitat are predicted to be *not significant*. It should also be noted that the likelihood of an accidental event is extremely low.

3.2.2 Commercial Fisheries

The three aspects or components of commercial fishing considered in this assessment are fishing gear and vessels (fouling or losing gear, vessel conflicts), access to fishing grounds ("off limits" or unharvestable areas), and fish "catchability" (issues related to scaring fish from a harvesting area or away from fishing gear).

Presence of Structures

The establishment of safety zones would preclude fishing in these areas. These zones will also contain the areas affected by excavation and any areas within which drill cuttings would be deposited. The artificial reef created by the surface and underwater structures may attract some species and life stages of fish. This artificial reef effect, while it represents an interaction with both fish (potentially positive in some respects such as increased food and protection), was considered negligible at most.

Because fishing will not be safe within these zones, the effect of exclusion will be potentially *negative*. However, since the zones will be located in areas where commercial fishing does not typically occur, this is not expected to have any operational or economic impact on fish harvesters. Based on past harvesting data, the areas where the new drill centres will be constructed do not appear to be particularly productive for commercial species. In this general area (Unit Area 3Lt), there are also many other alternative locations of equal productivity available to fishers should they wish to harvest them. Considering the drill centre locations in relation to harvesting areas, the effects of the presence of the safety zones on fish harvesting would *not significant*.

Effects will be additive with other projects (e.g. Hibernia and Terra Nova safety zones) and the current White Rose safety zone but the safety zones of the three projects will still not overlap, and their additive cumulative effect will not exceed the *not significant* rating. The artificial reef effect would not have an effect on fishing activity, per se, as it would likely be confined within the excluded areas. However, if it results in the creation of enhanced habitat for commercial or prey species, the effect could be positive for fishing success on a very small scale in the long term.

Sediment Excavation

Fishing will not be possible within the area of sediment removal and deposition while these activities are occurring. However, as these areas (and associated effects) will be contained within the excluded (safety zone) area, and since the original spoils area will be used for sediment deposition, there will be no further effects on fish harvesting activities beyond those considered for the safety zone. Therefore, the potential effects of sediment excavation on commercial fisheries are *not significant*.

No overlap of glory hole excavations is expected to occur during the project. Cumulative effects of excavation work on fish harvesting would not be additive beyond the extent of the safety zones, and thus will not change the overall effects rating.

Ships and Boats

Ships and boats associated with the project could interfere with fish harvesting activities if they interfere with the operation of fishing ships, or – more probably – if their operations conflict with fishing gear. Such conflicts are more likely to involve fixed fishing gear (e.g. crab pots), and might result in gear damage, gear loss, loss of catch and increased operational expenses for harvesters.

While supply vessels and support ships pose minimal risk to fishing gear (no more than other ocean-going ships or other fishing vessels in the area), surveys (including vertical seismic profiling (VSP) and geohazard surveys, which might occur during drilling activities do pose more of a specific risk if the seismic equipment is towed through the water. Seismic survey/fishing gear conflicts do occur sometimes once or twice a year in Atlantic Canada, although not usually as the result of localized VSP surveys, which are very small scale (i.e., on the order of a few km). As well, the C-NLOPB *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* provide guidance aimed at minimizing any impacts of VSP/well-site surveys on commercial fish harvesting.

With these mitigations in place (including compensation if a conflict with gear were to occur), and in light of the localized nature of VSP surveys, their small footprint, short duration (12 to 36 hours), and the lack of past harvesting activities in and near the new drill centre locations, the potential effect of ships and boats on commercial fisheries is *not significant*.

Project-related ship activity would be additive to other existing shipping, but these effects are not expected to be large enough to change the overall effects rating. During operations, there will be no additional supply vessels required (i.e., the supply vessels currently servicing White Rose will continue to do so). Cumulative effects with respect to

other shipping activities on the Grand Banks are not considered to be large enough to change the overall effects rating.

Noise

As noted previously, noise from shipping (e.g. project support vessels), dredging, drilling, the FPSO, and VSP surveys can affect fish and invertebrates. Project-related noise will occur during all project phases, although the most concern for potential effects on fish harvesting might be during drilling activities (VSP surveys).

Snow crab is the species that would be of concern to fishers nearest the White Rose area, although harvesting is not recorded close to the new drill centre locations. For this species, recent studies do not indicate significant effects on catch rates or behaviour related to seismic surveying. Based on these considerations, the effects of noise on the commercial fishery are *not significant.*

In terms of cumulative effects, fishing itself is one of the more notable contributors to the total Grand Banks anthropogenic background sound (e.g., from ships' engines, generators, winches and bottom-tending mobile gears such as dredges and trawls). Other existing sources of sound in the general area of the Project are related to petroleum exploration and production, and marine transportation (commercial, military, and recreational).

Naturally-occurring noise (e.g. from wind, waves, ice, marine animals) also exists throughout the Grand Banks, and is quite variable. Given the level of ambient sound, masking of much anthropogenic sound would be expected to occur. Also, sound itself does not "accumulate" in the environment and it ceases when the sound source stops.

Thus, the cumulative effects on fish harvesting activities of the additional localized contribution of sound from project construction and operations will be *negligible*, especially given the lack of harvesting recorded in areas close to most project activities.

Accidental Events

With respect to commercial fish harvesting, the present assessment concurs with the White Rose Comprehensive Study that effects on fish populations due to an oil spill or blow-out would be *not significant*. 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 an accidental spill are considered to be *not significant*.

Although physical effects on fish from a spill are deemed not significant, economic impacts might occur in the event of a spill, if the spill prevented or impeded a harvester's ability to access fishing grounds (because of areas temporarily excluded during the spill or spill clean-up), caused damage to fishing gear (through oiling) or resulted in a negative effect on the marketability of fish products (because of market perception).

If a spill slick were to reach this area when fisheries were active, it is likely that fishing would be halted, owing to the possibility of fouling the buoy lines, or the crab pots if these were raised through the slick. Because potential release sites within the White Rose area would be some distance from the snow crab fishing grounds, there would be time to notify fishers of the occurrence and prevent the setting or hauling of gear and thus prevent or minimize gear damage.

Exclusion from a spill area would be expected to be short-term, as typical sea and wind conditions in the area would promote fairly rapid evaporation and weathering of the slick, and fishing vessels would likely be able to return within several days. An interruption could result in an economic impact because of reduced catches, or extra costs associated with having to relocate crab harvesting effort.

Effects due to market perceptions of poor product quality (no buyers or reduced prices, etc.) are more difficult to predict, since the actual (physical) impacts of the spill might have little to do with these perceptions. It would only be possible to quantify these effects by monitoring the situation if a spill were to occur and if it were to reach snow crab harvesting areas.

Such economic effects (caused by loss of access, gear damage or changes in market value) could be considered *significant* to the commercial fisheries. However, the application of appropriate mitigative measures (e.g. economic compensation) would reduce the potential impact to *not significant*.

3.2.3 Marine Birds

Lights and Flares

The dredging vessel, drilling rigs, the FPSO, and supply and standby ships will carry navigation and warning lights, and working areas will be illuminated with floodlights. There may also be flaring during operations.

Several species of birds have been attracted at night to lights on offshore oil and gas platforms, especially during foggy or overcast conditions. These include seabirds as well as migrating landbirds. Birds can injure themselves by flying into structures on the platform. Some accounts also describe birds becoming disoriented and flying aimlessly

about the lights for hours, consuming energy and being delayed in their foraging or migration.

Storm-petrels have been reported to land on offshore installations on the Grand Banks and appear to be attracted to lighting. However, with proper mitigation measures in place, most petrels were released in good condition and are assumed to have survived stranding. On vessels currently involved in the White Rose project, reasonable efforts are made to allow seabirds found stranded on the FPSO, support vessels and drilling platforms to recover, and be released at night near minimal lighting. Birds found near dawn are not released until the following night.

No study results are available for the Grand Banks concerning the effects of flaring associated with offshore production on marine birds. However, in other areas it has been observed that birds can potentially injure themselves by flying into gas flares and dying.

Lights are expected to interact with marine birds during all phases of the project and flaring is expected to interact with marine birds during operations. There would be continuous use of lights during darkness but there would be no such effect during daylight. Based on the existing knowledge, the effects of lights and flares on marine birds are expected to be *not significant*. Cumulative effects are not expected to exceed those expected for individual oil development sites or other activities. Once the new drill centres are developed, there will be no additional lighting or flaring over what is currently there at White Rose. The sites of other activities are separated geographically so birds present in one area will not be attracted to the lights at another site. Effects will be additive with other Grand Banks projects/activities but not overlapping. Therefore, effects will not magnify.

Drill Muds and Cuttings

SBM might leave a sheen on the water surface that could affect seabirds. Project drilling will use mostly water-based muds (WBM). When SBM is used, subject to C-NLOPB conditions and approval, mitigation (discharge below surface) will be employed to minimize the potential for visible sheens on the water. If conditions are flat calm and a sheen appears, prop wash from support vessels will be used to disperse it. Based on the available knowledge, the effects of drill muds and cuttings on marine birds are expected to be *not significant*.

The cumulative effect of seabird exposure to drilling muds and cuttings from current drilling activities at Terra Nova and White Rose, and past drilling at Hibernia, will be *negligible* and *not significant*. There is little chance seabirds will interact with muds and cuttings, no likely pathway for significant exposure, and little chance that heavy metals will bioaccumulate to harmful levels.

Atmospheric Emissions

Although atmospheric emissions could, in theory, affect the health of some resident marine seabirds, the effects would likely be minimal because emissions of potentially harmful materials will be small and rapidly disperse to undetectable levels. Therefore, the rating of the effects of emissions on marine birds is predicted to be *not significant*.

Potential cumulative effects of atmospheric emissions released from the three offshore operations and their supply ships, seismic vessels, fishing vessels, and other ships in the study area will be *negligible* for marine birds. Emissions are not expected to be detectable beyond the immediate area of discharge, as they will rapidly disperse due to their volatility, temperature of emission and the exposed and often windy nature of the Grand Banks. Emissions will not accumulate to potential deleterious levels over the duration of the project.

Noise

Noise and disturbance from ships are unlikely to affect marine birds in the area. Birds have adapted to ship traffic throughout the world. Some species, such as Northern Fulmar and gulls, are attracted to ships and often follow them for extended periods. Thus, noise and disturbance from normal offshore ship operations will not affect marine birds in offshore waters. Effects would be minimal.

There is a concern that passing ships could disturb seabird colonies. Prudent seamanship and Husky policy dictate that the supply vessels will maintain adequate distances from any seabird colonies. A distance of two km will ensure the safety of nesting seabirds. Therefore, there should be minimal effects on colonial marine birds.

Personnel and supplies will be transported to and from offshore structures via helicopters (Super Puma or equivalent class of aircraft) with flights occurring approximately six times per week. Noise from helicopters could potentially result in some behavioural disturbance of marine birds in the area. However, through avoidance of critical areas (i.e., breeding colonies) and repeated overflights of marine bird concentrations, such disturbances should be minimal.

Noise produced by VSP is primarily a concern for biota occurring below the water's surface. While it is true that some marine birds dive, the likelihood of any serious effect on marine birds is low. Ramp up of the VSP array would likely scare some birds from the area.

Based on existing knowledge, noise effects on marine birds are predicted to be *not significant.* Cumulative effects from sound produced from these sources on marine birds would also be *not significant*.

Accidental Events

Seabirds are definitely the marine biota most at risk from oil spills and blowouts. Exposure to oil causes thermal and buoyancy deficiencies that typically lead to the deaths of affected seabirds. Although some may survive these immediate effects, long-term physiological changes may eventually result in death. Reported effects vary with bird species, type of oil, weather conditions, time of year, and duration of the spill or blowout. Although oil spills at sea have the potential to kill tens of thousands of seabirds, recent studies suggest that even spills of great magnitude may not have significant long-term effects on seabird populations.

External exposure to oil occurs when flying birds land in oil slicks, diving birds surface from beneath oil slicks, and swimming birds swim into slicks. The external exposure results in matting of the feathers which effectively destroys the thermal insulation and buoyancy provided by the air trapped by the feathers. Consequently, oiled birds are likely to suffer from hypothermia and/or drown. Oiled birds that escape death from hypothermia and/or drowning often seek refuge ashore where they engage in abnormally excessive preening in an attempt to rid themselves of the oil. The preening leads to the ingestion of significant quantities of oil which, although apparently only partially absorbed, can cause lethal effects.

It appears that direct, long-term sublethal toxic effects on seabirds are unlikely. The extent of bioaccumulation of the chemical components of oil in birds is limited because vertebrate species are capable of metabolizing them at rates that minimize bioaccumulation. Birds generally excrete much of the hydrocarbons within a short time period. However, nesting seabirds that are contaminated with oil but still survive, generally exhibit decreased reproductive success.

Diving species such as Black Guillemots, murres, Atlantic Puffins, Dovekies, eiders, Oldsquaws, scoters, Red-breasted Mergansers, and loons are considered to be the most susceptible to the immediate effects of surface slicks. Other species such as Northern Fulmars, shearwaters, storm-petrels, gulls and terns are vulnerable to contact with oil because they feed over wide areas and make frequent contact with the water's surface. They are also vulnerable to the disturbance and habitat damage associated with oil spill cleanup. Birds are particularly vulnerable to oil spills during nesting, moulting, and prior to young seabirds gaining the ability to fly.

Oil spills have the greatest effects on marine bird populations if the spill occurs at a time and place where birds are concentrated, such as near feeding/staging/moulting aggregation areas or nesting colonies. It is extremely unlikely that crude oil accidentally spilled at the drilling sites will reach any seabird colonies in the nearshore. None of the individual oil spill trajectory model runs for the White Rose Comprehensive Study predicted oil onshore.

The oil spill trajectory models indicate that small areas near the spill site have a high probability that oil will occur there. Seabirds are known to associate with offshore structures and these birds are at increased risk to exposure in the unlikely event of an accidental release of oil. During summer, shearwaters, gulls, storm-petrels, and Northern Fulmars would be the species most likely exposed to oil near the release point. These species are vulnerable to contacting oil because individuals have frequent contact with the water's surface. Alcids are at an even greater risk to oiling, especially in winter, but it is uncertain whether this group associates with offshore structures to the same degree as shearwaters, gulls, storm-petrels, and Northern Fulmars.

The oil spill countermeasures that would be implemented in the event of an oil spill would likely reduce the number of oiled seabirds, but *significant* negative effects are still likely even after countermeasures are imposed. Any effects of oil exposure on individual seabirds would be irreversible and any rehabilitation attempts would likely be unsuccessful. It is likely that any effects at the population level would be reversible over time. Therefore, because the significant negative effect is reversible, in the unlikely event that it occurs, the population of marine birds, which is a renewable resource, will be able to meet future needs of resource users. Nonetheless, effects of exposure to oil spills and blowouts on marine birds would be *significant*

3.2.4 Marine Mammals

Presence of Structures

Potential effects on marine mammals are mainly related to the effects of sound produced by offshore structures and activities. With offshore projects, there is a slight possibility that marine mammals could interact with mooring cables or other subsea gear and become injured or entangled. However, the proposed project will have no permanent subsea structural components where marine mammals could become entangled. Marine mammals would most likely avoid the immediate area around drilling activities due to physical activities and underwater sound generated by equipment like the dredger, drill rig, and FPSO and attendant vessels. It is possible that marine mammals may be attracted to subsea structures if the artificial reef effect occurs and prey increases. Alternatively, it is possible that subsea structures will disrupt benthos but this would only occur in a small area and most marine mammals that occur in the White

Rose area do not directly feed on benthos. The physical presence of structures would have negligible effects on marine mammals. Therefore, the potential effects of presence of structures on marine mammals are *not significant*.

Considering that structures will be present in all phases of the project, there is potential for temporal overlap of this activity in different phases. However, despite these effects being additive, they are judged to not be large enough to change the overall effects rating. Cumulative effects with respect to other activities on the Grand Banks are considered to be *negligible*.

Sediment Excavation

Sediment excavation will occur only during glory hole excavation. Potential effects on marine mammals are mainly related to the effects of sound produced during excavation and deposition. Marine mammals would likely avoid the immediate area around excavation sites. It is possible that the prey of some marine mammals may be affected given that plankton may be affected by the suspension of sediment in the water column. However, the sandy nature of the sediment minimizes the amount and duration of sediment suspension in the water column and the area of each glory hole (70 m x 70 m) is relatively small. Therefore, the potential effects of sediment excavation on marine mammals is *not significant*.

No overlap of glory hole excavations is expected to occur during the project. Cumulative effects of sediment excavation on marine mammals would be additive but are judged as being not large enough to change the overall effects rating.

Lights and Flares

The dredging vessel, drill rig, FPSO, and supply and standby ships will all be equipped with navigation and warning lights and working areas will be illuminated with floodlights. There may also be periods of flaring during operations. Therefore, it is possible that lights or flares associated with vessels and rigs may attract prey for marine mammals. However, given the small areas where this may happen, any effects (assumed positive) would be *negligible*. Therefore, potential effects of lights and flares on marine mammals are not significant.

Considering that lights will be present during all phases of the project, there is potential for temporal overlap of this activity. However, despite these effects being additive, they are judged to not be large enough to change the overall effects rating. Cumulative effects with respect to other activities on the Grand Banks are considered to be *negligible*.

Drill Muds and Cuttings

Drilling activities are unlikely to produce concentrations of heavy metals in muds and cuttings that are harmful to marine mammals. In addition, none of the marine mammals that regularly occur in the White Rose area are known to feed on benthos in the area. The bearded seal, which is considered a benthic feeder, may occasionally occur in the area but typically occurs much farther north near ice. Therefore, physical impacts of drilling muds and cuttings on marine mammals are predicted to be *not significant*.

Given the relatively small area potentially affected by each drill centre relative to the total Grand Banks area, and the apparent short duration of smothering effect on benthos, and that few, if any marine mammals that regularly feed on the bottom occur in White Rose area, the cumulative effects of the project and all other activities on the Grand Banks is deemed to be *not significant*.

Noise

Marine mammals rely heavily on the use of underwater sounds to communicate and to gain information about their surroundings. Experiments also show that they hear and may respond to many man-made sounds including ships and sounds made during drilling and seismic operations (i.e., airgun pulses). Thus, the potential negative effects caused by human-made sound within the marine environment, including those associated with the project, are a concern.

n spite of the large amount of offshore drilling that has occurred worldwide, there has been little systematic study of the specific effects of drilling activities on marine mammals. As reviewed in previous documents and summarized below, marine mammals likely can hear the sounds by offshore drilling activities but many data gaps exist in terms of how they respond to drilling activities, and what received sound levels may elicit a response.

Vessels and Drilling Rigs

Sediment excavation will occur during glory hole construction. Support vessels and the *SeaRose FPSO* will be present for all phases of the project. In addition, there will be regular supply boat trips per week (e.g., 18 trips per well during the drilling phase) to the project site.

Baleen whales may show little reaction or slow, inconspicuous avoidance reactions to boats and supply vessels that are moving slowly on a steady course. If the vessel changes course and/or speed, whales likely will swim rapidly away. Avoidance is strongest when the vessel travels directly toward the whale.

Dolphins may tolerate and often approach vessels of all sizes and ride the bow and stern waves. This avoidance is often linked to previous boat-based harassment of the animals. Other toothed whale species avoid boats. Generally, small cetaceans avoid vessels when they are approached within 0.5 to 1.5 km, with some species showing avoidance at distances of up to 12 km.

The available evidence on the reactions of seals to boats indicates that seals in the water are quite tolerant of infrequent passage by boats; however, effects on the seals are generally unknown.

Drilling noise would be present throughout the drilling phase of the project. Based on source levels of typical semi-submersible rigs, it is unlikely that marine mammals would incur temporary or permanent changes in their hearing sensitivities. Also, given the low probability that a marine mammal would remain very close to drilling activity for any length of time, it is highly unlikely that any marine mammal would suffer temporary, much less permanent, hearing injuries.

Based on previous studies, it is possible that seals, toothed whales, and baleen whales may respond differently to sound from dredging and supply vessels, the FPSO and drill rigs. Because various project activities with supply vessels in attendance will continue for many days at a time, some habituation may occur. It appears that seals are somewhat tolerant of ship and drilling rig sounds. Baleen whales may avoid a localized area around vessels. Toothed whales (perhaps with the exception of sperm whales) are not as sensitive to the lower frequency sounds (relative to seals and especially baleen whales) typically produced by vessels and drilling rigs. Based on existing knowledge, impacts related to disturbance are judged to be *not significant* for seals, baleen whales, and toothed whales. Potential effects on mammals can be reduced if vessels maintain a steady course and speed whenever possible and if areas with large numbers of whales are avoided.

Helicopters

Helicopters will be used regularly during the project. However, helicopter activity during operations will be at the same level as it is for the currently operating White Rose Project. Sound does not transmit well from air to water and so effects of helicopter overflights are mainly related to disturbance of seals that are hauled-out on shore or ice, and marine mammals that are directly under the flight path of the helicopter.

Seals hauled out for pupping or moulting are very sensitive to aircraft disturbance. 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 White Rose area during these critical times or at other times of the year.

Helicopters and fixed-winged aircraft at low altitude (i.e., when approaching landing site) may disturb some marine mammals directly in its flight path or in the case of seals, when they are hauled out. It is unlikely that large numbers of marine mammals will be overflown, especially at low altitude. Helicopters will normally fly at a minimum altitude of 600 m whenever possible and thus, little, if any effects on marine mammal behaviour are likely. Helicopter landings at the rig and FPSO would probably affect a very small area with a radius less than 500 m. Aircraft will be prohibited from flying low over wildlife in order for passengers to "get a better look" or for photography. Therefore, impacts related to disturbance from aircraft, are judged to be *not significant* for marine mammals

Vertical Seismic Profiling (VSP) Surveys

Mitigation measures are routinely employed to minimize the potential for effects on marine mammals. Start up of airgun(s) will be delayed 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).

Considering that VSP source levels are typically less than those associated with typical, full-scale 2-D or 3-D exploratory seismic surveys and the short duration of the operation (two days per well), it is unlikely that marine mammals would incur temporary or permanent changes in their hearing sensitivities. Also, given the low probability that a marine mammal would remain very close to the airgun(s) for any length of time, it is highly unlikely that any marine mammal would suffer temporary, much less permanent, hearing injuries. Therefore, disturbance, hearing impairment and physical impacts of VSP sound on marine mammals are predicted to be *not significant*.

Accidental Events

Most marine mammals, with the exception of fur seals, polar bears, and sea otters, are not very susceptible to deleterious effects of oil. However, newborn seal pups, and weak or highly stressed individuals, may be vulnerable to oiling. Other marine mammals such as whales exposed to oil are generally not at risk because they rely on a layer of blubber for insulation and oiling of the external surface does not appear to have any adverse thermoregulatory effects. Population-level effects are unlikely, as no significant long-term and lethal effects from external exposure, ingestion, or bioaccumulation of oil have been demonstrated.

Studies of both captive and wild whales indicate that they can detect oil spills. Effects of oiling on whale skin appear to be minor and of little significance to the animal's health. It can be assumed that if oil contacted the eyes, effects would be conjunctivitis, corneal abrasion, and swollen nictitating membranes and that continued exposure to eyes could cause permanent damage.

Whales could ingest oil with water, contaminated food, or oil could be absorbed through the respiratory tract. Whales exposed to an oil spill are unlikely to ingest enough oil to cause serious internal damage. Whales may inhale vapours from volatile fractions of oil from a spill and blowout. The most likely effects of inhalation of these vapours would be irritation of respiratory membranes and absorption of hydrocarbons into the bloodstream. Stressed individuals that could not escape a contaminated area would be most at risk. In baleen whales, crude oil could coat the baleen and reduce filtration efficiency. However, effects are minimal and reversible. The effects of oiling of baleen on feeding efficiency appear to be only minor.

Based on available marine mammal data for the Jeanne d'Arc Basin area and the biology of marine mammals known to occur in the area, the area is not likely an important feeding or breeding area. Some species are likely present in the Jeanne d'Arc Basin area year round, but most species likely just occur there during summer months. However, there are limited available data for winter time. For marine mammals, it is likely that only small proportions of populations are at risk at any time.

Reports of the effects of oil spills and blowouts have shown that some mortality of hair seals may have occurred as a result of oil fouling; however, large scale mortality has never been observed. Effects on seals have not been well studied at most spills because of lack of baseline data and/or the short timeframe of the post-spill surveys.

Seals may interact with spilled oil but are not considered to be at high risk from the effects of oil exposure, but some evidence implicates oil spills with seal mortality, particularly young seals. As previously discussed, seals are present on or near Jeanne d'Arc Basin for at least part of the year. The majority of the White Rose area falls outside of the area were pack ice typically occurs. The pack ice that occurs in the proposed drilling area is distant from the primary harp seal breeding area known as the Front. The oil spill trajectory models indicate that after the oil moves away from the release point, it will likely be found east and northeast of the modelled release point. Therefore, it is unlikely that oil accidentally released at proposed drilling sites will reach the pack ice where harp seals breed. There is a possibility that aged oil could contact the southern edge of loose pack ice for a few weeks during years of very heavy ice conditions, but seals are much less common on the deteriorating southern extremities of the pack ice than they are farther north. Few seals are expected to be exposed to oil from an accidental release at the drilling and production sites and most seals do not

exhibit large behavioural or physiological reactions to limited surface oiling, incidental exposure to contaminated food, or ingestion of oil.

Based on existing knowledge, it is predicted that there will be *no significant* negative effect on marine mammals from an accidental release of oil at the new drilling sites in the White Rose area. The oil spill countermeasures that would be employed in the event of an accidental spill and the associated disturbance would likely reduce the number of marine mammals exposed to oil.

3.2.5 Sea Turtles

As noted above, during VSP operations, mitigation measures will be in place to minimize the potential for effects of sound on sea turtles. Effects of routine project activities were predicted to have *no significant* impacts on sea turtles, including the endangered leatherback sea turtle; however, the scientific information to support this is lacking. These impact predictions are primarily based on data that suggest sea turtles likely rarely occur in the Jeanne d'Arc Basin.

It is not known whether sea turtles can detect and avoid oil slicks. Loggerhead sea turtles experimentally exposed to oil had marked lesions present in the skin. Most effects were reversed by the tenth day following cessation of oil exposure. Other effects of oil on sea turtles include reduced lung diffusion capacity, decreased oxygen consumption, decreased digestion efficiency, and damaged nasal and eyelid tissue.

Sea turtles are likely rare on the Grand Banks and are even less likely to occur in the proposed drilling and production area. There is a very low likelihood that sea turtles will be exposed to oil from an accidental release near the proposed drilling and production area. Effects of oil on sea turtles will be reversible, but there is a possibility that foraging abilities may be inhibited by exposure to oil.

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. The oil spill countermeasures that would be employed in the event of an accidental spill and the associated disturbance may reduce the number of sea turtles exposed to oil. Based on existing knowledge, it is predicted that there will be *no significant* negative effect on sea turtles from an accidental release of oil at the new drilling sites in the White Rose area.

3.3 Mitigative Measures

Mitigative measures that will be employed during project activities include:

- recycling of drilling muds;
- chemical selection criteria as part of Chemical Management System;
- treatment of produced water, deck drainage, bilge water and sanitary/domestic waste;
- source level selection, ramp up, and temporal avoidance of sensitive periods when conducting VSP surveys;
- communications plan and information exchange with fishers;
- release of seabirds stranded on installations;
- avoidance of breeding seabird colonies by vessels and helicopters;
- support vessels avoid sea turtles and concentrations of marine mammals and maintain steady course and speed;
- oil spill contingency planning and response procedures and personnel training; and
- oil spill response equipment on site.

3.4 Residual Effects

After mitigation measures have been implemented, the overall predicted effects of the proposed Husky White Rose Development Project: New Drill Centre Construction & Operations Program on the biophysical environment and the fishery are assessed as *not significant*. The only exceptions are the potential effects of a large offshore oil spill on marine birds and on the marketability of offshore commercial fish. However, the likelihood of such an event is very low. In the event of an accidental blowout with release of oil, in calm conditions, some mitigation may be possible through oil spill response measures. Also, in the case of fishery losses directly attributable to the Project, actual loss would be mitigated through compensation. The capacity of renewable resources to meet present and future needs is not likely to be significantly affected by the proposed project.

4.0 Socio-economic Impacts

Details of the socio-economic impact statement (SEIS) are provided in the document *North Amethyst Satellite Tie-back Socio-economic Impact Statement* (Husky Document No. SR-SRT-RP-0005). Following is a summary of the findings of the socio-economic impact assessment.

The SEIS discusses the socio-economic effects of the North Amethyst Satellite Tie-back Project, as described in the North Amethyst Development Plan (SR-SRT-RP-0002) and the White Rose Development Plan Amendment - Modifications to the *SeaRose FPSO* (SR-SRT-RP-0003). It is an update of the SEIS completed in 2000 as part of the White Rose Oilfield Development Application and focuses mostly on the same components, summarizing the findings and providing an update where relevant. The impacts of the Project on these components are assessed.

While this SEIS is primarily concerned with the North Amethyst Tie-back, it may be undertaken at the same time as a potential non-North Amethyst related refurbishment and upgrading of the *SeaRose FPSO*. The combined employment and business benefits of the construction phases of these two projects would be substantially larger than those of North Amethyst alone, and as appropriate the SEIS addresses the joint impacts of them both.

The SEIS examines the same Valued Environmental Components (VECs) -- Business and Employment, Community Social Infrastructure, and Physical Infrastructure and Services -- as in the White Rose SEIS, other than for the Fisheries VEC. The effects of the Project on fisheries were recently considered in another assessment completed by Husky. The temporal scope extends from the initial development phase, through installation and operations. The geographic scope of the analysis is again provincial, with those areas most likely to experience direct effects from the Project – the St. John's, Isthmus of Avalon and Marystown Areas -- examined in greater detail.

4.1 Existing Social and Economic Setting

The last twenty years have seen major fluctuations in the Newfoundland and Labrador economy, not least as a result of the development of the Province's offshore oil industry, and the cod moratorium. Newfoundland and Labrador's population has been in decline since 1991 and the unemployment rate remains the highest in Canada. However, the offshore oil sector and the Voisey's Bay mine have been the primary economic drivers in the Province during the current decade and the reason why the economy of Newfoundland and Labrador is now one of the fastest growing in Canada.

The St. John's Area economy has fared comparatively well by provincial standards over this decade, and is currently enjoying an economic boom. In 2006, the real GDP for the St. John's Area grew by 1.2 percent, employment increased 3.4 percent and the unemployment rate declined 0.8 percentage points. Between 2001 and 2006, the population of the St. John's Area increased by 4.7 percent.

The Isthmus of Avalon Area has not fared as well as the St. John's Area, but its relatively diverse economy and large industrial projects have sheltered it from much of the economic disruption experienced elsewhere in rural Newfoundland and Labrador. These projects include activity at, and associated with, the Bull Arm yard, the Newfoundland Transshipment Terminal at Whiffen Head, and North Atlantic Petroleum's Come By Chance refinery and associated sulphur plant. However, there was still a steady decline in the Area's population between 1991 and 2006, from 17,845 to 15,479.

The economic fortunes of the Marystown Area have primarily reflected developments in the fishery and at the Marystown Shipyard. The activity at the Shipyard has included work on the Hibernia, Newfoundland Transshipment Terminal and White Rose projects.

However, the population of the Marystown Area still declined between 1991 and 2006, from 12,939 to 10,469.

4.2 Effects and Mitigative Measures

The SEIS assesses the effects of the Project on each of these three areas and, as appropriate, the Province as a whole. The assessment focuses on the direct effects of the Project, mostly through expenditures or activities. However, as appropriate, some secondary effects are considered, including those of any Project-related demographic change on community services and infrastructure and physical infrastructure. The great majority of socio-economic effects will occur during the construction phase.

During Project construction, the St. John's Area will see administrative, engineering, training, regulatory, and supply and service activity. This will have a wide range of positive economic effects, similar to, but much more modest than, those experienced during the Hibernia, Terra Nova and White Rose development phases. These include the provision of local employment, training, business and R&D. More generally, the Project will result in the further development of provincial expertise and capabilities, contributing to sustainable economic development.

This will include benefits to rural Newfoundland and Labrador. The Isthmus and/or Marystown Areas will receive direct and multiplier employment and business benefits, and the yards engaged in this work will further develop their capabilities. However, the scale of construction activity in these areas will be less than was experienced on earlier offshore petroleum projects and, given that they did not result in any substantial social services and infrastructure or physical infrastructure problems for local communities, it is anticipated that they will be able to absorb the smaller demands that result from the Project or even combined projects.

The Project effects on education at the provincial level will be limited to those associated with post-secondary training. Demands from the Project construction phase, even in combination with refurbishment and upgrading of the *SeaRose FPSO*, will be much smaller than those from Hibernia, Terra Nova and White Rose. In all those cases, project-related demands were accommodated without difficulty, and hence no problems are anticipated to arise from the Project. Furthermore, there will be no additional labour force requirements associated with Project operations. The Project is not expected to have any effect on education in the study areas.

The Project, or combined projects, will only have a small and relatively short-term incremental effect on the overall demand for St. John's Area medical services. Construction activity is similarly not expected to place notable demands on the health systems of the Isthmus and Marystown Areas, which may anyway have experienced some reductions in baseline levels of demand as a result of population decline.

The effects of the Project on St. John's Area Income Support and employment services will likely be small and primarily positive. Given the relatively small scale and short-term nature of the Project's, or combined projects', effects on the area, it is not expected to have any noticeable effect on demand. It is not expected that any Project construction activity on the Isthmus will have negative local effects on Income Support and employment services, and Project employment may well have a positive effect. White Rose project activity did have some minor effects on Income Support and employment services in the Marystown Area, driving up costs of local rental accommodations with some secondary effects on persons with low incomes. However, the smaller size of the Project, in conjunction with reduced housing demand as a result of population decline, will minimize any such effects associated with Project construction.

There has been no suggestion or evidence that Hibernia, Terra Nova or White Rose have affected the nature or level of crime, or the demands for policing services or fire protection, in the study areas. Similarly, the project had no effect on fire protection at the provincial level. The same is expected to be the case with the Project or combined projects.

While the population of the St. John's Area has grown in the last decade, there have also been increases in the provision of recreation services and facilities, and any Project or combined projects-related demands can be easily absorbed. In the Isthmus Area, the use of local area recreational facilities by Bull Arm workers during the Hibernia construction project was regarded as beneficial because it did not over-extend the facilities or reduce their availability to local residents, but generated revenue. Past projects have not resulted in problems related to the availability of recreation facilities in Marystown.

Past projects had a small effect on the housing market in the St. John's and Isthmus Areas. The Project or even combined projects construction-related requirements will be smaller than those for past projects, and any direct effects are likely to be small and short-term. They will be beneficial from the perspective of home-builders and suppliers, home sellers and municipal taxation. The White Rose project did result in housing problems in the Marystown Area that lasted about a year. Various adjustments were made, including the construction of the new hotel, the renovation of basement apartments, and people moving into their summer cottages so as to rent their homes to project workers. Given this experience, together with housing vacancies resulting from continued out-migration, only minor short-term negative Project or combined projects housing impacts are expected.

The Project or combined projects will have minor construction phase effects on industrial and commercial land, warehousing and office space in the St. John's Area, and will have no additional operations phase effects. Accordingly, they will benefit the area and

should not exceed its ability to meet demand. No construction activity-related demand for additional industrial land is expected in Clarenville, Arnold's Cove or other Isthmus Area communities, or as a result of Project operations. The Marystown Shipyard and the Cow Head facility proved capable of accommodating the demands placed on them by the White Rose project. Accordingly, they would have no difficulty accommodating work on the Project or combined projects, which would be welcomed and would generate benefits for the area.

The SEIS also discusses Husky's approach to sustainable development. Husky believes that sustainability is achievable and requires innovative thinking. In support of this, Husky's activities and proposed projects, and their effects, are continually analyzed and improved so as to meet, and often exceed, industry and government regulatory requirements. The Husky Operations Integrity Management System (HOIMS) is a systematic approach towards operational excellence. It details how Husky will "operate responsibly to minimize the environmental impact of our operations" and "leave a positive legacy behind us when we leave". Husky has a number of programs in place to meet this goal.

Husky has introduced a number of initiatives to contribute to positive and sustainable economic and social change. These include employment and training initiatives, supporting petroleum industry research and development work, involving the local business community in operations through the East coast business unit and promoting and supporting workplace diversity within Husky and the local oil and gas industry.

4.3 Conclusions

The North Amethyst Satellite Tie-back Project is the latest of a series of offshore petroleum development projects that Newfoundland and Labrador has experienced since 1990. While it is smaller than the White Rose and Terra Nova projects, let alone the Hibernia project, it represents another important step in the development of the Province's offshore oil and gas industry.

The Project will deliver a range of economic benefits to the Province, including the provision of local employment, training, business and R&D. More generally, the Project will result in the further development of provincial expertise and capabilities, contributing to sustainable economic development and thereby helping generate a lasting economic legacy for the people of the Province.

This will include benefits to rural Newfoundland and Labrador. The areas surrounding Project construction activity will receive direct and multiplier employment and business benefits, and the yard(s) engaged in this work will further develop their capabilities.

However, the scale of construction activity in these areas will be less than was experienced on earlier offshore petroleum projects and, given that they did not result in any substantial social services and infrastructure or physical infrastructure problems for local communities, it is anticipated that they will be able to absorb the smaller demands that result from the Project.

Similarly, the approaches and policies Husky has adopted at the corporate level, and the Project-specific policies, practices and initiatives that reflect them, will minimize the Project's bio-physical impacts. This represents sound environmental stewardship and resource conservation, to the long-term benefit of the Province and all its citizens.

5.0 Safety Analysis

To support the North Amethyst Satellite Tie-back Development Application, Husky commissioned a Concept Safety Assessment (CSA) of the potential new development. The purpose of the study was to review and expand upon existing safety studies that were developed for the White Rose project in order to determine the potential impacts of adding on the North Amethyst Satellite Tie-back and other tie-backs such as South White Rose Extension (SWRX) and West White Rose Extension (WWRX), collectively called the *SeaRose* Tie-back Project. The studies requiring review were:

- The White Rose Quantitative Risk Assessment (QRA) model, from which several key risk assessments were generated;
- Mobile Offishore Drilling Unit (MODU) Blowout Risk Assessment ;;
- MODU Dropped Object Analysis; and
- MODU Quantitative Risk Assessment.

5.1 Scope of Review

The CSA reviewed the risk profile of all the main potential scopes of the *SeaRose* Tie-back Project, including:

- The potential for three new drill centres tied back to the *SeaRose FPSO*:
- NADC (subject of this Development Plan);
- SWRX, subject of a White Rose Development Plan Amendment currently under review by the C-NLOPB); and
- WWRX, subject of a future White Rose Development Plan Amendment).
- Additional flowlines routed through the *SeaRose* turret to the topsides manifolds, in particular for NADC.
- Potential modifications to the *SeaRose* topsides processing facilities to increase produced water and gas handling capacity.

This strategy for inclusion of all potential White Rose expansion scopes was based on the following:

- a CSA is intended to be performed at an early stage of development, when development options are still being considered and explored;
- the SWRX CSA was already completed and under review by the C-NLOPB, covering a component of the overall project;
- fragmentation of the various components of the *SeaRose* Tie-back Project in separate CSAs does not accurately reflect the aggregate risk associated with the total Project; and
- there is ongoing analysis of the arrangement for the WWRX tieback, which will be subject to a separate White Rose Development Plan Amendment should it proceed.

5.2 Risk Assessment Results

Tie-back To *SeaRose FPSO*

The tie-back of new drill centres has a marginal effect on the overall risk levels on the *SeaRose FPSO*. In the base case concept, the SWRX and WWRX drill centres are tied back through existing drill centres and will, therefore, have minimal effects on the *SeaRose* risk levels. However, the NADC may be tied back directly to the *SeaRose*, resulting in two new hydrocarbon risers and flowlines being installed on the SeaRose. Additionally, the risk assessment considered the option of having the WWRX drill centre tied back directly to the *SeaRose* in a manner similar to North Amethyst.

Relative to the risk levels in the most recent revision of the *SeaRose FPSO* QRA, it was shown that tie-back of North Amethyst or WWRX directly to the *SeaRose* would result in a slight increase in risk related to the Temporary Refuge Impairment Frequency (TRIF) and the maximum Individual Risk Per Annum (IRPA). However, the risk levels remain well below Husky's Target Levels of Safety.

Blowout Risk Assessment

A review of the blowout risk assessment has indicated that there is an increase in the blowout frequency (for the new drill centres compared to the initial White Rose development) simply as a result of the increased number of well operations being carried out over the period of each of the new developments. The consequences of a blowout at each new location were reviewed and considered to be the same as for blowouts at the existing Southern Glory Hole (SGH) and risks of blowout remain well below Husky's Target Levels of Safety.

MODU Dropped Object Risk Assessment

The dropped object study was also reviewed to determine the potential for damaging subsea equipment as a result of SWRX, North Amethyst and WWRX development and installation activities. The assessment concluded that the frequency of damage to subsea equipment at the new drill centres was of a similar order to that assessed for the base White Rose development. It was assumed that, for the dropped objects assessments, there would be no live subsea equipment and therefore only damage to the xmas trees was considered to have the potential to result in a loss of hydrocarbon containment. This assumption is very conservative since wells would be shut-in downhole during heavy construction activities in the glory hole.

MODU Risk Assessment

The CSA was based upon the use of a semi-submersible MODU for planned development drilling and completion activities. The assessment identified hazards to which MODU personnel would be exposed during the well operations in the SWRX, WWRX and North Amethyst drill centres. The analysis assessed the potential consequences of such hazards and subsequently determined the associated risk to personnel.

The annualized risk levels for the MODU carrying out the drilling activities for the SWRX, WWRX and North Amethyst tie-backs are each predicted to be slightly higher than the previously assessed risks for the MODU operating in the White Rose field during the development phase. The main cause of the increased annualized risks is the higher number of wells to be drilled and completed per year. For the initial White Rose project, the risks relating to the year with the highest planned drilling activities were included – this was predicted to be year 2005, with the equivalent of 4 wells to be drilled and 7 completed. The equivalent numbers of wells to be drilled and completed in a year range from 4.9/yr at WWRX to 5.2/yr for SWRX. The blowout frequency associated with the drilling of wells is higher than that for well completion and, therefore, the overall annualized risks associated with blowouts has increased marginally, although results for TRIF and IRPA remain well below the Target Levels of Safety.

6.0 Glossary and Acronyms

ADW. Acronym for Approval to Drill Wells.

Anthropogenic. Derived or resulting from human activity.

CIS. Acronym for Canadian Ice Service.

CSA. Acronym for Concept Safety Assessment

Cuttings. Chips and small fragments of rock that are brought to the surface by the drilling mud as it circulates.

C-NLOPB. Acronym for Canada-Newfoundland and Labrador Offshore Petroleum Board

Development Application. The official title of the documentation submitted to the C-NLOPB in support of an oilfield development request.

Drilling Mud. A circulating fluid used in drilling wells. Usually contains weighting agents, viscosifiers and fluid loss additives. Can be water or synthetic based.

FEED. Acronym for Front End Engineering and Design

FPSO. Acronym for Floating Production, Storage and Offloading Vessel.

Glory Hole. Hole, excavated in the seabed, in which wellhead facilities are placed for protection from iceberg scour.

IRPA. Acronym for Individual Risk Per Annum

Umbilical. Device through which control of subsea instrumentation is maintained from the FPSO.

Flowlines. Pipe which conveys crude oil, water and/or gas from the well to the riser, or water or gas from the riser to the well.

Flowline Weak Link Technology. Technology that is built into the flowline system so that the wellhead structures are protected should flowlines be snagged due to scouring icebergs.

Gas Lift. Gas injected into the well to reduce the hydrostatic pressure on the fluid column and hence enhance flow.

Ichthyoplankton. Collective term for fish eggs and larvae when planktonic.

MODU. Acronym for Mobile Offishore Drilling Unit

NADC. Acronym for North Amethyst Drill Centre

NDC. Acronym for Northern Drill Centre

OPEX. Acronym for operating expenditure.

Phytoplankton. Planktonic (that is, floating or swimming) photosynthesizing organisms that are mostly single-celled, although some are colonial; some are capable of swimming, while others are incapable of independent motion.

Plankton. Organisms living in water that are not capable of swimming vigorously enough to move independently of water movements.

Produced Water. Water from the producing formation that comes to surface with the oil and gas. It separates from the oil and gas at atmospheric temperatures and pressure.

QRA. Acronym for Quantitative Risk Assessment

Riser. A flowline carrying oil or gas from the seabed to the deck of a production platform or a tanker loading platform.

Spider Buoy. Disconnectable interface between the risers and the FPSO.

SWRX. Acronym for South White Rose Extension

TRIF. Acronym for Temporary Refuge Impairment Frequency

Template. Device through which a group of wells is drilled and produced.

Topside (or topsides) Facilities. The oil- and gas-producing and support equipment located on the top of an offshore structure.

Turret. A low, tower-like structure capable of revolving horizontally within the hull of a ship and connected to a number of mooring lines and risers. It allows the ship to rotate with the weather while maintaining a fixed mooring system.

VSP. Acronym for vertical seismic profile.

WWRX. Acronym for West White Rose Extension

Zooplankton. The animal component of those organisms drifting or weakly swimming in the ocean largely at the mercy of prevailing currents.