



SNC · LAVALIN

# BEAR HEAD LNG

UPDATED REGISTRATION DOCUMENT

BEAR HEAD LNG CORPORATION



## Table of Contents

<b>1 INTRODUCTION .....</b>	<b>1-1</b>
1.1 IDENTIFICATION OF THE PROPONENT .....	1-1
1.2 PROJECT OVERVIEW .....	1-2
1.3 COMPARISON OF LNG IMPORT AND LNG EXPORT .....	1-6
1.4 PROJECT PURPOSE .....	1-6
1.5 NEED FOR THE PROJECT .....	1-6
1.6 REGULATORY AND PLANNING CONTEXT .....	1-10
1.6.1 Federal Environmental Legislation .....	1-10
1.6.2 Provincial Environmental Legislation .....	1-11
1.6.3 Municipal Environmental Legislation .....	1-12
1.7 GUIDELINES, POLICIES AND CODES .....	1-13
1.8 EXISTING AUTHORIZATIONS AND STATUS OF REGULATORY PERMITTING .....	1-13
1.9 APPROACH .....	1-16
1.10 SPATIAL AND TEMPORAL BOUNDARIES .....	1-16
1.11 STRUCTURE OF THE DOCUMENT .....	1-17
<b>2 PROJECT DESCRIPTION .....</b>	<b>2-1</b>
2.1 PROJECT OVERVIEW .....	2-1
2.2 PROJECT ACTIVITIES .....	2-1
2.2.1 Completed Works .....	2-1
2.2.2 Continued Construction .....	2-4
2.2.3 Commissioning .....	2-5
2.2.4 Operation .....	2-6
2.2.5 Decommissioning .....	2-6
2.2.6 Project Schedule .....	2-6
2.3 LAND BASED FACILITIES .....	2-6
2.3.1 Gas Supply .....	2-9
2.3.2 Pre-Treatment Plant .....	2-9
2.3.3 Liquefaction Plant .....	2-10
2.3.4 Heavy Hydrocarbon Liquid Handling .....	2-10
2.3.5 LNG Tank and Marine Vessel Loading .....	2-11
2.3.6 Boil-off Gas System .....	2-11
2.3.7 Auxiliary Ammonia Refrigeration Plant .....	2-11
2.3.8 Waste Heat Recovery and Steam Plant .....	2-11
2.3.9 Electrical Power .....	2-12
2.3.10 Utilities .....	2-12
2.4 MARINE TERMINAL .....	2-14
2.5 EMISSIONS AND WASTE DISCHARGES .....	2-16
2.5.1 Air Emissions .....	2-17
2.5.2 Wastewater Discharges .....	2-18
2.5.3 Noise Emissions .....	2-19
2.5.4 Lighting .....	2-20

2.5.5	Material and Hazardous Waste .....	2-20
2.6	HAZARDOUS MATERIALS.....	2-20
2.7	TECHNOLOGICAL RISK ASSESSMENT .....	2-22
2.7.1	Methodology and Analysis .....	2-23
2.8	ENVIRONMENTAL AND SAFETY PROTECTION SYSTEMS .....	2-28
2.8.1	Equipment Inspection and Maintenance .....	2-28
2.8.2	Hazard Mitigation and Fire Protection Measures.....	2-29
2.8.3	GHG Management Plan.....	2-31
2.8.4	Flare Emissions Management .....	2-32
2.9	EMPLOYMENT AND ECONOMIC CONSIDERATIONS.....	2-33
2.10	HEALTH, SAFETY AND ENVIRONMENTAL MANAGEMENT .....	2-34
2.11	A DESCRIPTION OF ALTERNATIVES TO THE PROJECT .....	2-36
2.11.1	Project Does Not Proceed.....	2-36
2.11.2	Alternative Locations.....	2-36
2.12	OTHER METHODS FOR CARRYING OUT THE PROJECT .....	2-37
2.12.1	Product Transport.....	2-37
2.12.2	Site Layout.....	2-37
2.12.3	LNG Storage Tanks .....	2-38
2.12.4	Removal of Acid Gases (CO <sub>2</sub> and H <sub>2</sub> S).....	2-38
2.12.5	Cooling System.....	2-40
2.12.6	Refrigeration Circuit .....	2-42
2.12.7	Comparison of Technologies .....	2-48
2.12.8	Driving Compressors .....	2-49
2.12.9	Boil-Off Gas Recovery .....	2-49
2.12.10	Utilities and Infrastructure .....	2-50
2.13	SUMMARY .....	2-50
<b>3</b>	<b>PUBLIC CONSULTATION AND FIRST NATIONS ENGAGEMENT .....</b>	<b>3-1</b>
3.1	PUBLIC CONSULTATION.....	3-1
3.1.1	Preliminary Consultations.....	3-1
3.1.2	Project Internet Site.....	3-2
3.1.3	Stakeholder Meetings and Outreach .....	3-2
3.1.4	Media Coverage.....	3-3
3.1.5	Ongoing Consultations .....	3-4
3.1.6	Comments Received.....	3-4
3.2	FIRST NATIONS ENGAGEMENT .....	3-6
<b>4</b>	<b>OVERVIEW OF THE ENVIRONMENT .....</b>	<b>4-1</b>
4.1	SETTING THE SCENE .....	4-1
4.2	PHYSICAL ENVIRONMENT .....	4-1
4.2.1	Physiography, Surficial and Bedrock Geology.....	4-1
4.2.2	Acid Rock Drainage Potential.....	4-2
4.2.3	Hydrogeology and Water Quality.....	4-2
4.2.3.1	Peat and Organic Deposits .....	4-2
4.2.3.2	Glacial Till.....	4-4

4.2.3.3	Cumberland Group .....	4-4
4.2.4	Water Sources .....	4-4
4.2.5	Climate .....	4-7
4.2.5.1	General Climate and Weather Patterns .....	4-7
4.2.5.2	Temperature Normals and Extremes .....	4-9
4.2.5.3	Precipitation Normals and Extremes .....	4-10
4.2.5.4	Wind Normals and Extremes.....	4-10
4.2.5.5	Adverse Weather.....	4-11
4.2.6	Ambient Air Quality .....	4-12
4.2.7	Acoustic Environment.....	4-12
4.2.8	Physical Oceanography .....	4-16
4.2.8.1	Bathymetry .....	4-16
4.2.8.2	Temperature and Salinity .....	4-17
4.2.8.3	Tides, Storm Surge and Sea Level Rise.....	4-17
4.2.8.4	Winds.....	4-19
4.2.8.5	Waves .....	4-24
4.2.8.6	Ice Cover.....	4-26
4.3	ECOLOGICAL ENVIRONMENT: TERRESTRIAL .....	4-28
4.3.1	Habitat and Vegetation.....	4-28
4.3.1.1	Wetlands .....	4-28
4.3.2	Fauna and Flora .....	4-31
4.3.2.1	Freshwater Fish and Fish Habitat .....	4-31
4.3.3	Mammals .....	4-34
4.3.4	Reptiles and Amphibians.....	4-36
4.3.5	Birds.....	4-37
4.3.5.1	Breeding Birds.....	4-37
4.3.5.2	Rare and Sensitive Birds.....	4-38
4.3.6	Plants .....	4-39
4.3.7	Species at Risk (SAR) .....	4-40
4.3.7.1	Terrestrial SAR.....	4-40
4.3.7.2	Marine SAR .....	4-41
4.4	ECOLOGICAL ENVIRONMENT: MARINE.....	4-43
4.4.1	Marine Ecosystem.....	4-43
4.4.2	Marine Water and Sediment Quality.....	4-44
4.4.2.1	Water Quality.....	4-44
4.4.2.2	Sediment Quality.....	4-44
4.4.2.3	Plankton .....	4-46
4.4.2.4	Ichthyoplankton .....	4-46
4.4.3	Marine Benthic Habitat and Communities .....	4-48
4.4.3.1	Sediments.....	4-49
4.4.3.2	Intertidal .....	4-49
4.4.3.3	Subtidal .....	4-49
4.4.4	Marine and Estuarine Fish and Fish Habitat.....	4-50
4.4.4.1	Demersal and Benthic Fish .....	4-53
4.4.4.2	Pelagic Fish.....	4-53

4.4.4.3 Invertebrates .....	4-54
4.4.5 Coastal and Water Associated Birds .....	4-54
4.4.5.1 Seabirds .....	4-54
4.4.5.2 Coastal Waterfowl and Divers .....	4-57
4.4.6 Marine Mammals.....	4-57
4.4.6.1 Cetaceans.....	4-59
4.4.6.2 Pinnipeds.....	4-59
4.4.6.3 Sea Turtles .....	4-59
4.5 SOCIO-ECONOMIC ENVIRONMENT .....	4-63
4.5.1 Key Settlements, Land Use, Community Services and Infrastructure.....	4-63
4.5.1.1 Recreation and Entertainment .....	4-66
4.5.1.2 Local Emergency Response Services.....	4-66
4.5.1.3 Medical Services and Hospitals.....	4-66
4.5.1.4 Police .....	4-68
4.5.1.5 Social and Community Support Services .....	4-68
4.5.1.6 Accommodation and Related Services .....	4-68
4.5.1.7 Transportation Infrastructure.....	4-68
4.5.2 Economic Development.....	4-72
4.5.2.1 Employment and Income .....	4-72
4.5.2.2 Business .....	4-72
4.5.3 Marine Navigation.....	4-73
4.5.3.1 Safety of LNG Operations .....	4-74
4.5.3.2 Marine LNG Vessels .....	4-74
4.5.3.3 Ocean Passage into Canadian Waters.....	4-75
4.5.4 Fisheries, Aquaculture and Marine Harvesting .....	4-76
4.5.4.1 Commercial Fishery .....	4-76
4.5.4.2 Landings and Value .....	4-78
4.5.4.3 Fishing Effort .....	4-89
4.5.4.4 Recreational Fishery .....	4-92
4.5.4.5 Aquaculture .....	4-92
4.5.5 First Nations Land and Resource Use.....	4-94
4.5.6 Archaeological and Heritage Resources.....	4-94
4.5.6.1 Archaeological Potential – Pre-Contact.....	4-96
4.5.6.2 Archaeological Potential – Historic.....	4-96
4.5.6.3 Field Survey .....	4-96
<b>5 EFFECTS ASSESSMENT METHODOLOGY.....</b>	<b>5-1</b>
5.1 OVERVIEW AND APPROACH.....	5-1
5.2 STEPS IN THE ASSESSMENT PROCESS .....	5-2
5.2.1 Scoping: Definition of VECs and Socio-Economic Issues .....	5-2
5.2.2 Defining Boundaries and Thresholds.....	5-9
5.2.3 Analysis, Mitigation and Evaluation .....	5-13
5.2.4 Residual Effects Prediction.....	5-14
5.2.5 Monitoring and Follow Up.....	5-14
5.3 CUMULATIVE EFFECTS .....	5-15

5.3.1 Identifying Projects/Activities .....	5-15
5.4 EFFECTS OF THE ENVIRONMENT ON THE PROJECT .....	5-17
<b>6 ENVIRONMENTAL EFFECTS ASSESSMENT .....</b>	<b>6-1</b>
6.1 PHYSICAL ENVIRONMENT .....	6-1
6.1.1 Groundwater .....	6-1
6.1.1.1 Boundaries and Threshold .....	6-1
6.1.1.2 Interactions and Potential Effects.....	6-4
6.1.1.3 Mitigation .....	6-5
6.1.1.4 Potential Residual Effects .....	6-6
6.1.1.5 Monitoring and Follow-up.....	6-6
6.1.2 Surface Water .....	6-6
6.1.2.1 Boundaries and Threshold .....	6-6
6.1.2.2 Interactions and Potential Effects.....	6-10
6.1.2.3 Mitigation .....	6-11
6.1.2.4 Potential Residual Effects .....	6-12
6.1.2.5 Monitoring and Follow-up.....	6-13
6.1.3 Climate .....	6-13
6.1.3.1 Boundaries and Threshold .....	6-15
6.1.3.2 Interactions and Potential Effects.....	6-16
6.1.3.3 Potential Residual Effects .....	6-22
6.1.3.4 Monitoring and Follow-Up.....	6-22
6.1.4 Air Quality .....	6-22
6.1.4.1 Boundaries and Threshold .....	6-22
6.1.4.2 Interactions and Potential Effects.....	6-26
6.1.4.3 Mitigation .....	6-32
6.1.4.4 Potential Residual Effects .....	6-33
6.1.4.5 Monitoring and Follow-up.....	6-35
6.1.5 Acoustic Environment.....	6-36
6.1.5.1 Boundaries and Threshold .....	6-36
6.1.5.2 Interactions and Potential Effects.....	6-39
6.1.5.3 Mitigation .....	6-43
6.1.5.4 Potential Residual Effects .....	6-43
6.1.5.5 Monitoring and Follow-Up.....	6-43
6.2 ECOLOGICAL ENVIRONMENT .....	6-45
6.2.1 Terrestrial Habitat.....	6-45
6.2.1.1 Boundaries and Threshold .....	6-45
6.2.1.2 Interactions and Potential Effects.....	6-47
6.2.1.3 Mitigation .....	6-48
6.2.1.4 Potential Residual Effects .....	6-49
6.2.1.5 Monitoring and Follow-up.....	6-49
6.2.2 Terrestrial Fauna .....	6-49
6.2.2.1 Boundaries and Threshold .....	6-51
6.2.2.2 Interactions and Potential Effects.....	6-53
6.2.2.3 Mitigation .....	6-55
6.2.2.4 Potential Residual Effects .....	6-56

6.2.2.5	Monitoring and Follow-up.....	6-56
6.2.3	Freshwater Fish and Fish Habitat .....	6-57
6.2.3.1	Boundaries and Threshold .....	6-57
6.2.3.2	Interactions and Potential Effects.....	6-60
6.2.3.3	Mitigation .....	6-62
6.2.3.4	Potential Residual Effects .....	6-62
6.2.3.5	Monitoring and Follow-up.....	6-62
6.2.4	Species at Risk .....	6-64
6.2.4.1	Boundaries and Thresholds .....	6-64
6.2.4.2	Interactions and Potential Effects.....	6-66
6.2.4.3	Mitigation .....	6-68
6.2.4.4	Potential Residual Effects .....	6-69
6.2.4.5	Monitoring and Follow Up.....	6-69
6.3	ECOLOGICAL ENVIRONMENT: MARINE .....	6-71
6.4	SOCIO-ECONOMIC ENVIRONMENT .....	6-71
6.4.1	Key Settlements, Land Use, Community Services and Infrastructure.....	6-74
6.4.1.1	Boundaries and Threshold .....	6-74
6.4.1.2	Interactions and Potential Effects.....	6-75
6.4.1.3	Mitigation .....	6-77
6.4.1.4	Potential Residual Effects .....	6-77
6.4.1.5	Monitoring and Follow-Up.....	6-78
6.4.2	Economic Development .....	6-78
6.4.2.1	Boundaries and Threshold .....	6-78
6.4.2.2	Interactions and Potential Effects.....	6-79
6.4.2.3	Mitigation .....	6-80
6.4.2.4	Potential Residual Effects .....	6-80
6.4.2.5	Monitoring and Follow-Up.....	6-80
6.4.3	Marine Navigation .....	6-80
6.4.3.1	Boundaries and Threshold .....	6-80
6.4.3.2	Interactions and Potential Effects.....	6-83
6.4.3.3	Mitigation .....	6-83
6.4.3.4	Potential Residual Effects .....	6-84
6.4.3.5	Monitoring and Follow-Up.....	6-84
6.4.4	Fisheries, Aquaculture and Marine Harvesting.....	6-84
6.4.4.1	Boundaries and Threshold .....	6-84
6.4.4.2	Interactions and Potential Effects.....	6-85
6.4.4.3	Mitigation .....	6-86
6.4.4.4	Potential Residual Effects .....	6-87
6.4.4.5	Monitoring and Follow-Up.....	6-87
6.4.5	First Nations Land and Resource Use .....	6-87
6.4.5.1	Boundaries and Threshold .....	6-87
6.4.5.2	Interactions and Potential Effects.....	6-88
6.4.5.3	Mitigation .....	6-88
6.4.5.4	Potential Residual Effects .....	6-88
6.4.5.5	Monitoring and Follow-Up.....	6-89

6.4.6	Archaeology .....	6-89
6.4.6.1	Boundaries and Threshold .....	6-89
6.4.6.2	Interactions and Potential Effects.....	6-89
6.4.6.3	Mitigation .....	6-89
6.4.6.4	Potential Residual Effects .....	6-89
6.4.6.5	Monitoring and Follow-up.....	6-90
6.5	CUMULATIVE EFFECTS.....	6-90
6.5.1	Cumulative Interactions and Potential Effects on VECs .....	6-90
6.6	EFFECTS OF THE ENVIRONMENT ON THE PROJECT .....	6-98
6.6.1	Extreme Weather .....	6-98
6.6.2	Sea Ice .....	6-99
6.6.3	Climate Change and Sea Level Rise .....	6-99
6.6.4	Seismic Activity.....	6-100
6.6.5	Security .....	6-100
<b>7</b>	<b>SUMMARY AND CONCLUSIONS.....</b>	<b>7-1</b>
<b>8</b>	<b>REFERENCES.....</b>	<b>8-3</b>
8.1	ACTS, STANDARDS AND REGULATIONS.....	8-3
8.2	REFERENCES .....	8-4
8.3	PERSONAL COMMUNICATIONS .....	8-15

## List of Tables

Table 1-1:	Key Elements of the Bear Head LNG Import vs. Export Facilities .....	1-9
Table 1-2:	Pertinent Canadian Federal Legislation .....	1-11
Table 1-3:	Pertinent Nova Scotian Provincial Legislation.....	1-12
Table 1-4:	Existing Authorizations.....	1-14
Table 1-5:	Concordance with Environmental Assessment Regulations made under Section 49 of the <i>Environment Act</i> .....	1-18
Table 2-1:	Overview of Bear Head LNG Project .....	2-4
Table 2-2:	Average feed gas composition .....	2-10
Table 2-3:	Example Dimensions of LNG Vessels .....	2-15
Table 2-4:	Routine Project Emissions/Effluents.....	2-16
Table 2-5:	Anticipated Hazardous Materials Present at the Plant.....	2-21
Table 2-6:	Anticipated Economic Impacts Resulting from Construction of Bear Head LNG.....	2-34
Table 2-7:	Comparison of Amine Systems for the Chemical Absorption of Acid Gases.....	2-39
Table 2-8:	Other Methods Available for Acid Gas Removal.....	2-40
Table 2-9:	Cooling Methods Comparison .....	2-42
Table 3-1:	Stakeholder Organization Meetings .....	3-3
Table 3-2:	Comments Received During Public Consultation .....	3-5
Table 3-3:	Engagement with First Nations .....	3-7
Table 4-1:	Physical Observations and Water Quality Measurements at the Bear Head LNG Site, Point Tupper, Nova Scotia (2014) .....	4-5
Table 4-2:	Mean Monthly and Annual Site Runoff (mm) .....	4-7



Table 4-3: Annual Average Climate Data .....	4-9
Table 4-4: Monthly Average Relative Humidity .....	4-10
Table 4-5: Annual Average Precipitation Data .....	4-10
Table 4-6: Summary of Ambient Air Quality Monitoring Results in Port Hawkesbury.....	4-13
Table 4-7: Summary of Industrial Atmospheric Emissions in the Study Area.....	4-14
Table 4-8: Ambient Sound Levels at the LNG Project Site, October 1, 2014.....	4-14
Table 4-9: Ambient Sound Levels at Residential Monitoring Sites, October 1–2, 2014 .....	4-14
Table 4-10: Yearly Extreme Hsig and Wind Speed, at AES40 grid point 5294 (Scotian Shelf, 45 N; 60 50' W). 4-25	
Table 4-11: Seasonal Extreme Hsig and Wind Speed – 3 Month Running Period Centered on Each Month, at AES40 grid point 5394 (Scotian Shelf, 45 N; 60 50' W) <sup>2</sup> .....	4-25
Table 4-12: Extreme wave and wind statistics for Bear Head LNG Terminal Site .....	4-26
Table 4-13: Species Identified in Wetlands through Field Survey in 2004 (JWEL, 2004a).....	4-29
Table 4-14: Present Status of Wetlands through Field Survey in May 2014. ....	4-30
Table 4-15: Mammals Recorded at or near Bear Head site (JWEL, 2004a) .....	4-35
Table 4-16: Reptiles and Amphibians Found at Bear Head site (JWEL, 2004a).....	4-36
Table 4-17: Terrestrial Rare Species List.....	4-41
Table 4-18: Characteristics of Federally listed marine & estuarine fish species at risk.....	4-42
Table 4-19: Sediment Quality at Bear Head and Strait of Canso, 2003.....	4-45
Table 4-20: Monthly Distribution of Fish and Invertebrate Larvae by Species on the Scotian Shelf, From the Scotian Shelf Ichthyoplankton Program (SSIP), 1978-1982.....	4-48
Table 4-21: Fish Species Observed in Strait of Canso, Inhabitants Bay, Chedabucto Bay Area.....	4-51
Table 4-22: Common and important benthic invertebrate species in Strait of Canso, Inhabitants Bay, Chedabucto Bay Area .....	4-53
Table 4-23: Characteristics of Cetacean (dolphins, whales and porpoises) and Seal Species occurring in Eastern Canadian Waters.....	4-61
Table 4-24: Characteristics of sea turtles occurring in Eastern Canadian Waters occurring in Eastern Canadian Waters.....	4-63
Table 4-25: Health Services for the Point Tupper and Port Hawkesbury Area .....	4-67
Table 4-26: Summary of Nearby Hospitals.....	4-67
Table 4-27: Seasonal Variation in Average Daily Volumes.....	4-69
Table 4-28: Description of Industrial Park Road and Bear Island Road.....	4-70
Table 4-29: Allowable Weights and Dimensions.....	4-71
Table 4-30: Collision History at Reeves Street Intersection 1998 to 2002 .....	4-71
Table 4-31: Division of Labour in Richmond and Inverness Counties .....	4-73
Table 4-32: Number of Vessel Movements in Strait of Canso Area 2014.....	4-74
Table 4-33: Particulars of Bear Head LNG Vessels .....	4-75
Table 4-34: Catch (metric tonnes) and Value (\$'000) within Unit Area 4Wd .....	4-78
Table 4-35: Landings (metric tonnes) and Value (\$'000) for Statistical Districts 9, 14 and 15.....	4-79
Table 4-36: Landings (metric tonnes) and Value (\$'000) by Species and Species Group for Districts 9, 14 and 15 .....	4-82
Table 4-37: Number of Licensed Fishing Vessels Registered with Statistical District 9, 14 and 15 by Size Class .....	4-90
Table 4-38: Fishing Effort by Month and Major Species for Management Area 4Wd .....	4-91
Table 4-39: Major Aquaculture Sites in Chedabucto Bay, Nova Scotia.....	4-92
Table 5-1: Potential VECs and Socio-economic Issues.....	5-5
Table 5-2: Valued Environmental Components (VECs) Selection Process.....	5-5

Table 5-3: Project Interactions with Valued Environmental Components (VECs) During Construction and Commissioning .....	5-10
Table 5-4: Project Interactions with Valued Environmental Components (VECs) During Operations .....	5-11
Table 5-5: Project Interactions with Valued Environmental Components (VECs) During Malfunctions, Accidental Events, and Decommissioning .....	5-12
Table 6-1: Potential Environmental Effects Assessment Matrix for Groundwater .....	6-7
Table 6-2: CCME Guidelines for the Protection of Aquatic Life.....	6-9
Table 6-3: Surface Water Environmental Effects Assessment Matrix .....	6-14
Table 6-4: Baseline greenhouse gas emissions for the 3-year construction phase of proposed Project. ....	6-17
Table 6-5: Baseline annual greenhouse gas emissions for operations phase of Proposed Project.....	6-18
Table 6-6: Regional and national GHG emission inventories for 2012, compared to proposed Project annual operation GHG emissions.....	6-19
Table 6-7: Potential Environmental Effects Assessment Matrix for Climate .....	6-23
Table 6-8: Nova Scotia Air Quality Standards .....	6-24
Table 6-9: Canadian Ambient Air Quality Standards.....	6-24
Table 6-10: Comparison of Project’s Emissions with NO <sub>x</sub> Air Emissions Limits.....	6-25
Table 6-11: Estimated Annual Emissions – Proposed Natural Gas Liquefaction Plant (Tonnes/Year).....	6-27
Table 6-12: Summary of Industrial Atmospheric Emissions in the Study Area (2013) .....	6-28
Table 6-13: Maximum Predicted Concentrations in Ambient Air for the LNG Plant, including LNG Vessel Hotelling and Background Concentrations at Normal Operation.....	6-30
Table 6-14: Maximum Predicted Concentrations in Ambient Air for the LNG Plant with Flaring, including LNG Vessel Hotelling and Background Concentrations at Normal Operation.....	6-31
Table 6-15: Potential Environmental Effects Assessment Matrix for Air Quality .....	6-34
Table 6-16: Health Canada Approach to Noise Assessment .....	6-38
Table 6-17: LNG Facility Construction Sound Levels at Off-Site Receptors.....	6-40
Table 6-18: LNG Facility Operation Sound Levels at Site Boundary and Off-Site Receptors.....	6-42
Table 6-19: Potential Environmental Effects Assessment Matrix for the Acoustic Environment.....	6-44
Table 6-20: Potential Environmental Effects Assessment Matrix for Terrestrial Habitat .....	6-50
Table 6-21: Potential Environmental Effects Assessment Matrix for Terrestrial Fauna .....	6-58
Table 6-22: Potential Environmental Effects Assessment Matrix for Freshwater Fish and Fish Habitat .....	6-63
Table 6-23: Potential Environmental Effects Assessment Matrix for Species at Risk .....	6-70
Table 6-24: Potential Environmental Effects Assessment Matrix for Marine Habitat .....	6-72
Table 6-25: Potential Environmental Effects Assessment Matrix for Marine Life .....	6-73
Table 6-26: Roles of Marine Authorities Within the Strait of Canso .....	6-82

## List of Figures

Figure 1-1: Bear Head LNG Project Location .....	1-3
Figure 1-2: Aerial Photograph of the Site.....	1-4
Figure 1-3: Aerial Photograph of the Project Area .....	1-5
Figure 1-4: Process Flow Diagram Comparison of LNG Import and LNG Export Facilities.....	1-7
Figure 1-5: Site Boundaries and Project Footprint.....	1-8
Figure 2-1: Proposed Project Site Layout.....	2-2
Figure 2-2: Proposed Project Site Layout (3D) .....	2-3
Figure 2-3: Project Schedule .....	2-7
Figure 2-4: Simplified OSMR <sup>®</sup> Schematic for the Bear Head LNG Project.....	2-8
Figure 2-5: Waste Heat Recovery and Steam Plant Schematic .....	2-13
Figure 2-6: LNG Liquefaction Processes.....	2-43
Figure 2-7: Simplified Cascade Process Diagram .....	2-44
Figure 2-8: Schematic Diagram of a Single Mixed Refrigerant Process .....	2-45
Figure 2-9: Schematic Diagram of a Propane Mixed Refrigerant Process .....	2-46
Figure 2-10: Relative Efficiencies of the Refrigeration Circuits.....	2-48
Figure 4-1: Geology of the Surrounding Region.....	4-3
Figure 4-2: Surface Water and Ground Water Features.....	4-6
Figure 4-3: Meteorological Monitoring Stations.....	4-8
Figure 4-4: Windrose Plot for Eddy Point (JWEL, 2004a) .....	4-11
Figure 4-5: Noise Monitoring Stations.....	4-15
Figure 4-6: Bathymetry and coastal features of the study area (JWEL, 2004a) .....	4-18
Figure 4-7: Winter wind rose (wind speed, direction, and frequency) from Eddy Point (JWEL 2004a) .....	4-20
Figure 4-8: Spring wind rose (wind speed, direction, and frequency) from Eddy Point (JWEL, 2004a).....	4-21
Figure 4-9: Summer wind rose (wind speed, direction, and frequency) from Eddy Point (JWEL, 2004a).....	4-22
Figure 4-10: Summer wind rose (wind speed, direction, and frequency) from Eddy Point (JWEL, 2004a) ...	4-23
Figure 4-11: Annual wind rose (wind speed, direction, and frequency) from Eddy Point and the MSC50 wind & wave hindcast dataset (CBCL, 2015).....	4-24
Figure 4-12: Annual significant wave height probability and direction, AES40 grid point 5394 (Scotian Shelf, 45 N; 60 50' W) (Source: JWEL, 2004a).....	4-26
Figure 4-13: Sample modelled extreme waves (significant wave height) for Chedabucto Bay and terminal location based on MSC50 dataset and MIKE21 model calibrated with current meter observations from the terminal site (Source: CBCL 2015) .....	4-27
Figure 4-14: Wetlands and Sensitive Terrestrial Species.....	4-32
Figure 4-15: Stream A west of the project footprint, December 22, 2014.....	4-33
Figure 4-16: Stream B east of the project footprint, May 8, 2014.....	4-34
Figure 4-17: Benthic Habitat Survey (JWEL, 2004a).....	4-47
Figure 4-18: View of beach and upper intertidal at jetty location, May 2014. Drainage ditch for site runoff management is in the foreground.....	4-50
Figure 4-19: Seabirds Colonies .....	4-56
Figure 4-20: Coastal Waterfowl .....	4-58
Figure 4-21: Generalized Whale and Dolphin Concentrations and Migration patterns.....	4-60
Figure 4-22: Development Features.....	4-65
Figure 4-23: Marine Navigation .....	4-77
Figure 4-24: Groundfish Catches (2010-2013).....	4-81
Figure 4-25: Pelagic and Estuarine Catches (2010-2013).....	4-84
Figure 4-26: Location of Bluefin Tuna Catches from logbook records, 2000-2009* .....	4-85

Figure 4-27: Shellfish Catches (2010-2013) .....	4-86
Figure 4-28: Lobster Fishing Areas and Sampling Areas for Research Studies (Tremblay et al. 2012).....	4-87
Figure 4-29: Fishing Effort (Number of traps hauls per 1 minute grid) for Snow Crab from Logbooks in 2013. 4-88	
Figure 4-30: Annual Effort ('000 hours) Fishing for Shrimp in 2012 .....	4-89
Figure 4-31: Aquaculture Leases .....	4-93
Figure 4-32: Archaeological Sites .....	4-95
Figure 5-1: The Environmental Assessment Process .....	5-3

## Appendices

- A: Updated Permitting Documentation
- B: Technological Risk Assessment
- C: Metocean Study
- D: Flora and Fauna Data
- E: ACCDC Data Report
- F: Archaeological Assessment
- G: Air Quality Assessment
- H: Noise Assessment
- I: Mi'kmaq Ecological Knowledge Study

## LIST OF ACRONYMS

AADT	Annual Average Daily Traffic
ACCDC	Atlantic Canada Conservation Data Centre
ASME	American Society of Mechanical Engineers
BACT	Best Available Control Technologies
BOG	Boil off Gas
C <sub>2</sub> H <sub>6</sub>	Ethane
C <sub>3</sub> H <sub>8</sub>	Propane
CAAQS	Canadian Ambient Air Quality Standards
CCG	Canadian Coast Guard
CCGT	Combined Cycle Gas Turbines
CCME	Canadian Council of Ministers of the Environment
CCTV	Closed Circuit Television
CEAA	<i>Canadian Environmental Assessment Act</i>
CEPA	<i>Canada Environment Protection Act</i>
CH <sub>4</sub>	Methane
CHB	Community Health Boards
CIP	Calling in Point
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO <sub>2</sub>	Carbon Dioxide
COS	Carbonyl Sulphide
COSEWIC	Canadian Committee on the Status of Endangered Wildlife in Canada
CS <sub>2</sub>	Carbon Disulphide
CSA	Canadian Standards Association
DFO	Fisheries and Oceans Canada
DIM	Direct Inspection and Maintenance
DMR	Duel Mixed Refrigerant
ECREG	Eastern Canada Vessel Traffic Services Zone Requirements
EMO	Emergency Management Office
EMP	Environmental Management Plan
ENGO	Environmental Non-Governmental Organizations
EPA	Environmental Protection Agency
EPP	Environmental Protection Plan
ESA	Environmental Site Assessment
FEED	Front End Engineering Design
FWAL	Freshwater Aquatic Life
GASHA	Guysborough Antigonish Strait Health Authority
GHG	Green House Gas
GWP	Global Warming Potential
H <sub>2</sub> S	Hydrogen Sulfur
Ha	Hectare
HSE	Health, safety and Environment
ISO	International Standards Organizations

ISQG	Interim Sediment Quality Guidelines
IUCN	International Union for the Conservation & Nature
KMKNO	Kwilmu'kw Maw-klusaqn Negotiation Office
KO	Knockout
LDAR	Leak Detection and Repair
LFL	Lower Flammability Limit
LNG	Liquefied Natural Gas
LNGL	Liquefied Natural Gas Limited
M <sup>3</sup>	Cubic Meters
MBBA	Maritime Breeding Birds Atlas
MCTS	Marine Communications and Traffic Services
MDEA	Methyldiethanolamine
MEKS	Mi'kmaq Ecological Knowledge Study
MFC	Mixed Fluid Cascade
MOU	Memorandum of Understanding
MR	Mixed refrigerant
MSDS	Material Safety Data Sheet
MTPA	Million Tonnes Per Annum
MW	Mega Watt
N	Nitrogen
NAPS	National Air Surveillance Program
NEB	National Energy Board
NFPA	National Fire Protection Association
Ni	Nickel
N <sub>2</sub> O	Nitrous Oxide
NO <sub>2</sub>	Nitrogen Dioxide
NPA	<i>Navigation Protection Act</i>
NPIR	National Pollutant Release Inventory
NS	Nova Scotia
NSBI	Nova Scotia Business Inc.
NSCC	Nova Scotia Community College
NSDNR	Nova Scotia Department of Natural resources
NSE	Nova Scotia Environment
NSPI	Nova Scotia Power Inc.
NSTIR	Nova Scotia Transportation and Infrastructure Renewal
NSUARB	Nova Scotia Utilities and Review Board
NTU	Nephelometric Turbidity Units
O <sub>3</sub>	Ozone
OCIMF	Oil Companies International Marine Forum
OSMR <sup>®</sup>	Optimized Single Mixed Refrigerant
OTSG	Once Through Steam Generators
PCB	Polychlorinated Biphenyl
PIRI	Partners in RBCA Implementation
PLC	Programmable Logic Controller
PM	Particulate Matter

PM <sub>2.5</sub>	Fine Particulates
POL	Petroleum, Oil and Lubricants
RBCA	Risk Based Corrective Action
RBSL	Risk Based Screening Level
SAR	Species at Risk
SARA	<i>Species at Risk Act</i>
SCGT	Single Cycle Gas Turbine
SIGTTO	Society of International Gas Tanker and Terminal Operators
SIS	Safety Instrument System
SMR	Single Mixed Refrigerant
SO <sub>x</sub>	Sulphur Oxide
SO <sub>2</sub>	Sulphur Dioxide
SOLAS	International Convention for Safety of Life at Sea
SSIP	Scotian Shelf Ichthyoplankton Program
TDC	Transportation Development Centre
TRC	Technical Review Committee
TSS	Total Suspended Solids
VEC	Valued Ecosystem Component
VOCs	Volatile Organic Compound
VTS	Vessel Traffic Services
WHMIS	Workplace Hazardous Materials Information System
WHR	Waste Heat Recovery